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Indian Prosthodontic Society (IPS) was officially formed in the year 1973. IPS was in fact formed way before the European Prosthodontic Society came into existence. The aim of starting IPS was most importantly to promote the study and practice of Prosthodontics and educate the Indian Public about the importance of Prosthodontics and Oral rehabilitation. The objective of the society was to create a platform for exchange of information on the methods of practice of Prosthodontics, facilitating the improvements and advancements in the techniques practiced in Prosthodontics, amongst practitioners in Inda as well as abroad. Keeping this objective in view IPS started The Journal of Indian Prosthodontic Society which is an amalgamation of literature related to the art and science of Prosthodontics.

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The Journal of Indian Prosthodontic Society is the official publication of The Indian Prosthodontic Society. Published quarterly, this journal serves as a platform for the exchange of interesting case reports, scientific studies, literature reviews and valuable tips for the common benefit of the prosthodontic community. The journal also aims to bring evidence - based dentistry to the forefront and highlight its importance.

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## CONTENTS

**ORIGINAL ARTICLES**

ORIGINAL ARTICLE

# An In Vitro Study For Comparison of The Load At Failure of Soldered And Non-soldered Porcelain-fused-to-Nickel Chromium (ni-cr) Base Metal Crowns

Dr. Praveen Vasant Badwaik, Dr. Pronob Kumar Sanyal, Dr. Guruprasad Handal, Dr. Manisha Kulkarni

**Abstract**: Although soldering is a common laboratory procedure, the use of Ni-Cr soldering alloys could affect the porcelain-to-metal failure load & possibly compromise the longevity of porcelain-fused-to-Ni-Cr Base Metal crowns. The purpose of study was to assess the influence of soldering on porcelain failure load between Ni-Cr base metal & porcelain, using crown shaped specimens & also to evaluate the mode of failure between the alloy-ceramic interfaces with the help of Scanning Electron Microscope (SEM). Fifty crown patterns were fabricated on die of premolar analogue & cast with Ni-Cr base metal alloy, which were equally divided in soldered & non-soldered groups. A 2-mm diameter perforation was produced on buccal surface & was repaired with high fusing Ni-Cr ceramic solder (Wiron-Lot) material. All castings were finished with air abrasion, 2 layers each of opaque & dentin porcelain were applied on all specimens. The bond strength was tested by application of vertical compressive load with a universal testing machine at a crosshead speed of 0.5-mm/min by use of a custom made loading jig which contacted only the buccal cusp. Load at failure of each crown were recorded in both groups & compared by use of a t test. Visual examination was done to see mode of failure of porcelain fused to metal (PFM) specimen. One representative PFM sample from both the groups were taken for scanning electron microscopic (SEM) examination of the fractured surfaces of the specimen. A voltage of 25 kV, a current of 1.05mA, a working distance of 39 mm and a collection time of 100 seconds were used. The surfaces were thoroughly scanned and photomicrographs were taken & interpreted according to the failure pattern.

Mean failure load for nonsoldered crowns was 117.413 ± 32.974. kgf and that for soldered crown was 125.643 ± 32.847 kgf. On visual examination the most failures occurred partly in ceramic and partly in metal. Visual examination of the fractured specimens showed a smooth surface starting from tip of the buccal cusps towards the margin. All the fractured specimens of the control and test groups were similar and consistent and did not allow a definitive assessment of porcelain failure mode (cohesive or adhesive). Examination with SEM revealed a similar pattern of porcelain adherence to both control and test samples. The photomicrograph indicated that the porcelain was not in contact with the metal after load application.

The result meant that statistically no significant difference was found among the control (nonsoldered) and test (soldered) groups. ($p > 0.05$). Within the limitations of this study, it was concluded that the application of Ni-Cr solder material does not decrease

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the overall metal-porcelain bond strength. Examination with SEM revealed a similar pattern of porcelain adherence to both control and test copings. Porcelain failures occurred in a mixed mode, with areas of adhesive failure between the metal & metal oxide and areas of cohesive fracture in the porcelain.

**Keywords :** Soldering, Porcelain fused to metal restorations, Porcelain fracture.

## Introduction

Porcelain-fused-to-metal (PFM) restorations are currently popular in restorative dentistry. They combine the natural esthetics of a brittle material such as porcelain, with the durability and marginal fit of a metal casting. Most casting and soldering techniques used in dentistry were developed specifically for dental gold alloys. The newer base metal alloys [nickel chromium (Ni-Cr)] have higher melting ranges and other characteristics that differ from those of gold alloys. Because of cost and continued improvement, base metal alloys are becoming more acceptable to the dental profession. These Nickel-Chromium (Ni-Cr) alloys allows the possibility of one piece castings and of soldering before (presoldering) or after (postsoldering) the application of ceramic to the metal structure.

In fixed prosthodontics, soldering is a procedure usually performed to connect retainers or pontics in fixed partial denture, add proximal contact, repair casting voids, breaking solder joints and preveneer or postveneer metal ceramic alloy soldering[1], [2]. Technically, soldering is performed at temperature below 425°C and brazing at temperatures above 425°C. In dentistry, the latter procedure is commonly called soldering[3]. The heat source which is commonly used is a gas-air or gas-oxygen torch. The gases which can be used for soldering are hydrogen gas, natural gas, propane and acetylene gas[4]. The main concerns regarding base metal alloys used in metal ceramic restoration are the long term effects on the health of the oral tissues and the ability of the restoration to withstand the stresses incurred in the oral cavity[5].

A major obstacle in achieving consistent & predictable porcelain-to-metal bonding with base metal alloys is the difficulty of controlling the oxide layer that forms on the surface of the metal coping at elevated temperatures [6]. In porcelain fused to metal (PFM) restorations, metal ceramic bonding is obtained through (1) a chemical bond between metallic oxides and porcelain, (2) mechanical interlocking and (3) van der Waals forces. Chemical bonds which plays a major role in the overall adherence between metal and porcelain. are promoted by the continuity of an electron structure across the metal-metal oxide interface and the metal oxideporcelain interface through metallic, ionic and covalent bonds. Reactive oxides form in the most superficial layer of casting and chemically bond to the porcelain[7].

The influence of the high fusing white ceramic solder material to noble alloy (Pd-Ga) has been mentioned in the literature[8], [9] but the influence of Ni-Cr solder has not been investigated. A survey of crown and fixed partial denture failures by Walton et al[10] indicated that the incidence of porcelain failure is the second most common causes of PFM prosthesis replacement. Therefore it is highly desirable that the addition of solder material in Ni-Cr copings does not compromise the metalporcelain bond strength and longevity of the restorations.

## Material and Methods

Fifty copings were fabricated over master die which was machined in stainless steel, reproducing shape and dimensions of a maxillary premolar analogue with 6-degree taper of axial walls using a milling machine. The stainless steel analogue was attached to a metal base having four reference notches over it. These notches were placed to ensure consistent repositioning of silicone molds used for fabricating wax patterns & also for ceramic build-up. The metal base on lower side was attached with a metal plate to ensure proper grip in the 'Instron testing machine'.

A wax-up was fabricated to the anatomy of a maxillary premolar. A polyvinylsiloxane (PVS) impression (Elite HD +, Zhermack, Italy), labelled PVS no.1, was made extending into the 4 reference notches (Fig.1). The wax pattern was cut back for 1.5-mm uniform thickness of porcelain on all surfaces. A

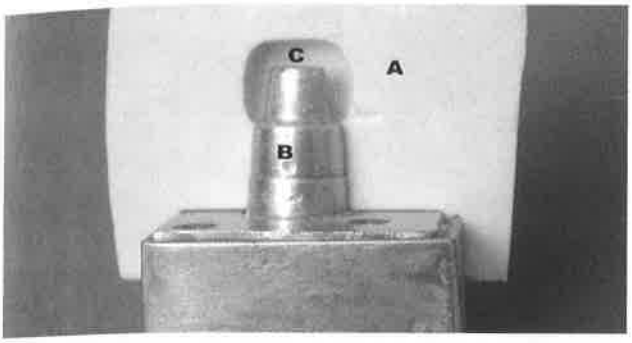


**Fig. 1. Proximal view showing (A) PVS no. 1, (B) metal die, (C) 2 mm space for PFM crown specimen**

second PVS impression (Elite HD +, Zhermack, Italy), labelled PVS No.2 was made as the previous impression. Both PVS matrixes were sectioned in half through the long axes to recover die & wax pattern. The original wax patterns were then disposed.

A single coat of die spacer (Colour spacer CS-1000, Heartman, India) was applied over the master die leaving 0.5-1 mm area near the margins. Die lubricant (Die lube wax sep, Dentecon Inc, USA) was applied over the master die and also on the impression surface of PVS no. 2 silicone mold. The molten wax (Ceradip, BEGO, Germany) was flown into mold space of PVS no. 2 silicone mold and correctly positioned over the master die, according to the four reference notches. The thickness of wax pattern was once more measured to ensure 0.5 mm thickness with Iwanson's wax gauge. In this way 50 wax patterns of 0.5 mm thickness were fabricated and attached with sprue wax (Renfert, Germany).

All patterns were invested using phosphate bonded investment (Deguvest GF Degussa Dental GmbH Germany), and cast in Ni-Cr base metal alloy (Heranium S; Heraeus Kulzer, GmbH, Germany) (Ni 62.5%, Cr 23.0%, Mo 10.0%, Si 2.0%, Fe 1.5%, Ce < 1.0). After being divested, all the copings were inspected & completely seated on metal die with the use of silicone disclosing medium (Fit Checker; GC Corp, Japan). The specimens were airborne-particle abraded with 50-µm aluminous oxide particles (Al2O3) (Koroxx, BEGO, Germany) at 75 psi. The cast specimens were divided into 2 groups of 25. For group A, which served as the control, 25 copings were left as cast.

For group B, the remaining 25 copings were marked with a marker showing 2 mm circle on buccal surface. This circular marking was consistently marked 1.5 mm apical to the junction between the occlusal and buccal surfaces as described by Kang et al. 9 The drill was positioned on the 2 mm circular marking and a perforation was made using a press stand drill (Capital Machine Tools, Delhi, India) having a 2 mm drill (HSS parallel shank drill, India). Platinum foil (Dead soft, 0.013mm thickness, Ivoclar Vivadent, NY) was adapted to the inner surface of the copings and soldering was performed according to protocol described by Shillingburg et al[2].

Samples were soldered by the same investigator who used a micro-tip gas-oxygen flame. The Ni-Cr soldering material (Wiron-Lot, BEGO, Germany) incorporated with flux was introduced onto the perforation and heated till the soldering material flowed into the perforation. After soldering, the metal flash was removed with tungsten carbide metal finishing burs (DFS, Germany) and observed under an optical microscope (Meiji Techno; America) at original magnification X 10 for complete fill of the perforation. The thickness of the soldered area was measured with the Iwanson's metal caliper and adjusted to 0.5 mm.

All the test and control group copings were finished with metal finishing burs (DFS, Germany) and airborne particle abraded with 50µm Al2O3 (Koroxx, BEGO, Germany). All the specimens of each group were steam cleaned & oxidized according to manufacturer's instructions (Touch and Press, Dentsply DeTrey GmbH, USA). Two layers of opaque & 2 layers of dentin porcelain (Ceramco 3, Dentsply DeTrey GmbH, USA) were applied on all copings for total porcelain thickness of 1.5 mm. Porcelain thickness was standardized by silicone mold PVS No.1 & condensed as described by Kang et al[9]. After ceramic firing, all the nonsoldered and soldered (group A and B respectively) porcelain-fused-to-metal crowns were checked for even thickness of 2.0 mm with Iwanson's metal caliper.

The specimens were placed on metal die & subjected to a vertical compressive load with a

universal testing machine (Instron testing machine, Model no. 4467, Instron Corp. Canton, Ma, UK) (Fig.2) at a crosshead speed of 0.5- mm/min by use of a custom made loading jig which contacted only the buccal cusp.

The loading jig consisted of a 10 mm diameter stainless steel shaft, on one end, which was made 8

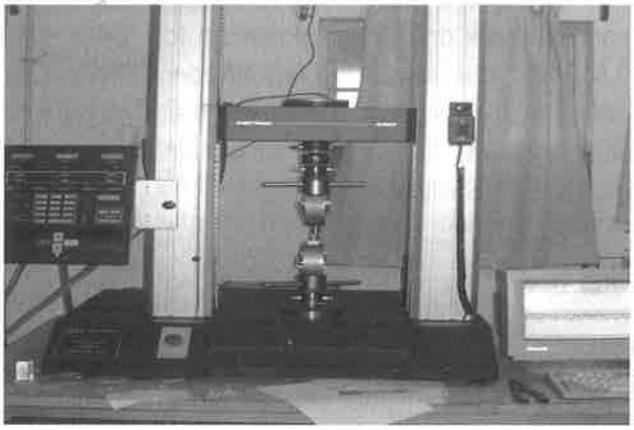

**Fig. 2. Instron testing machine used in this study**

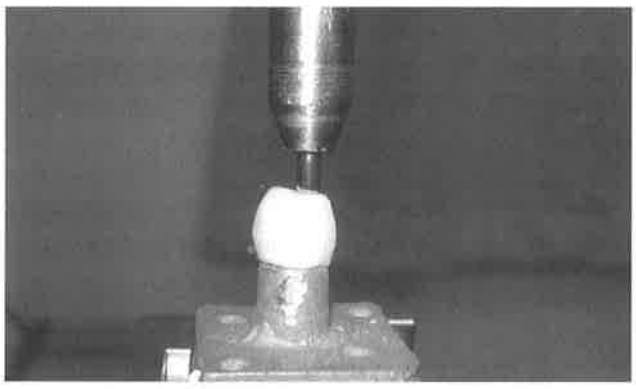

**Fig. 3. Carbon-steel pin (3 mm diameter) touching the buccal cusp**

mm in diameter to mount it to the upper member of testing machine. On the other end of shaft a tap was machined with 3mm drill using lathe machine (Capital Machine Tools, Delhi India) to house carbon-steel pins (3mm diameter, HSS parallel-shank Drill, India). Only this latter pin contacted the porcelain on the buccal cusp during testing (Fig.3). Loading of all, 25 control & 25 test specimens, was done with same method using a new carbon-steel pin as described by Kang et al [9]. Maximum values of load at failure were recorded for each specimen. Mean values for control and test groups were calculated & compared by use of a t test.

**Fig. 4. Scanning Electron Microscope**

Visual examination was done to see mode of failure of PFM crown in following three types whether it is totally in ceramic; partly in ceramic and partly in metal; or is totally in metal. One representative PFM sample from both the groups was taken for scanning electron microscope (Joel JXA-840A, JEOL Ltd., Tokyo, Japan) examination (SEM) of the fractured surfaces of the specimen to confirm the visual examination (Fig.4). The PFM crowns were mounted on brass stumps with conductive silver solution and allowed to dry completely. Since the porcelain is a bad conductor of electrons the test surfaces were coated with gold layer of 300 Ao [Angstrom] in an Ion-sputtering device (Fig.5). This was done to allow the conduction of electrons for proper visualization of the fractured surfaces. A voltage of 25 kV, a current of 1.05mA, a working distance of 39 mm and a collection time of 100 seconds were used. The surfaces were thoroughly scanned and photomicrographs were taken (Fig.6). Later these were interpreted according to failure pattern.

**Fig. 5. Gold Coating done over fractured PFM specimen**

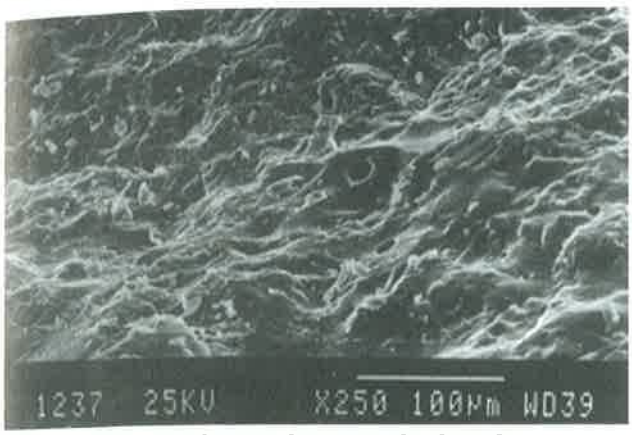


**Fig. 6. Photomicrograph showing hemispheric voids (Magnification X 250)**

## Results

With the help of data obtained, the comparison between two groups was done. Mean failure load for nonsoldered (control) crowns was 117.413 ± 32.974. kgf and that for soldered (test) crown was 125.643 ± 32.847 kgf. The greatest load at failure than the group mean was 192.51 kgf of sample no. 1 in the control group and 177.526 kgf of sample no. 25 in the test group(Table No. 1). In the entire 50 PFM crown testing there was no visible bending of loading pin. A sound, possibly caused initial porcelain fracture was heard before every specimen failure.

On visual examination the most failures occurred partly in ceramic and partly in metal. Failures totally in ceramic were less and failures totally in metal were rare. Visual examination of the fractured specimens showed a smooth surface starting from tip of the buccal cusps towards the margin. All the fractured specimens of the control and test groups were similar and consistent and did not allow a definitive assessment of porcelain failure mode {cohesive (of porcelain material itself) or adhesive (of the interface between metal and porcelain)}as stated by McLean in 1979 [9].

Examination with SEM revealed a similar pattern of porcelain adherence to both control and test samples. Under SEM the fractured surface of the porcelain is seen as white area and metal or metal oxide as dark or grey color. Depending on this shade, the mode of failure can be predicted. They mostly had areas of adhesive failure (no opaque porcelain) alternating with areas of cohesive failure (opaque porcelain present). The photomicrograph indicated that the porcelain was not in contact with the metal after firing. Consequently the use of Ni-Cr solder material for metal-ceramic restoration increases the probability of failure.

**TABLE No. I : Load at failure of soldered and non-soldered porcelain-fused-tometal crowns (in kgf).**

| Specimen no. | Nonsoldered crowns (Control) | Soldered crowns (Test) |
|---|---|---|
| 1 | 192.51 | 72.641 |
| 2 | 74.151 | 166.513 |
| 3 | 119.71 | 108.59 |
| 4 | 153.767 | 132.96 |
| 5 | 81.584 | 172.427 |
| 6 | 141.837 | 167.125 |
| 7 | 115.73 | 100.601 |
| 8 | 86.101 | 116.753 |
| 9 | 132.66 | 114.815 |
| 10 | 176.71 | 98.776 |
| 11 | 137.86 | 142.65 |
| 12 | 136.739 | 160.59 |
| 13 | 107.372 | 83.103 |
| 14 | 86.54 | 156.418 |
| 15 | 110.635 | 148.26 |
| 16 | 141.837 | 116.24 |
| 17 | 102.477 | 86.224 |
| 18 | 83.685 | 116.24 |
| 19 | 97.97 | 84.409 |
| 20 | 70.215 | 146.22 |
| 21 | 131.23 | 89.42 |
| 22 | 69.307 | 152.951 |
| 23 | 147.95 | 83.205 |
| 24 | 137.758 | 146.426 |
| 25 | 98.99 | 177.526 |

## Discussion

In fixed prosthodontics, the Ni-Cr base metal alloys are the alternative to the costly precious metal

as well as semiprecious alloys for PFM restorations. Porcelain adherence that is the bond strength between porcelain and metal is a complex property and is of fundamental importance in any PFM restoration[7]. It is essential that the addition of solder material do not compromise the mechanical properties and longevity of the PFM restoration, otherwise costly remakes may be necessary.

The single loading fracture test with crown shaped specimens was designed to better simulate the clinical situation and allow comparison with the previous study done by Kang et al[9]. The metal-ceramic bond strength of dental porcelain to Ni-Cr alloy was not influenced by the presence of solder material since no significant difference was found between the mean failure load for nonsoldered and soldered crowns. This suggests that addition of solder to the base metal (Ni-Cr) alloy does not affect the metal-ceramic bond strength which is similar to the results of the study by Nikellis et al[11]. However, the results of this study differs to that done by Kang et al [9] which compared load at failure of soldered & nonsoldered PFM crowns using Pd-Ga alloy. Thickness of 1.5-mm porcelain was standardized with a custom-made silicone mold for a final thickness of 1.3 to 1.5-mm. This was done according the specimens prepared by Kang et al[9].

According to the present study, the mean failure load for nonsoldered PFM crowns was 117.413 kgf ± 32.974 and that for soldered PFM crowns was 125.643 kgf ± 32.487. These values are greater than the average biting force. The data indicated that the compressive force needed to fracture the PFM crowns exceeded the reported maximum occlusal biting force of an individual[12], [13]. Therefore the porcelain should not fracture clinically, regardless of where the occluding contacts are placed. So, soldering with Ni-Cr solder will not compromise the longevity of PFM crowns, which was similar to the result suggested by Galindo et al [8].

The size of the perforation, 2-mm in diameter was selected to compare with the previous studies[8], [9]. It is unknown whether smaller or larger defects would have similar influence on the results and affects the metal-porcelain fracture strength. The mode of fracture was studied by examination of fractured PFM crowns by visual inspection and Scanning Electron Microscope (SEM). Most failures occurred partly in ceramic and partly in metal. The failure was characterized by a progressive separation of entire porcelain layer starting from the tip of buccal cusps towards the margin. Examination under SEM revealed a similar pattern of porcelain adherence to both control and test samples. They mostly had a mixed mode of failure, with areas of adhesive failure between the metal and metal oxide and areas of cohesive failure in porcelain. These mixed modes of failures in the present study were similar to those reported by Papazoglou et al[14], [15]. Porcelain failure type (cohesive or adhesive) was determined microscopically by examining the percentage of the metal surface covered with residual opaque porcelain. The frequency per unit area and average diameter of hemispheric voids increased for test group specimens. Large interfacial voids may act as 'stress concentrator[16] and can weaken the metal-ceramic restoration. Consequently, the use of solder material for PFM crowns increases the probability of failure; however the comparison of load at failure of test specimens showed no significant difference with that of the control group. This suggested acceptable bond strength of soldered PFM crowns. Moreover, this study was conducted on a 2mm perforation; further study is required with different defect sizes to investigate the critical defect size-threshold that affects the metal porcelain fracture strength.

This study being an 'in vitro' study, had limitations and results of this study should be cautiously correlated to a clinical situation, because of the loading and environmental differences with the oral cavity. However, this study provides new information about the influence of nickel chromium (Ni-Cr) solder material on porcelain failure strength.

## Conclusions

The load at failure of soldered and nonsoldered porcelain-fused-to-Ni-Cr base metal crowns was evaluated to investigate the influence of Ni-Cr solder material on metal-porcelain bond strength. The result

meant that statistically no significant difference was found among the control (nonsoldered) and test (soldered) groups. ($p > 0.05$). Within the limitations of this study, it was concluded that the application of Ni-Cr solder material does not decrease the overall metal-porcelain bond strength.

Examination with SEM revealed a similar pattern of porcelain adherence to both control and test copings. Porcelain failures occurred in a mixed mode, with areas of adhesive failure between the metal & metal oxide and areas of cohesive fracture in the porcelain.

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ORIGINAL ARTICLE

# Fabrication Technique of One Piece Hollow Maxillary Complete Denture

Dr. Amrit Tandan, Dr. Swati Gupta, Dr. Garima Agarwal, Dr. Hina Naim

**Abstract :** Dentures are designed to replace missing teeth, and are worn by the patient for considerable period of time. Technological advancements have resulted in dentures that are lightweight, mimic the look and feel of natural teeth.

Extreme resorption in one or both of the residual alveolar ridges accompanied by resilient maxillary denture bearing tissues in the edentulous patient presents a difficult restorative problem and may lead to problems with prosthetic rehabilitation.

This article highlights on a technique for the fabrication of a hollow maxillary complete denture and the use of a hollow maxillary complete denture in situation where there is excessive resorption of the maxillary residual alveolar ridge. This technique greatly reduces the weight of an exceptionally heavy maxillary denture. Whenever weight of a denture may be a contributing factor to the successful resolution of a patient's problem, the hollow denture should be considered.

**Key. words :** Dentures, Resorption, Lightweight, Hollow.

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PG student

## Introduction

Dentures are designed to replace missing teeth, and are worn by the patient for considerable period of time. Technological advancements have resulted in dentures that are lightweight and mimic the look and feel of natural teeth.

Extreme resorption in one or both of the residual alveolar ridges of the complete denture patient presents difficult restorative problems. Severe atrophic area may lead to problems with prosthetic rehabilitation. The advantage of a hollow maxillary or mandibular denture is the reduction of excessive weight of acrylic resin which normally replaces lost alveolar ridge in the interridge space of the denture wearer.

Historically, weight reduction approaches have been achieved using a solid 3 dimensional spacer, including dental stone,[1] cellophane wrapped asbestos,[2] silicone putty,[3,4] or modelling clay [5,6] during laboratory processing to exclude denture base material from the hollow cavity of the prosthesis.

Prosthetic rehabilitation of acquired maxillary defect with limited mouth opening and unfavorable undercuts in the defect was successfully treated by making a two piece hollow bulb obturator. The two pieces were connected by the use of magnets.[7]

Holt[3] processed a shim of acrylic resin over the residual ridge and used a spacer (Insta-mold; Nobilium, Albany, NY). The resin was indexed and the second half of the denture processed against the spacer and shim. The spacer was then removed and the 2 halves luted with autopolymerized acrylic resin using the indices to facilitate positioning. The primary disadvantage of such techniques is that the junction between the 2 previously polymerized portions of the

denture occurs at the borders of the denture. This is a long junction with an increased risk of seepage of fluid into the denture cavity. increasing the risk of leakage. Fattore et al[8] used a variation of a double flask technique for obturator fabrication[9] by adding heat polymerizing acrylic resin over the definitive cast and processing a minimal thickness of acrylic resin around the teeth using a different drag. Both portions of resin were then attached using heat-polymerized resin.

This article describes a technique for fabrication of one piece hollow maxillary complete denture.

**Technique**

1. Make a definitive impression of the maxillary residual ridge and fabricate the denture to the trial denture stage and seal the trial denture to the definitive cast.
2. Hollow denture is constructed using two split dental flasks. Denture is flasked and dewaxed. The flask is separated in the usual manner.
3. Place a wax shim (2mm thickness) to cover the maxillary denture teeth area (fig-1) and 2mm below the labial and buccal flange area & palataly it should cover only that area where excessive interridge space is present.
4. Apply the separating media over the plaster.
5. Place the top half of the second split flask over the wax shimmed lower half of the flask.(fig-1)
6. Pour the plaster into the flask through the open hole.
7. Dewax, and separate the flasks halves.
8. Apply separating media and pack with heat polymerising acrylic resin, process, and separate the flask.
9. Place orientation notches around the periphery.
10. Place silicone putty in the processed alveolar part of the denture (fig-2).
11. Apply petrolatum on the surface of silicone putty and the exposed edges of the processed alveolar part of the denture.
12. Make a shim of autopolymerizing acrylic resin on the silicone putty(fig-3).
13. After the polymerization, separate the silicone putty & autopolymerizing acrylic resin shim (fig-4).
14. Acrylic shim placed back over the processed alveolar part of the denture (fig-5).

**Figure 1 - Top Half of The Second Split Flask Over The Wax Shimmed**

**Figure 2 - Silicone Putty in the Processed Alveolar Part Of The Denture**

**Figure 3 - Shim of Autopolymerizing Acrylic Resin on the Silicone Putty**

**Figure 4 - Separate the Silicone Putty & Autopolymerizing Acrylic Resin Shim**

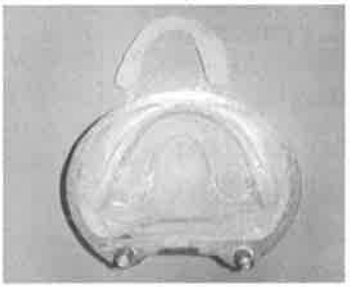

**Figure 5 - Acrylic Shim on the Processed Alveolar Part of the Denture**

**Figure 6 - Floating Maxillary Denture**

15. Pack with heatpolymerising acrylic resin over the acrylic resin shim.
16. After processing, separate the flask and a one-piece hollow maxillary denture is obtained.
17. Test the denture for a complete seal by immersing in water, the denture floats(fig-6).

## Discussion

Extreme resorption of the maxillary denture-bearing area may lead to problems with prosthetic rehabilitation. Leakage and difficulty in gauging resin thickness are problems inherent in previously described techniques.[1] The procedures described in this article overcome these problems. Heat polymerizing 1 portion of the denture against polymerized resin may reduce leakage at the junction of the 2 portions of the denture. Silicone putty is used as a spacer because of previously described advantages,[4] including its stability, its ability to be carved, and the fact that it does not adhere to acrylic resin. A severely atrophic maxilla poses a clinical challenge for the fabrication of successful complete denture prosthesis. This may be due to a narrower, more constricted residual ridge; decreased supporting tissues and a resultant large restorative inter ridge space. This may be applicable to situations where there is severe atrophy of the residual alveolar ridges and placement of implants is not a realistic option.

## Summary

The use of hollow denture in situations where there is excessive resorption of the residual alveolar ridge. This technique was described that one-piece hollow maxillary denture and greatly reduces the weight of an exceptionally heavy maxillary denture. When the weight of a denture is a contributing factor to the successful resolution of a patient's problem, the use of a hollow denture should be considered.

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ORIGINAL ARTICLE

# Comparitive Evaluation of Tensile Strength, Tear Resistance and Residual Monomer Content in Three Soft Denture Liners Before and after Thermocycling- An Invitro Study

Dr. Pulagam Mahesh, Dr. Srinivasa Rao P Rao, Dr. T. Pavan Kumar, Dr. Dhanalakshmi M

**Abstract :** This study evaluated the effect of thermocycling on tensile strength, tear resistance & residual monomer content of three soft denture liners (heat activated (Coe Soft), chemically activated (Super Soft) & light activated (Triad Dual Line). Dumbbell and trouser-leg specimens were used for tensile strength and tear resistance tests, square shaped specimens were prepared for evaluation of residual monomer content. A total of 180 specimens were prepared (60 for each test). Half of the Test specimens c in a thermocycler. Before thermocycling, light cure material gave the lowest tensile strength, while heat cure material exhibited low residual monomer content & highest tensile strength, tear resistance values among the materials tested. Thermocycling significantly affected the tear resistance of light cure material & residual monomer content of three soft denture liner materials. This invitro study revealed that tensile strength, tear resistance and residual monomer content of soft liner materials tested varied according to their chemical composition and degree of cross linking.

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**Keywords :** Tensile Strength, Tear Resistance, Residual Monomer, Soft Denture Liners , Thermocycling

## Introduction

The success of complete denture depends on the comfort and function for a significant period of time. The soft bearing mucosa is confined between the bone and hard denture base. Because of the soft friable nature of supporting mucosa, soreness is a continuous problem for denture wearing geriatric patients. In order to alleviate the possibility of discomfort arising from denture base, the clinical use of soft lining material was first reported by "Tylman" in 1943 and "Popper" in 1945. These liners act as shock absorbers to reduce & distribute the stresses on the denture bearing tissues because of their visco elastic properties[1]. Based on the composition two groups of soft denture liners available for regular use, Plasticized acrylics, and Silicone elastomers. And according to usage, soft liners are Temporary and Permanent, and most of these liners are available in auto polymerizing, heat polymerizing & light polymerizing forms. Soft denture liners are expected to function in the aqueous oral environment for longer periods of time under constantly oral changing temperatures [2].The thermal behaviour of the structural components with in a material will influence the mechanical & physical properties under cyclic temperature changes. Thermo cycling procedure is used in this study to simulate the oral environment and the temperature changes.

## Aims & Objectives

This study is conducted to evaluate & compare some of the mechanical properties and residual

monomer content of three commercially available soft denture liners before & after thermocycling.

The objectives of this study are,

1) To evaluate residual monomer content, tensile strength, and tear resistance in three different soft denture liners before and after thermo cycling.

2) To compare residual monomer content, tensile strength, and tear resistance in three different soft denture liners before and after thermo cycling.

**Materials and Methods**

This in vitro study is done to evaluate the tensile strength, tear resistance & the amount of residual monomer content in 48 hrs periods of time and to compare the same before and after 500 cycles of Thermo cycling in three different soft denture liners (Heat activated, Chemical activated, and Light activated). This study is undertaken at the Department of Prosthodontics, Narayana Dental College in collaboration with Central Research Laboratory, Narayana General Hospital, Nellore and Department of Mechanical Engineering, CIPET, Chennai.

Specimen Fabrication for Tensile Strength, and Tear Resistance evaluation; Two standard brass metal

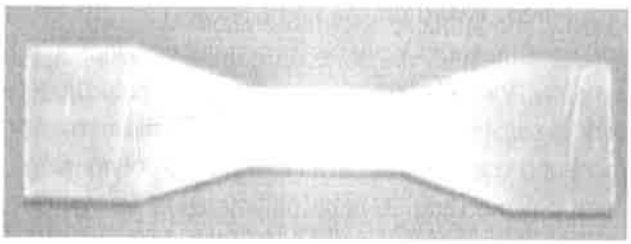


**Fig 1: Dumbbell Shaped Brass Metal Die**

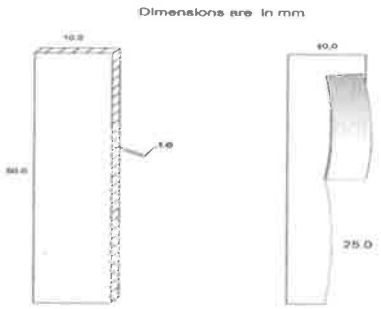



**Fig 2: Rectangular Shaped Brass Metal Die**

die was designed and fabricated for the preparation of test samples. A dumb-bell shaped brass die was milled according to ASTM standards with a measurement of 2mm thickness, 80mm length and 10mm width for testing the tensile strength and 50mm in length and 10mm in width for testing the tear resistance (fig.1 & 2). For the fabrication of soft liner samples, both the brass tools are invested in dental flasks by following the standard procedures to create the mould space. In to the mould space the heat activated and liner are mixed and packed and trial closures are done to remove the flash. The flasks are held at 1500 psi for 5-10 min. The liner is cured at 73oc for 30 min and slowly increases the temperature to 90oc in the next 30 min. 20 specimens are made in this way and are trimmed with fine abrasives and stored in distilled water (fig.3). For the chemical activated liners the mould is packed with the liner mix and held at 1500 psi for 10 min. 20 samples are made in this way and are trimmed with fine abrasives and stored in distilled water. A total number of 20 light cure specimens were fabricated by light activated procedure. Light cure material was injected into the mould space and flasks were closed. After 5min samples were removed and cured in BluLux

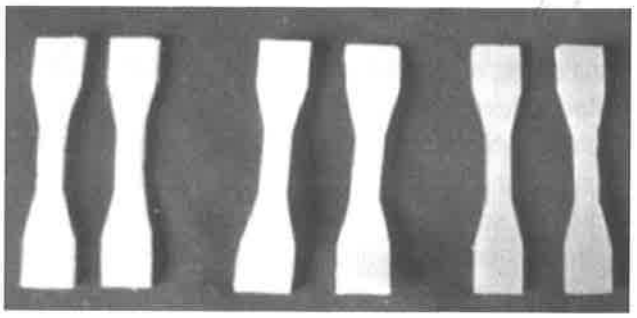


**Fig 3: Specimens Prepared For Evaluation of Tensile Strength & Tear Resistance [heat Cure, Self Cure & Light Cure]**

light curing unit for 12min according to manufacturer instructions. Then samples were recovered and excess flash was removed with fine abrasive. The specimens were stored in dispenser containing distilled water at room temperature.

**Specimens for Evaluation of Residual Monomer Content**

A Standardized mould (fig.4) was fabricated from carbon steel metal for the purpose of fabrication of

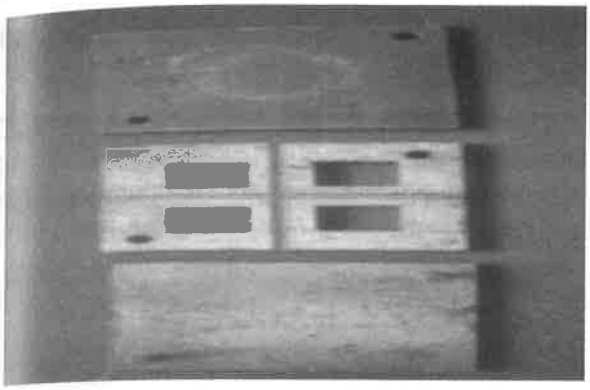


**Fig 4: Metal Mold**

putty indices. This mould consists of a base (43×43 mm) with guiding pins, a middle compartment consisting of mould spaces with guiding holes and covering lid with guiding holes. The mold spaces in middle compartment were milled precisely to produce four (10×10×3mm) square shaped spaces which are equidistant from each other. Putty [EXAFLEX PUTTY (GC AMERICA INC)] indices (60 numbers) prepared from the standard mould and invested with dental stone type III in Brass metal flask for fabrication of specimens for residual monomer evaluation. A total 20 each are made in the same way that was followed in the previous section to make heat, chemical and light activated soft liner samples.

**Thermocycling**

A total of 90 samples (30 dumb-bell shaped samples for tensile strength, 30 trouser leg samples for tear resistance, 30 samples for residual monomer evaluation) were subjected to thermocycling for 500 cycles between 5°c to 55°c with a 60-second dwell time in a thermocycler (fig.5) at Department of Zoology, Sri Lalitha Institute of Medical Sciences, Trivendrum. After that samples were removed, the specimens were allowed for evaluating tensile strength, tear resistance and residual monomer content and results were statistically analyzed. [table 1] A total no. of 180 specimens was prepared for tensile strength, tear resistance and residual monomer evaluation before and after thermocycling. Among these 60 specimens were fabricated with heat cure (Super - soft) material, 60 specimens were fabricated with self cure (Coe-soft) & 60 specimens were prepared with light cure (Dual Line).

**Fig 5: Thermocycler**

**Evaluation Of Tensile Strength**

A total number of 60 acrylic soft liner samples (30 specimens were control group, 30 specimens after 500 cycles of Thermocycling) were evaluated for Tensile strength through Universal Testing Machine (SHIMADZU), in Department of Mechanical Engineering, CIPET, Chennai (fig.6 & 7) at speed of 50 mm/min. Evaluation of tensile strength and percentage were measured automatically by the software (Trapezium2) using following equations.

**Fig 6: Universal Testing Machine**

**Fig 7: Specimens In Universal Testing Machine-Tensile Strength, Tear Resistance**

### Evaluation Of Tear Resistance

A total number of 60 acrylic soft liner samples (30 specimens were control group, 30 specimens after 500 cycles of Thermocycling) were evaluated for tear resistance through universal testing machine fitted with load cell. Specimens were tested at a constant cross head speed of 50 mm/min at a gauge length of 25mm, on failure of the specimen the computer software (Trapezium 2) automatically calculate the tear resistance by following equation.

Where,

$T_S$ = Tear Resistance (N/ mm)

F = The load at failure (N)

t = thickness of specimen (mm)

### VI. Evaluation of Residual Monomer Content

A total number of 60 specimens (30 specimens were control group, 30 specimens after 500 cycles of Thermocycling) were evaluated for Residual monomer content by using a Double Beam Spectrophotometer (fig.8) in Central Research Laboratory, Narayana General Hospital, Nellore. A spectrophotometer measures the amount of the light absorbed by a compound when it is subjected to the UV and visible spectrum. The principle behind the Double beam spectrophotometer is that when light pass through a liquid substance, some of light gets absorbed and by measuring this, the concentration of that liquid substance can be analyzed. The amount of absorption was depending on the concentration of that substance.

**Fig 8: Uv Double Beam Spectrophotometer**

### Residual monomer analysis of acrylic soft liner samples after 48 hrs period

Each specimen immediately after preparation, placed in screw capped containers consists of 20 ml of distilled water and stored at room temperature for 48 hrs. The solutions were transferred into the cuvets after

$$T_s = F/t$$

previously mentioned duration and they were subjected to double beam spectroscopy [fig 9] at 210 nm. The unknown amount of residual monomer leached into the distilled water was analyzed and values were compared with standard graph.

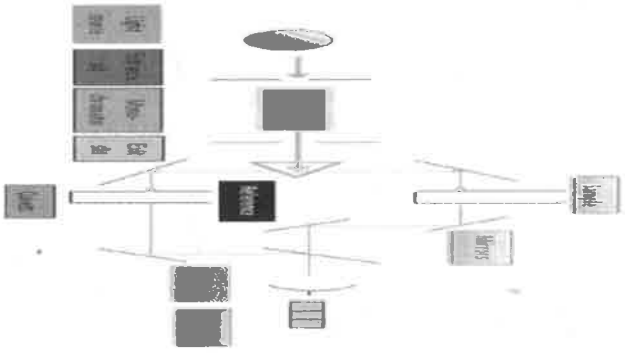


**Fig 9: Double Beam Spectrophotometer**

### Preparation of standard graph of methyl methacrylate in distilled water

A stock solution of 1 % v/v methyl methacrylate was prepared by dissolving 1 ml of methyl methacrylate in 99 ml of distilled water. From the above stock solution a series of concentrations are prepared between 0.03 % to 0.5% by diluting with distilled water. By using Double beam spectroscopy at 210 nm the absorbencies of these standard solutions were determined and a standard graph was plotted (fig.10) between concentration and absorbance.

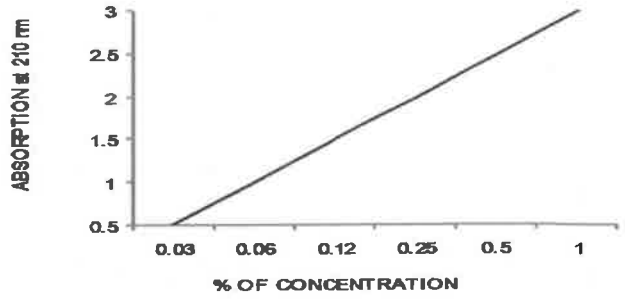



**Fig 10: Standard Graph Of Mma**

## Results

The measured values are tabulated and subjected to Statistical analysis by using one-way analysis of variance, ANOVA, by using Daniel soper statistical software. The "mean" standard deviation and 'p'values are obtained for the variables. In this present study $p<0.05$ is considered as level of significance.

Table 2 shows the mean and standard deviation values of the tensile strength of three soft denture liner specimens. Among all the specimens which has studied before thermocycling Heat Cure processed specimens had shown highest values of tensile strength (6.374) followed by Self Cure (2.014) and Light Cure (1.606). After thermocycling, the tensile strength values were decreased in Heat Cure (5.72) and Light Cure (0.994) but Self Cure specimens has shown slight increase in tensile strength (2.746) after thermocycling. The decrease in tensile strength of Light Cure specimens was statistically significant ($p<0.05$) where as in Heat Cure and Self Cure specimens it was not statistically significant ($p>0.05$) (graph -1)

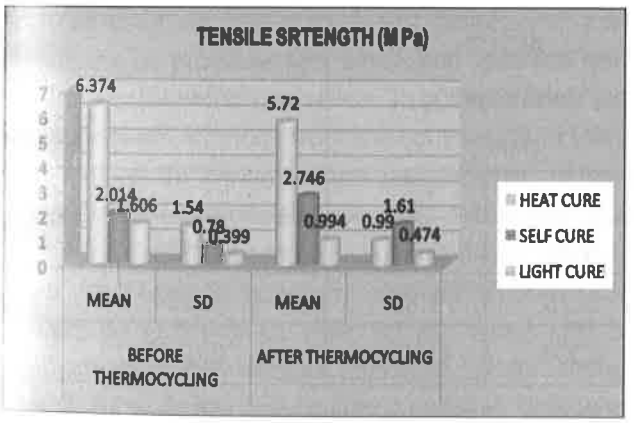
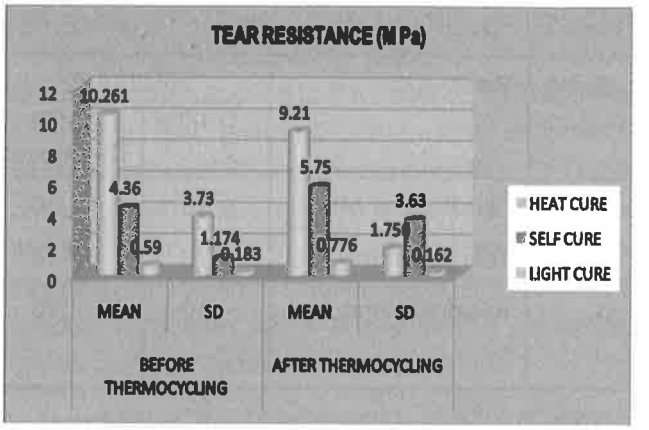
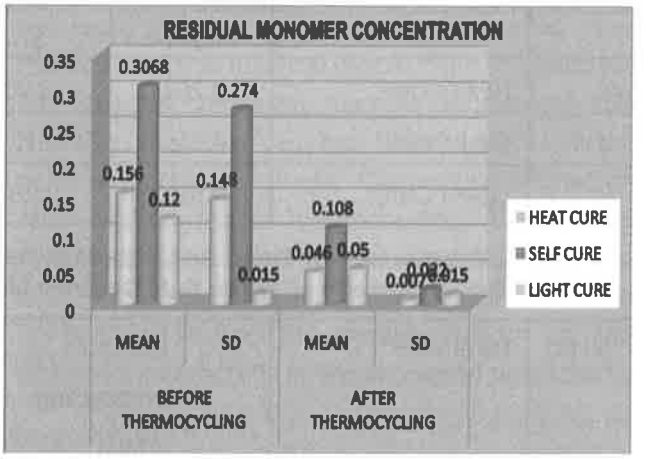



Table 3 shows the mean and standard deviation values of tear resistance of three soft denture liners. Among all the specimens which has studied before thermocycling Heat Cure processed specimens had shown highest values of tear resistance (10.26), followed by Self Cure (4.36) and Light Cure (0.59). After thermocycling, the tear resistance values were decreased in Heat Cure (9.21) but Self Cure (5.75) and Light Cure (0.77) specimens has shown slight increase




whole range of diagnostic, adjunctive and treatment purposes in the management of patients. The liner material (velum rubber) at that time was comprised of sponge rubber and provided better comfort than the other vulcanite materials.

Soft denture liners are polymers with a glass transitional temperature (Tg) that is below that of mouth temperature at which the polymer loses its brittleness and change to a rubber like form and expected to function for longer periods of time without any deformation and discomfort to the patient. The plasticizer lowers the glass transition temperature (Tg) of soft liner and act as a lubricant between the polymer chains. These are activated by heat, and processed in a water bath to initiate polymerization. Chemically activated soft denture liners have the composition




which is similar to that of heat activated soft liners, but polymerized by peroxide tertiary amine system. These materials are applied as chair side reliners, and they can be used on temporary basis, because of their tendency to produce bad smell and debond from

**Table 1 : Specimens Prepared For Tensile Strength, Tear Resistance & Residual Monomer Evaluation**

| Sl. No. | Parameter | HEAT CURE | | SELF CURE | | LIGHT CURE | |
|---|---|---|---|---|---|---|---|
| | | Control | For Thermocycling | Control | For Thermocycling | Control | For Thermocycling |
| 1 | Tensile Strength | 10 | 10 | 10 | 10 | 10 | 10 |
| 2. | Tear Resistance | 10 | 10 | 10 | 10 | 10 | 10 |
| 3. | Residual Monomer Content | 10 | 10 | 10 | 10 | 10 | 10 |

**TABLE 2 : Comparison of Mean and Standard Deviation Values of Tensile Strength of Three Soft Denture Liner Materials Before and After Thermocycling.**

| Sl. No. | Parameter | BEFORE Thermocycling (MPa) | | AFTER Thermocycling (MPa) | | 'p' VALUE |
|---|---|---|---|---|---|---|
| | | MEAN | SD | MEAN | SD | |
| 1 | HEAT CURE | 6.374 | 1.54 | 5.72 | 0.99 | 0.197 |
| 2 | SELF CURE | 2.014 | 0.78 | 2.746 | 1.61 | 0.212 |
| 3 | LIGHT CURE | 1.606 | 0.399 | 0.994 | 0.474 | 0.006 |

**TABLE 3: Comparison of Mean and Standard Deviation Values of Tear Resistance of Three Soft Denture Liner Materials before and after Thermocycling**

| Sl. No. | Parameter | BEFORE Thermocycling (MPa) | | AFTER Thermocycling (MPa) | | 'p' VALUE |
|---|---|---|---|---|---|---|
| | | MEAN | SD | MEAN | SD | |
| 1 | HEAT CURE | 10.261 | 3.73 | 9.21 | 1.756 | 0.431 |
| 2 | SELF CURE | 4.36 | 1.174 | 5.75 | 3.63 | 0.264 |
| 3 | LIGHT CURE | 0.59 | 0.183 | 0.776 | 0.162 | 0.027S |

**TABLE 4: Comparison of Mean And Standard Deviation Values of Residual Monomer Content After 48 Hrs of Storage of Three Soft Denture Liner Materials Before and After Thermocycling**

| Sl. No. | Parameter | BEFORE Thermocycling (MPa) | | AFTER Thermocycling (MPa) | | 'p' VALUE |
|---|---|---|---|---|---|---|
| | | MEAN | SD | MEAN | SD | |
| 1 | HEAT CURE | 0.156 | 0.148 | 0.046 | 0.007 | 0.031 |
| 2 | SELF CURE | 0.3068 | 0.274 | 0.1080 | 0.022 | 0.0001 |
| 3 | LIGHT CURE | 0.120 | 0.015 | 0.050 | 0.015 | 0.0001 |

through the early 1960's the soft liners were introduced and used in tissue management, lining for surgical splints, stabilizing the record bases and for functional impression procedures[1]. The soft resilient nature of these materials inside the mouth provides a whole range of diagnostic, adjunctive and treatment purposes in the management of patients. The liner material (velum rubber) at that time was comprised of sponge rubber[2] and provided better comfort than the other vulcanite materials.

Soft denture liners are polymers with a glass transitional temperature (Tg) that is below that of mouth temperature[3] at which the polymer loses its brittleness and change to a rubber like form and expected to function for longer periods of time without any deformation and discomfort to the patient. The plasticizer lowers the glass transition temperature (Tg) of soft liner and act as a lubricant between the polymer chains. These are activated by heat, and processed in a water bath to initiate polymerization. Chemically activated soft denture liners have the composition which is similar to that of heat activated soft liners, but polymerized by peroxide tertiary amine system. These materials are applied as chair side reliners, and they can be used on temporary basis, because of their tendency to produce bad smell and debond from denture base with in few weeks. In light activated soft denture liners, photons from the light source activate the initiator to generate free radicals that, in turn initiate the polymerization process. When the light activated system was introduced to dentistry, UV light was used initially. However, because of drawbacks about the effect of UV light on the retina and on unpigmented oral tissues, because of its limited penetration depth, new initiator systems that were subsequently developed are activated by Visible Light. In the visible light cured systems, camphoroquinone serves as initiator to generate free radicals when irradiated by light in the blue-to-violet region. Light with a wavelength of about 470nm is needed to initiate this reaction.

The main purpose of the soft liner is to absorb some of the energy produced by masticatory impact. It serves as a "shock absorber" between the denture and underlying soft tissues[5]. Ideally it should have high resilience and tensile strength so that it withstands the functional stress applied to the material. It should also have high tear resistance, and most importantly dimensional stability and biocompatibility. The main drawback with the presently available soft denture liners is their low tear resistance, lose of surface integrity with in a short span of usage, and leaching of residual monomer[3] which is a potential source for cytotoxic effects on the oral mucosa.

Tensile strength indicates maximum tensile stress that can be applied uniformly over a cross section of a test piece in the course of stretching it to failure. Among the many desired properties of the soft liners, high tensile strength is of particular importance to the final product. In this study three different soft denture liners processed by Heat, Chemical and Light are used, and they were evaluated for tensile strength before and after thermo cycling.

In this present study, heat processed soft liner has shown highest tensile strength 6.37 MPa than chemically processed 2.01 MPa and light processed 1.60 MPa soft liner specimens. These findings are coinciding with the test conducted by **Serra Oguz et al** in 2007[2]. The reason could be their difference in chemical structure, components and mode of interaction between the filler and matrix interface. Based on the results obtained in this study, heat processed soft liner will be having the better filler-matrix interaction than the others. Light activated soft liner material has shown least tensile strength 1.60 MPa than the other variables because of insufficient polymerization, and weak filler-matrix interaction. After 500 cycles of thermocycling, there is no statistically significant differences in tensile strength of heat activated and chemical activated soft liners ($p>0.05$). However, the tensile strength of light activated material 0.09 MPa is decreased significantly.

Tear resistance, on the other hand, measures the resistance to growth of a nick / cut when tension is applied to a cut sample. With soft liners, tear resistance is probably the most important mechanical property as they are prone to tearing when subjected to chemical or mechanical cleansing. In the present

study, tear resistance value was higher in heat activated soft liner 10.2 MPa, than chemical activated 4.36 MPa and light activated 0.59 MPa soft liners. This shows chemical and light activated liners have less degree of cross linking, and a decreased molecular weight of polymer chains and filler concentration. After 500 cycles of thermocycling, there is no statistically significant difference in tear resistance of heat activated 9.21 MPa and chemical activated 5.75 MPa soft denture liners ($P>0.05$). But the significant increase in tear resistance of light activated soft liner 0.77 MPa is observed. This could be due to loss of plasticizer during thermocycling, there by leading to hardening.

The high tear resistance of heat cure soft liners may be explained by relative differences in degree of cross linking in each material. High degree of cross linking leads to reduced segmental mobility of polymeric chains, resulting in localized stress concentration i.e, tear energy. These results are coinciding with the investigations conducted by **Serra Oguz et al**[5] in 2007 **and Walters and Jagger et al**[6] in 1999.

The other parameter studied was residual monomer content in three different soft denture liners processed by heat, chemical, and light. In this study, light activated liners has 0.12 and heat activated liners showed 0.15 of residual monomer content than chemical cure soft liners which is 0.30. The low value for light activated liners could be due to their different chemical composition. Where as in heat activated soft denture liners, it could be due to usage of heat for activation process, causing benzyl peroxide decomposition and polymerization becomes faster and complete. A rapid polymer structure hinders the conversion of methyl methacrylate monomers especially at curing temperatures lower than glass transition temperature (Tg) of polymers. Above the glass transition temperature of polymer the monomer in soft denture liner have a better ability to polymerize due to higher molecular chain motions and neutralization, immobilization of methyl methacrylate in polymer at higher temperature[6,7]. Where as increase in amount of residual monomer content in chemical activated soft denture liner may be due to its higher methacrylate content and the more porous structure. After 500 cycles of thermocycling, there was statistically significant reduction in all three types of soft denture liners is observed ($p<0.05$). It could be due to decrease in release of monomer as a result of monomer diffusion in water with temperature changes and continuous polymerization promoted by active radicals found in polymer chains.

In case of light activated soft liner, the tensile strength and tear resistance evaluation is different compare to the other two materials, because of its brittle nature. Evaluation of tensile strength and tear resistance of light activated soft liner specimens occur at one single point without any elongation, as against soft liner specimens in the study. Evaluation of the residual monomer content in all the three soft liner materials is done by using UV double beam Spectrophotometer that gave acceptable readings. Due to the cytotoxic potential, its accurate evaluation by using Infra Red Spectroscopy would be very useful to determine the biocompatibility of these materials. The tensile strength and tear resistance of all the three groups of specimens were evaluated before and after thermocycling but the same specimens could not be used for this parameter, because once the tensile strength and tear resistance are measured, the same specimens could not be used again because of stretching and breakage of the specimens. Further studies should be carried out in clinical conditions for better understanding of the nature of these materials for their application in the daily routine practice.

**Summary and Conclusion**

The tensile strength of heat cure soft liner has shown highest value than the others (chemical cure and light cure soft liners). After thermocycling, tensile strength values of heat cure and self cure has shown no statistically significant difference ($p>0.05$). Light cure material showed a slight decreased tensile strength value and statistically significant($p<0.05$)

1. Among all the materials tested, heat cure material shows the highest tear resistance value than others. After thermocycling, there was no

statistically significant difference in heat cure & self cure soft liners ($p>0.05$). Light cure material showed a slightly increased tear resistance value.

2. The residual monomer content in light cure and heat cure soft denture liner materials has shown lowest value than self cure soft denture liner. After thermocycling, the residual monomer content value was decreased significantly ($p<0.05$) in all three soft denture liner materials.

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ORIGINAL ARTICLE

# Interrelationship Between the Various Facial Landmarks and The Maxillary Anterior Teeth - A Comparative Study Between Young Adults of North & South Indian Population

Dr. Shafath Ahmed, Dr. Munirathnam Naidu E

**Abstract :** The purpose of this study was to evaluate and compare the interrelationship between various anatomic facial landmarks and the width of the maxillary anterior teeth among young adults of North Indian and South Indian population. This would serve as a guideline for the aesthetic selection of maxillary anterior teeth. 200 Dental students of North and South Indian population between the age of 18 and 25 years were selected.

Interpupillary distance (IPD), Bizygomatic width, interalar width, intercommissural width and the width of maxillary anterior teeth were measured. Correlation coefficient, regression equation, one way analysis of variance and descriptive statistics were the analytical methods used to record and study the interrelationship between various parameters. Scheffes multiple comparison tests showed how these groups differed. It was found that for North Indian male (NIM), Interalar width was highly related to the maxillary anterior teeth width, and for North Indian female (NIF), Interpupillary distance and Bizygomatic width were in close relation with the width of maxillary anterior teeth.

The study results showed that except for South Indian female (SIF), there exists a corelation between the width of the mouth and the width of maxillary anterior teeth.

The conclusion drawn from the study was that the width of the maxillary anterior teeth is approximately the same as the width of the mouth except for South Indian female, where no single parameter co-relates.

**Keywords :** Anterior teeth selection, Bizygomatic width, Interpupillary distance, Inter commissural width, Interalar width.

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## Introduction

Esthetics is a primary concern for patients seeking prosthodontic care. Appearing healthy and attractive has always been important for every individual. In order to attain a rewarding goal, pleasing natural appearing teeth must be provided to remove the patient's inhibitions, to give poise, dignity and improve one's outlook in life. During the early part of this century various techniques and guidelines have been suggested to facilitate the prosthodontist to select the shape, size and form of anterior teeth. Some of these were, Halls typal form concept [1], Berrys biometric ratio [1] STEINS coordinated size technique [1]. Anthropometric cephalic index method of sears [1] and the Dentogenic concept of tooth selection [2]. Lombardi [3] was the first to emphasize the importance of order in the dental composition with a recurring ratio noted between all teeth from the central incisor to the first

premolar. Levin [4] and more recently other authors [5,6] indicated that the most harmonious recurrent tooth to tooth ratio was that of the golden proportion, conflicting reports indicate that the majority of beautiful smiles did not have proportions coinciding with the golden proportion formula [7-10]. Recently, the recurring esthetic dental proportion concept was introduced, stating that clinicians may use a proportion of these as long as it remains consistent, proceeding distally in the arch [7, 9, 10].

To appear attractive, the maxillary anterior teeth must be in proportion to facial morphology [5, 7]. Several anatomic measurements have been proposed to aid in determining the correct size of the anterior teeth. Among them are the intercommissural width, Bizygomatic width, interalar width and the interpupillary distance [11-15]. The purpose of the present study was to compare and to correlate whether the use of facial measurements such as interpupillary distance, bizygomatic width, interalar width and intercommissural width can be used as guides for the selection of maxillary anterior teeth among young adults of North and South Indian population which form the majority of the Indian population in the age group studied.

## Materials and Methods

The study was conducted on 200 subjects which comprised of four groups, Group I – 50 North Indian Males (NIM), Group II – 50 North Indian Females (NIF), Group III – 50 South Indian Males (SIM) and Group IV – 50 South Indian Females (SIF). The entire study was done by a single operator to avoid inter examiner bias. An average of three readings was taken for each of the selected parameters to standardise the measurements. Ethical clearance was taken from the institute before commencement of the study and informed consent from the subjects for participation.

## Recording procedures

### Interpupillary distance

Interpupillary distance was measured with the subjects head held upright and mandibular occlusal plane parallel to the floor. The subjects were asked to look at an object, a light source placed at a distance of

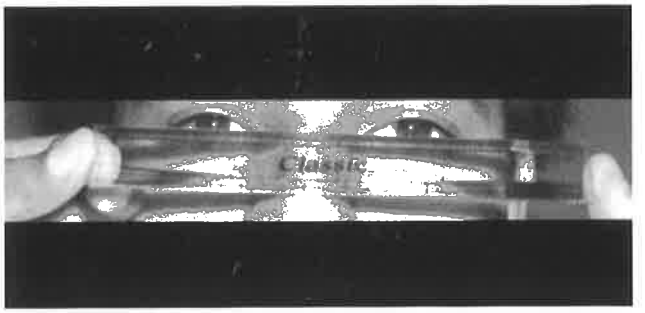

**Fig 1: Measurement of Interpupillary distance**

one meter in a well lit room (Fig 1). The reflection of the bright light on both the cornea was noted. The distance between both the reflections of the bright light on both the cornea was recorded. The distance was measured with a transparent plastic scale placed horizontally over the bridge of the nose [16]. The interpupillary distance (IPD) is the distance between these two images Bizygomatic width.

The Bizygomatic width is measured from zygoma to zygoma, which is one to one half inches back of the lateral corner of the eye [17]. The width was measured with the help of a bow caliper with its beak touching the most lateral part of the zygomatic arch (Fig 2). The bizygomatic width is normally the widest point of the face [18] Width of the nose (interalar width)

The interalar width was measured from the

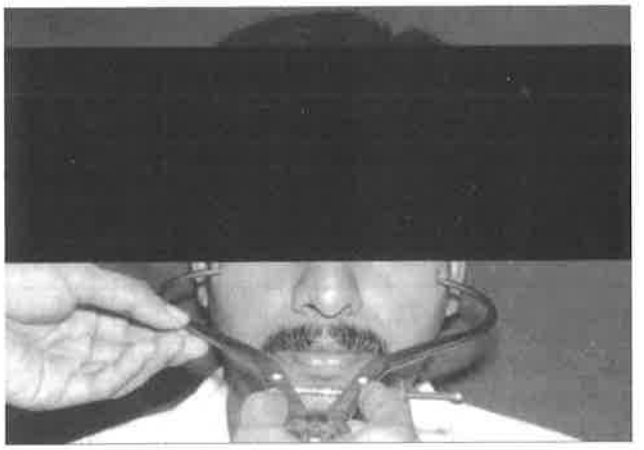

**Fig 2: Measurement of Bizygomatic width**

widest point of either ala [19]. This was recorded by placing the vernier caliper with its beak open laterally to the alae region and gradually closing the beaks to bring them closer till an initial passive contact was made on the widest point of either ala (Fig 3). While

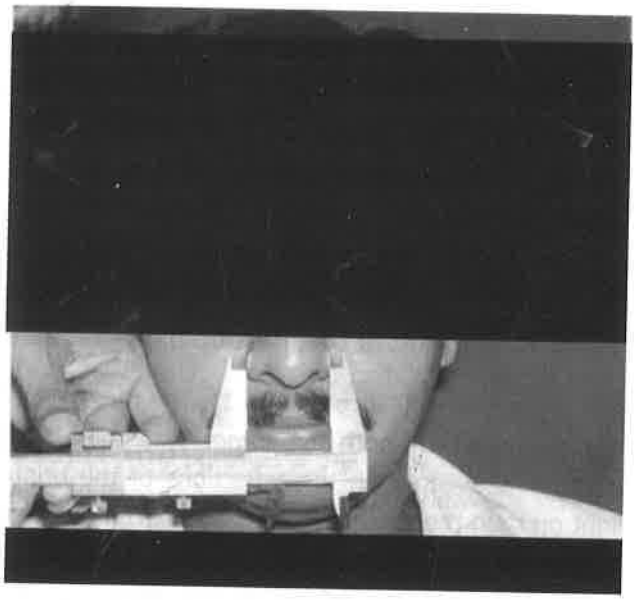

**Fig 3: Measurement of Interalar width**

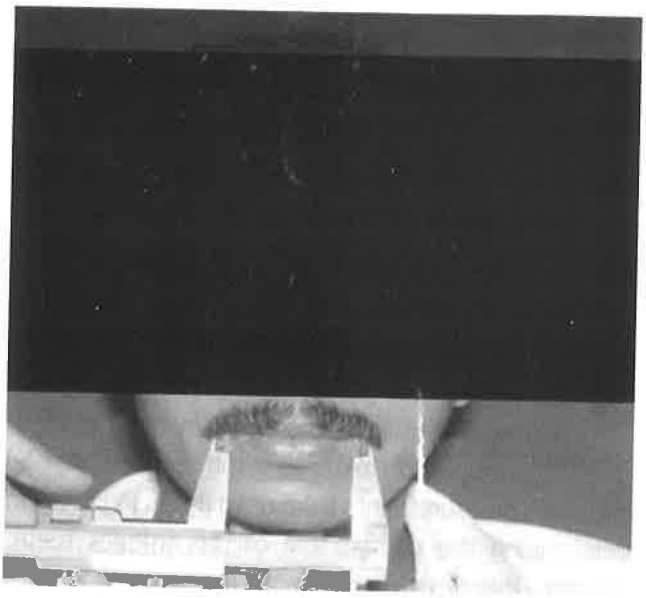

**Fig 4: Measurement of Intercommissural width**

recording the subject was asked to stop breathing momentarily.

**Width of the mouth (Intercommissural width)**

The width of the mouth was determined by measuring the maxillary lip vermillion from commissure to commissure [14]. The distance was measured by placing the tip of the vernier caliper beaks at the commissure in passive position (Fig 4).

**Width of the maxillary anterior teeth**

The maxillary anterior teeth were measured from accurate stone plaster casts. The measurement was done on a cast with a sharp pointed divider. The fundamental protocol is to measure the greatest mesiodistal diameter of the tooth from one ideal contact point to another. The divider was held parallel to the long axis of the crown to obtain a true reading.

**Results**

**Table 1 – Descriptive statistics**

| | Age | Interpupillary distance (mm) | Bizygomatic width (mm) | Width of the nose (Interalar width) (mm) | Width of the mouth (from commisure to commisure) (mm) | Width of maxillary anterior teeth (mm) |
|---|---|---|---|---|---|---|
| Mean | 21.77 | 60.03 | 122.96 | 34.95 | 45.43 | 48.46 |
| Standard deviation | 2.34 | 5.22 | 6.93 | 3.66 | 4.85 | 4.17 |
| Standard error | 0.165 | 0.369 | 0.49 | 0.258 | 0.343 | 0.295 |
| Coefficient variation | 10.75 | 8.70 | 5.64 | 10.47 | 10.68 | 8.61 |
| Minimum | 17.00 | 48.00 | 110.00 | 27.00 | 34.00 | 38.00 |
| Maximum | 28.00 | 68.00 | 141.00 | 44.00 | 58.00 | 57.00 |

Table 2 – Mean and standard deviation of the selected parameters group wise

| | North Indian males | | South Indian males | | North Indian females | | South Indian females | | F.R. | P.R+ | Scheffes test |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inter pupillary | 61.9200 | 2.5058 | 60.4800 | 7.2259 | 57.9800 | 5.3241 | 59.7400 | 3.9685 | 5.2386 | <0.01 | $G_1VsG_3$ |
| Bizygomatic width | 129.2600 | 5.5672 | 121.5800 | 5.772 | 120.4400 | 6.889 | 120.5800 | 5.7891 | 25.4233 | <0.01 | $G_1VsG_2G_3G_4$ |
| Width of the nose | 35.3600 | 3.2561 | 37.300 | 2.9225 | 33.7000 | 4.3154 | 33.4400 | 2.6092 | 14.2666 | <0.01 | $G_1VsG_4$ $G_3VsG_1G_3G_4$ |
| Width of the mouth | 46.2600 | 3.0157 | 48.9600 | 3.9742 | 42.9600 | 5.1743 | 43.5400 | 4.8479 | 21.0851 | <0.01 | $G_1Vs G_3G_4$ $G_3VsG_3G_4$ |
| Width of the teeth | 50.7800 | 2.7052 | 48.6400 | 3.7349 | 48.3600 | 4.8938 | 46.0400 | 3.7449 | 12.6920 | <0.01 | $G_1Vs G_3G_4$ $G_2VsG_4$ $G_3VsG_4$ |
| Age | 23.12 | 1.84 | 21.76 | 2.09 | 22.88 | 1.64 | 19.34 | 1.61 | 45.84 | <0.001 | $G_4VsG_1G_2G_3$ $G_2Vs G_3G_4$ |

**Table III – Correlation coefficient with width of maxillary anterior teeth**

| | Group I | Group II | Group III | Group IV |
|---|---|---|---|---|
| Interpupillary distance | 0.2924 | 0.1661 | 0.6299*** | 0.1612 |
| Bizygomatic width | 0.2307 | 0.0906 | 0.5175*** | 0.1673 |
| Width of the nose | 0.4007** | 0.1260 | 0.3222 | 0.1216 |
| With od the mouth | 0.41800*** | 0.4679*** | 0.7598*** | 0.2730 |

** P<0.01 *** P<0.001

**Table IV – Regression Equation**

| | |
|---|---|
| Group I (width of the maxillary anterior teeth) | = 30.86 + 0.4305 X (width of the mouth) |
| Group II (width of the maxillary anterior teeth) | = 27.11 + 0.4397 X (width of the mouth) |
| Group III (width of the maxillary anterior teeth) | = 17.48 + (width of the mouth) x 0.7186 |
| Group IV (width of the maxillary anterior teeth) | = 32.65 + 0.1793 (width of the mouth) – 0.1878 (Interpupillary distance) + 0.1203 (Bizygomatic width) + 0.0683 (width of nose) |

**Table V – Ratio of different variables to width of the maxillary anterior teeth**

| | | |
|---|---|---|
| Interpupillary distance | : Maxillary anterior teeth | 1:0.80 |
| Bizygomatic width | : Maxillary anterior teeth | 1:0.39 |
| Width of the nose | : Maxillary anterior teeth | 1:1.38 |
| Width of the mouth | : Maxillary anterior teeth | 1:1.07 |

**Appendix 1: Selection criteria**

- Age group 18-25 years.
- All the subjects had a full complement of teeth.
- No history of orthodontic treatment.
- All healthy permanent teeth were present in normal arch form and alignment.
- Subjects with no interdental spacing or crowding present were selected.
- Subjects whose teeth were not grossly abraded or attrited.
- Subjects who had not undergone any restorative treatment were selected.

The descriptive statistics (mean, standard deviation, standard error, coefficient variation, minimum and maximum values) of the variables measured are listed in Table I. Table II shows the mean and standard deviation of the selected parameters groups wise, to assess the difference between these groups one way analysis of variance test was applied and it was observed that a 'p' value (significance value) of <0.01 which implies that there exists a difference between the study groups. Table III shows that since there exist some differences between the four groups correlation coefficient of the selected parameters with the width of the maxillary anterior teeth was calculated. Table IV shows that the regression equation was used in order to study the relationship that exists between the different parameters with that of the width of the maxillary anterior teeth. The stepwise linear regression analysis was done. The relationship between the width of the mouth and the width of the anterior teeth was significant for the groups except the South Indian females. Since no parameter was related for group IV with the maxillary anterior teeth width all the four parameters were included for predicting the width of the teeth. Table V shows the ratio of the different variables to the width of the maxillary anterior teeth. The width of the mouth was closely related to the width of the maxillary anterior teeth.

## Discussion

The objective of this study was to determine whether any definite correlation existed between the width of the maxillary anterior teeth and certain anatomical facial landmarks, which would serve as a guideline in selecting maxillary anterior teeth. The data collected in the study was statistically analyzed. The mean, standard deviation and standard error of measurements in all the groups indicated that the interpupillary distance, Bizygomatic width, interalar width and the width of the mouth were acceptable.

From the descriptive statistics, the mean interpupillary distance for all four groups was 60.03 mm (Refer Table I). In similar studies conducted by Latta et al, [14] the average interpupillary distance was 38-73 mm. Studies by Cesario et al[12] and Lucas & Pryor as quoted by Cesario[12] had averages of 59.16 mm and 58 mm respectively.

The mean bizygomatic width was found to be 122.96 mm, (Refer Table I) whereas in a study by Latta et al [14] the value ranged between 125-168 mm which is in close proximity to the value obtained in the present study. The mean interalar width on the subjects investigated was found to be 34.95 mm (Refer Table I). In other studies measuring the interalar width, the average values found was 29-63 mm by Latta et al [14], 35.33 mm by Marvroskoufis [20], 28.45 mm by Lee as quoted by Mavroskoufis [20], 34.28 mm by Hoffman et al [19] and 33.9 mm by Brian Smith[21].

The mean width of the mouth was found to be 45.43 mm, which fell well within range of 36-68 mm on a study done by Latta et al [14]. (Refer Table I)

The mean width of the maxillary anterior teeth was found to be 48.46 mm (Refer Table I). In a study done by Ray Mc Arthur [22], the average width of the maxillary anterior teeth was found to be 52.3 mm for women and 54.6 mm for men. Hoffman in his studies

on the ARCD (Circumferential arc distance between the distal surfaces of the canines) on 340 subjects of mixed sex and age measured the ARCD to be 44.85 mm [19].

To assess the difference that exists between the groups, one way analysis of variance test was applied, and it was found that a statistically (significance value) 'p' value of <0.01 mm, which implies that there exists a difference between the study groups.

Scheffes multiple comparison test was applied to study the groups. In North Indian males, the average width of the maxillary anterior teeth was higher than both North and South Indian females. In North Indian females, the average width of the maxillary anterior teeth was more than the South Indian females. Whereas, the South Indian females it was found to be much lesser than the other three groups.

On observation, it was revealed that the average width of the mouth was more in South Indian males on comparison to the other three groups. Whereas, the width of the mouth was significantly more in North Indian males when compared to the North and South Indian females.

Considering the bizygomatic width, the average value for North Indian males was significantly greater than the other three groups. The average interpupillary distance was significantly greater for the North Indian males than the North Indian females.

The correlation coefficient of the width of the maxillary anterior teeth was compared for the four groups against the four variables. A correlation exists for the three groups except the South Indian female, and no single parameter correlated with the width of the teeth for this group. This could be attributed to the fact that the average age of the South Indian females was less compared to the other groups. For North Indian males alone, the nose width was closely related to the width of the maxillary anterior teeth. The interpupillary distance and the bizygomatic width were closely related with the maxillary anterior teeth width for North Indian females. A study by Forrest Scandrett [23], revealed that the intercommissural width had the highest correlation of 0.44 mm with the width of the maxillary anterior teeth similar to the close correlation that exists with the group II of the current study.

The regression equation helps to predict the width of the maxillary anterior teeth. The stepwise linear regression analysis shows that the width of the mouth was significant for all the groups except South Indian females. It has been inferred that, if 1 mm of mouth width increases 0.43 mm of maxillary anterior teeth width increases for Group I and II. For Group III it shows that if there is 1 mm increase in mouth width, then there is an increase of 0.72 mm in the width of the maxillary anterior teeth (Refer Table IV). The stepwise regression analysis was not included for Group IV, since no parameter was related with maxillary anterior teeth.

Similarly other variances can be used to predict the width of the maxillary anterior teeth. On comparing the ratio of the different variables to the width of maxillary anterior teeth it shows that if the interpupillary distance is taken as one unit, we can expect that the maxillary anterior teeth width to be 0.8 times lesser. Similarly if the bizygomatic width is taken as one unit then the maxillary anterior teeth width will be 0.39 times less. If the width of the nose and the width of the mouth is taken as one unit the maxillary anterior teeth width will be 1.38 and 1.07 times greater respectively. (Refer Table V)

In this study the subjects were selected within a narrow age range. The two groups of population studied are based on the geographical location of the origin. This is strictly restricted to the subject and not the previous generation. Final tooth selection for edentulous subjects can be made in accordance with other methods available, though the data obtained from this study serves as a guideline. Additional research on a greater sample size selected is needed before extrapolating the results to the general population.

## Conclusion

A study on four groups of subjects of Indian origin between the age groups of 18-25 years segregated into North Indian males, South Indian males, North Indian females and South Indian females

was conducted, in an attempt to correlate the relationship between the various facial landmarks to the width of the maxillary anterior teeth.

According to the conditions of the study we conclude that

a) Except for the South Indian females, there exists a correlation for the remaining three groups with the width of the mouth and the width of the maxillary anterior teeth

b) The width of the nose was closely related with the maxillary anterior teeth width, for North Indian males.

c) The interpupillary distance and bizygomatic width were highly related with the maxillary anterior teeth width for all the groups.

d) The maxillary anterior teeth width is approximately the same as the width of the mouth for all the groups.

e) The ratios obtained between the different variables to the width of the maxillary anterior teeth are

| | | |
|---|---|---|
| Interpupillary distance | | : Maxillary anterior teeth |
| | 1 | : 0.80 |
| Bizygomatic width | | : Maxillary anterior teeth |
| | 1 | : 0.39 |
| Width of the nose | | : Maxillary anterior teeth |
| | 1 | : 1.38 |
| Width of the mouth | | : Maxillary anterior teeth |
| | 1 | : 1.07 |

The results of the study conclude that the mouth width can be taken as a stable anatomical facial landmark for selecting the maxillary anterior teeth. This study done amongst young North and South Indian population would serve as a guideline for the aesthetic selection of maxillary anterior teeth.

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ORIGINAL ARTICLE

# An Epidemiological Study to Ascertain the Shade Selection of the Esthetic Zone in the Adult Population of South Coastal Karnataka

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**Abstract :** The importance of esthetics in dentistry has shown marked increase owing to new interest and public awareness. In this study tooth colour was obtained for each individual tooth using vita lumin shade guide.

The study was conducted to evaluate the shade characteristics of anterior teeth in south canara population to find out the most commonest shades in different age groups. Methodology:- For this study 1020 subjects comprising of both sexes was selected from the outpatient department of A. B. Shetty Memorial Institute of Dental Sciences ranging from 18 to 55 years of age. Results :- It was observed that the most commonest shade for the incisal 1/3rd of maxillary incisors was B-2 in 27.1% subjects which was followed by A-2 and A-1 shades whereas the commonest shade for the body portion of the maxillary incisors was found to be B-3 in 27.4% and 26.8% in central incisors and lateral incisors respectively, shade for the incisal portion of the maxillary canine was A-2 in 23.1% and A-3 for 19.1% subjects, whereas the body portion of the canine shows A-3.5 as the most common shade in 23.1% followed by A-4 in 18.6% and C-3 in 11.2% of the subjects.

**Key Words** : Shade selection, Porcelain, Shade guide, Esthetics

**Introduction :** A smile is the most visible record of a Dentist's care. The significance of tooth shade in one's perception of smile attractiveness cannot be underestimated. In today's beauty conscious society, the demand for esthetic dentistry has increased a lot in last few years. Tooth shade is one of the most significant factors affecting esthetics . It is general misconception in people that white bright teeth are more attractive than yellow teeth. But we as dentists are aware of the fact that teeth shade vary with skin colour, age and gender. Tooth color has a strong correlation with age, generally becoming darker and yellower with time. As the age advances the pulp chamber which are large during young age becomes smaller as a result of deposition of secondary dentin, making tooth more opaque. Many studies have shown that women have lighter and less yellow teeth than men.

Colour is dependent on three factors, namely the observer, the object and the light source. Each one of these is a variable and when any one is altered, the perception of colour changes. Understanding these three dimensions can affect colour matching of ceramic restorations. Gratifying results are achieved when a careful attention is given to each of these factors.

Perception of shade varies depending on whether shade matching is done in artificial or daylight. This

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also should be taken into consideration while recording shade for anterior restorations. The existing shade guides used for Indian population are fabricated to suit the colour characteristics of western race. It is not known how far these shades would be acceptable to match the colour of anterior teeth in Indian subjects. Keeping this in view a study was planned to ascertain the shade characteristics of anterior teeth with vita shade guide in the adult population of south coastal Karnataka.

## Materials and Methods

For this study 1020 subjects comprising of both sexes was selected from the outpatient department of A. B. Shetty Memorial Institute of Dental Sciences ranging from 18 to 55 years of age. The subjects were divided into 18-27, 28- 37, 38-47, 48-57 years for convenience. Demographic and personal characteristic such as occupation, smoking , beetle nut and tobacco chewing and alcohol consumption were recorded on an examination form.

### Criteria for Selection of the subject

1. Upper and lower anterior teeth existed in all the subjects included for the investigation
2. The anterior teeth were free from extensive restoration which are likely to change.
3. Non-vital teeth were not included in the study.
4. Teeth with heavy extrinsic stains due to smoking or tobacco or other similar habits were not included.
5. Shade was recorded in natural daylight.
6. Patients were asked to avoid any kind of lip sticks or make up.

Vita Lumin Shade guide was used to assess the tooth colour of anterior teeth. Though several types of tooth shade guides are available, in this study vita lumin shade guide was used. Shade selection was done in normal daylight because normally there is more than an adequate level of intensity is available in natural daylight.

Daylight is the eyes natural element and therefore the standard to which all sources are related.

The subject was made to sit comfortably on the dental chair near the window for adequate natural day light and the patient mouth is kept at the dentist eye level. The teeth were divided into two compartments along the horizontal axis into incisal third and body portion. The shade selection procedure is preceded with thorough prophylaxis of the teeth.

Lips were gently retracted till the incisal third of the teeth were exposed, the clinician matches the shade and selects the shade of incisal third of the tooth with that of the incisal third of the shade guide. Similarly the remaining part of teeth as exposed by retracting the lips and the colour for body part of the tooth was matched with the body portion of shade table of vita lumin shade guide. The shade were matched for each tooth included in this study with vita lumin shade guide the shade thus obtain for maxillary and mandibular anterior teeth were recorded in a proforma.

**PROFORMA**

**Sub. No.**

| | | | |
|---|---|---|---|
| 1. | Name | 2. | Age group |
| 3. | Sex | 4. | Occupation |
| 5. | Address | | |

**PERSONAL HABITS**

| | | | |
|---|---|---|---|
| 1. | Smoking | 2. | Pan Chewing |
| 3. | Alcohol | 4. | Tea/Coffee |
| 5. | Brushing habits | | |

**TOOTH EXAMINATION**

| | | | |
|---|---|---|---|
| 1. | Teeth Stains | 2. | Attrition |
| 3. | Abrasion | 4. | Erosion |
| 5. | Enamel defects | | |
| 6. | Spices/ Dyes | 7. | Others |
| | a. hypoplasia | | |
| | b. Flurosis | | |

**Facial Complexion**

| | | | |
|---|---|---|---|
| 1. | Fair | 2. | Wheatish |
| 3. | Dark | 4. | Very Dark |

**Table I : Shade Variations Observed in the Incisal 1/3rd of Maxillary Central Incisor**

| Shade | 18-27 | 28-37 | 38-47 | 48-57 | Total |
|---|---|---|---|---|---|
| A1 | 58 | 26 | 24 | 9 | 117(115%) |
| A2 | 36 | 47 | 29 | 15 | 127(12.5%) |
| A3 | 1 | 87 | 16 | 20 | 45(4.4%) |
| A3.5 | 18 | | | | 18(1.8%) |
| A4 | | | | | |
| B1 | | 37 | 17 | 12 | 66(65%) |
| B2 | 84 | 99 | 56 | 37 | 276(27.1%) |
| B3 | | | 14 | 33 | 47(4.6%) |
| B4 | | | | | |
| C1 | | 37 | 17 | 12 | 66(6.5%) |
| C2 | 8 | 19 | 14 | 11 | 52(5.1%) |
| C3 | | | 5 | 1 | 9(0.6%) |
| C4 | | | | | |
| D2 | 28 | 39 | 30 | 12 | 109(107%) |
| D3 | 10 | 34 | 16 | 12 | 72(7.1%) |
| D4 | | | | | |
| Column Total | 255 25% | 334 32.70% | 250 24.50% | 181 17.70% | 1020 100% |

**Table II : Shade Variations Observed in the Body ½ of Maxillary Central Incisor**

| shade | 18-27 | 28-37 | 38-47 | 48-57 | Total |
|---|---|---|---|---|---|
| A1 | 12 | | | | 12(1.2%) |
| A2 | 46 | 18 | 19 | 7 | 90(8.85%) |
| A3 | 53 | 57 | 32 | 24 | 166(16.3%) |
| A3.5 | 1 | 4 | 14 | 10 | 29(2.8%) |
| A4 | 1 | 8 | 4 | 3 | 16(1.6%) |
| B1 | | | | | |
| B2 | | 31 | 27 | 14 | 72(7.1%) |
| B3 | 84 | 96 | 61 | 38 | 279(27.4%) |
| B4 | | | 9 | 29 | 38(3.7%) |
| C1 | | | | | |
| C2 | 12 | 25 | 24 | 21 | 82(8.0%) |
| C3 | 8 | 22 | 14 | 11 | 55(54%) |
| C4 | | | | | |
| D2 | | | | | |
| D3 | 28 | 45 | 30 | 12 | 115(11.3%) |
| D4 | 10 | 28 | 16 | 12 | 66(6.5%) |
| Column Total | 255 25% | 334 32.70% | 250 24.50% | 181 17.70% | 1020 100% |

**Table III : Shade Variations Observed in the Incisal 1/3rd of Maxillary Lateral Incisor**

| Shade | 18-27 | 28-37 | 38-47 | 48-57 | Total |
|---|---|---|---|---|---|
| A1 | 58 | 26 | 24 | 9 | 117(11.5%) |
| A2 | 36 | 42 | 27 | 14 | 119 (11.7%) |
| A3 | 1 | 13 | 18 | 21 | 53(5.2%) |
| A3.5 | 18 | | | | 18(1.8%) |
| A4 | | | | | |
| B1 | | 37 | 17 | 12 | 66(6.5%) |
| B2 | 84 | 99 | 56 | 37 | 276(27.1%) |
| B3 | | | 14 | 36 | 47(4.6%) |
| B4 | | | | | |
| C1 | 12 | 25 | 29 | 19 | 85 (8.3%) |
| C2 | 8 | 19 | 19 | 12 | 58(5.7%) |
| C3 | | | | | |
| C4 | | | | | |
| D2 | 28 | 39 | 30 | 12 | 109(10.7%) |
| D3 | 10 | 34 | 16 | 12 | 72(7.1%) |
| D4 | | | | | |
| Column Total | 255 25% | 334 32.70% | 250 24.50% | 181 17.70% | 1020 100% |

**Table IV : Shade Variations Observed in the Body ½ of Maxillary Lateral Incisor**

| Shade | 18-27 | 28-37 | 38-47 | 48-57 | Total |
|---|---|---|---|---|---|
| A1 | | | | | |
| A2 | 46 | 23 | 21 | 8 | 98(9.6%) |
| A3 | 65 | 52 | 30 | 23 | 170(16.7%) |
| A3.5 | 1 | 4 | 14 | 10 | 29(2.8%) |
| A4 | 1 | 8 | 4 | 3 | 16(1.6%) |
| B1 | | | | | |
| B2 | | 31 | 22 | 13 | 66(6.5%) |
| B3 | 84 | 96 | 56 | 37 | 273(26.8%) |
| B4 | | | 9 | 29 | 38(3.7%) |
| C1 | | | | | |
| C2 | 12 | 25 | 29 | 22 | 88(8.6%) |
| C3 | 8 | 22 | 19 | 12 | 61(6.0%) |
| C4 | | | | | |
| D2 | | | | | |
| D3 | 28 | 45 | 30 | 12 | 115(11.3%) |
| D4 | 10 | 28 | 16 | 12 | 66(6.5%) |
| Column Total | 255 25% | 334 32.70% | 250 24.50% | 181 17.70% | 1020 100% |

**Table V : Shade Variations Observed in the Incisal 1/3rd of Maxillary Canine**

| Shade | 18-27 | 28-37 | 38-47 | 48-57 | Total |
|---|---|---|---|---|---|
| A1 | | | | | |
| A2 | 65 | 71 | 53 | 47 | 236(23.1%) |
| A3 | 55 | 63 | 52 | 25 | 195(19.9%) |
| A3.5 | 16 | 19 | 8 | 4 | 47(4.6%) |
| A4 | 2 | 16 | 5 | 22 | 45(4.4%) |
| B1 | | | | | |
| B2 | 8 | 17 | 11 | 10 | 46(4.5%) |
| B3 | 7 | 23 | 18 | 11 | 59(5.8%) |
| B4 | 9 | 10 | 18 | 20 | 57(5.7%) |
| C1 | | 6 | | | 6(0.6%) |
| C2 | 60 | 27 | 28 | 18 | 133(13%) |
| C3 | 1 | 15 | 6 | 3 | 25(2.5%) |
| C4 | | 8 | 13 | 5 | 26(2.5%) |
| D2 | | 15 | 4 | 3 | 22(2.2%) |
| D3 | 23 | 30 | 11 | 5 | 69(6.8%) |
| D4 | 9 | 14 | 23 | 8 | 54(5.3%) |
| Column Total | 255 25% | 334 32.70% | 250 24.50% | 181 17.70% | 1020 100% |

**Table VI : Shade Variations Observed in the Body ½ of Maxillary Canine**

| Shade | 18-27 | 28-37 | 38-47 | 48-57 | Total |
|---|---|---|---|---|---|
| A1 | | | | | |
| A2 | 31 | 9 | 4 | 2 | 46(4.5%) |
| A3 | 2 | 22 | 5 | 28 | 57(5.6%) |
| A3.5 | 65 | 71 | 57 | 43 | 236(23.1%) |
| A4 | 40 | 73 | 52 | 25 | 190(18.6%) |
| B1 | | | | | |
| B2 | 8 | 11 | 11 | 7 | 37(3.6%) |
| B3 | 1 | 19 | 16 | 12 | 48(4.7%) |
| B4 | 15 | 14 | 20 | 22 | 71(7%) |
| C1 | | | | | |
| C2 | 9 | 18 | 14 | 9 | 50(4.9%) |
| C3 | 52 | 30 | 20 | 12 | 114(11.2%) |
| C4 | | 8 | 13 | 5 | 26(2.5%) |
| D2 | | | 5 | 1 | 6(0.6%) |
| D3 | 23 | 45 | 15 | 8 | 91(8.9%) |
| D4 | 9 | 14 | 18 | 7 | 48(4.7%) |
| Column Total | 255 25% | 334 32.70% | 250 24.50% | 181 17.70% | 1020 100% |

**Table VII : Shows the most commonest shade for mandibular central incisors**

| Shade | 18-27 | 28-37 | 38-47 | 48-57 | Total |
|---|---|---|---|---|---|
| A1 | 21 | 43 | 38 | 32 | 134(13.1%) |
| A2 | 32 | 39 | 25 | 23 | 119(11.7%) |
| A3 | 12 | | | | 12(1.2%) |
| A3.5 | | 5 | 2 | 1 | 8(0.8%) |
| A4 | | 5 | 4 | 10 | 19(1.9%) |
| B1 | 57 | 70 | 39 | 18 | 184(18%) |
| B2 | 48 | 27 | 31 | 15 | 121(11.9%) |
| B3 | 1 | 4 | 2 | 1 | 8(0.8%) |
| B4 | | | | | |
| C1 | 1 | 54 | 19 | 30 | 104(10.2%) |
| C2 | | 23 | 27 | 24 | 74(7.3%) |
| C3 | 19 | 9 | 8 | 5 | 41(4.0%) |
| C4 | | | | | |
| D2 | 35 | 19 | 23 | 11 | 88(8.6%) |
| D3 | 20 | 27 | 29 | 10 | 86(8.4%) |
| D4 | 1 | 3 | 3 | 1 | 8(0.8%) |
| Column Total | 255 25% | 334 32.70% | 250 24.50% | 181 17.70% | 1020 100% |

**Table VIII : Shows the shade for body portion of the mandibular central incisors**

| Shade | 18-27 | 28-37 | 38-47 | 48-57 | Total |
|---|---|---|---|---|---|
| A1 | | 10 | 6 | 11 | 27(2.6%) |
| A2 | 32 | 35 | 30 | 37 | 134(13.1%) |
| A3 | | | | | |
| A3.5 | | 8 | 5 | 1 | 14(1.4%) |
| A4 | | | | | |
| B1 | 1 | 26 | 25 | 13 | 65(6.4%) |
| B2 | 49 | 70 | 33 | 15 | 167(16.4%) |
| B3 | 1 | 54 | 19 | 38 | 112(11%) |
| B4 | | | | 6 | 6(0.6%) |
| C1 | 18 | 5 | 10 | 2 | 36(3.5%) |
| C2 | 25 | 47 | 28 | 17 | 117(11.5%) |
| C3 | | 5 | 2 | 1 | 8(0.8%) |
| C4 | | | | | |
| D2 | 35 | 19 | 17 | 8 | 79(7.9%) |
| D3 | 21 | 30 | 38 | 14 | 103(10.1%) |
| D4 | | | | | |
| Column Total | 255 25% | 334 32.70% | 250 24.50% | 181 17.70% | 1020 100% |

**Table IX : Shows the most commonest shade for incisal 1/3rd of mandibular lateral incisors**

| Shade | 18-27 | 28-37 | 38-47 | 48-57 | Total |
|---|---|---|---|---|---|
| A1 | 29 | 43 | 38 | 32 | 147(13.9%) |
| A2 | 33 | 47 | 30 | 25 | 135(12.5%) |
| A3 | 12 | | | | 12(1.2%) |
| A3.5 | 8 | | | | 8(0.8%) |
| A4 | | | | | |
| B1 | 16 | 67 | 32 | 15 | 174(17.1%) |
| B2 | 36 | 27 | 31 | 15 | 109(10.7%) |
| B3 | 19 | 15 | 12 | 15 | 61(6%) |
| B4 | 1 | 46 | 18 | 22 | 87(8.5%) |
| C1 | 1 | 4 | 2 | 1 | 8(0.8%) |
| C2 | | 23 | 27 | 24 | 74(7.3%) |
| C3 | 1 | 9 | 6 | 11 | 27(2.7%) |
| C4 | | | | | |
| D2 | 35 | 19 | 28 | 1 | 2 94(9.2%) |
| D3 | 1 | 3 | 3 | 1 | 8(0.8%) |
| D4 | 19 | 23 | 22 | 3 | 8 72(7.1%) |
| Column Total | 255 25% | 334 32.70% | 250 24.50% | 181 17.70% | 1020 100% |

**Table X : Shows the most commonest shade for body portion of the mandibular lateral incisors**

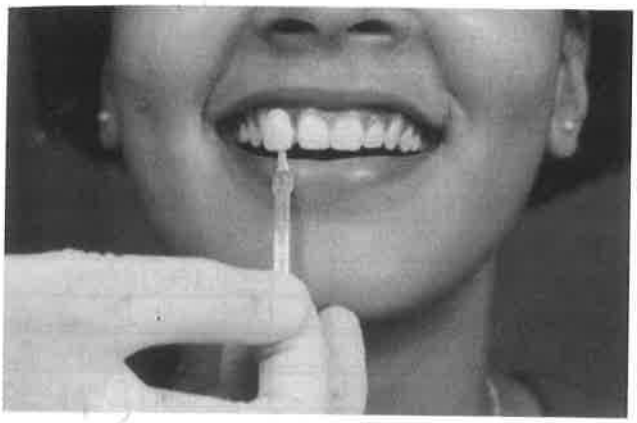
| Shade | 18-27 | 28-37 | 38-47 | 48-57 | Total |
|---|---|---|---|---|---|
| A1 | | 10 | 6 | 11 | 27(2.6%) |
| A2 | 40 | 30 | 28 | 36 | 134(13.1%) |
| A3 | 33 | 47 | 28 | 17 | 125(12.3%) |
| A3.5 | 8 | 5 | 7 | 2 | 22(2.2%) |
| A4 | | | | | |
| B1 | 1 | 26 | 25 | 13 | 65(6.4%) |
| B2 | 49 | 70 | 33 | 15 | 167(16.4%) |
| B3 | 1 | 46 | 18 | 13 | 95(9.3%) |
| B4 | | | | 14 | 14(1.4%) |
| C1 | 18 | 12 | 14 | 4 | 48(4.7%) |
| C2 | 37 | 26 | 33 | 16 | 112(11%) |
| C3 | 12 | 5 | 2 | 1 | 20(2%) |
| C4 | | | | | |
| D2 | 35 | 19 | 17 | 8 | 79(7.7%) |
| D3 | 21 | 30 | 33 | 13 | 97(9.5%) |
| D4 | | | 5 | 1 | 6(0.6%) |
| Column Total | 255 25% | 334 32.70% | 250 24.50% | 181 17.70% | 1020 100% |

**Table XI : Shows the shade for incisal 1/3rd of mandibular canines**

| Shade | 18-27 | 28-37 | 38-47 | 48-57 | Total |
|---|---|---|---|---|---|
| A1 | 8 | | | | 8(0.8%) |
| A2 | 1 | 15 | 6 | 17 | 39(3.8%) |
| A3 | 13 | 41 | 18 | 8 | 80(7.8%) |
| A3.5 | 75 | 58 | 45 | 20 | 198(19.4%) |
| A4 | 28 | 42 | 51 | 45 | 166(16.3%) |
| B1 | | | | | |
| B2 | 8 | 11 | 7 | 3 | 29(2.8%) |
| B3 | 45 | 31 | 37 | 17 | 130(12.7%) |
| B4 | 2 | 42 | 16 | 40 | 94(9.2%) |
| C1 | | | | | |
| C2 | 30 | 29 | 21 | 10 | 90(8.8%) |
| C3 | 10 | 8 | 6 | 1 | 25(2.5%) |
| C4 | | 8 | 8 | 4 | 20(2%) |
| D2 | | | 2 | 1 | 3(0.3%) |
| D3 | 27 | 29 | 10 | 7 | 73(7.2%) |
| D4 | 8 | 20 | 23 | 8 | 59(5.8%) |
| Column Total | 255 25% | 334 32.70% | 250 24.50% | 181 17.70% | 1020 100% |

**Table XII : Shows the most common shade for body portion of the mandibular canines**

| Shade | 18-27 | 28-37 | 38-47 | 48-57 | Total |
|---|---|---|---|---|---|
| A1 | 6 | | | | 6(0.6%) |
| A2 | 1 | 13 | 8 | 13 | 35(3.4%) |
| A3 | 32 | 49 | 26 | 14 | 121(11.9%) |
| A3.5 | 25 | 24 | 41 | 37 | 127(12.5%) |
| A4 | 67 | 64 | 45 | 32 | 208(20.4%) |
| B1 | | | | | |
| B2 | 14 | 11 | 11 | 5 | 41(4.0%) |
| B3 | 39 | 31 | 33 | 15 | 118(11.6%) |
| B4 | 2 | 42 | 16 | 34 | 94(9.2%) |
| C1 | | | 4 | 2 | 6(0.6%) |
| C2 | 10 | 8 | 6 | 1 | 25(2.5%) |
| C3 | 30 | 29 | 17 | 8 | 84(8.2%) |
| C4 | | 8 | 8 | 4 | 20(2%) |
| D2 | | 15 | 2 | 2 | 19(1.9%) |
| D3 | 8 | 15 | 23 | 8 | 54(5.3%) |
| D4 | 27 | 19 | 10 | 6 | 62(6.1%) |
| Column Total | 255 25% | 334 32.70% | 250 24.50% | 181 17.70% | 1020 100% |



**Selection of Body Shade for Maxillary Central Incisor**

## Results

The results were based on the data collected from 1020 subjects with an age range of 18-57 years. For different shade characteristics of maxillary and madibular anterior teeth. The results has been presented in table I-XII

## Discussion

The patient tends to give great importance on the esthetic appearance of restoration. Many qualities contribute, to the overall esthetic appearance of restorations, however determining the most appropriate shade of the tooth plays a very important role to satisfy the esthetic requirements of the restoration. Since the labial surface of anterior teeth do not have a one uniform colour, the shade selection cannot be generalized. The shade of anterior teeth varies from incisors to canines, from incisal to cervical and also between maxillary and mandibular teeth. These criteria should be meticulously imporated while fabricating a crown to give life like appearance. Most of the restorations made today either by the dentist or in the laboratory aim to achieve this perfection. With the advent of modern ceramics and ceramic stains, it is possible to build a restoration from its core to its final surface finish in series of build ups in different shades for different areas of the tooth.

No doubt, such a restoration produces an excellent esthetic effect. However if the shade variations in different areas of the tooth as normally seen in the natural teeth are incorporated during the fabrication of the restoration then the restoration becomes an art of perfection. In order to reproduce the shade characteristics in restorations, a detailed analysis of the shade characteristics in natural teeth is desirable. A study was therefore planned to realize this objective. It was carried out by observing the shade variation seen in different areas of the maxillary and mandibular anterior teeth among different age group in 1020 subjects. There are some description in the literature and text books regarding the incorporation of different shades in different areas of the same tooth and the difference of shades between incisors and canine to give the restoration a natural effect. Keeping this in view this study therefore was planned to ascertain the shade characteristics of anterior teeth to incorporate different shades in anterior restorations. In this study tooth colour was obtained for each individual tooth using vita lumin shade guide. This was preferred because in this shade guide which is grouped into Reddish brown, Reddish yellow, grey and Reddish grey shades and it is the most commonly used shade guide at the present time. Shade selection was done in normal day light in the forenoon as the day light is eyes natural element and therefore the standard to which all sources are related.

In this study it was observed that the most commonest shade for the incisal 1/3rd of maxillary incisors was B-2 in 27.1% subjects which was followed by A-2 and A-1 shades whereas the commonest shade for the body portion of the maxillary incisors was found to be B-3 in 27.4% and 26.8% in central incisors and lateral incisors respectively. This shows that the incisal 1/3rd is lighter than the body portion. But belong to the same reddish yellow shade.

Commenest shade for the incisal portion of the maxillary canine was A-2 in 23.1% and A-3 for 19.1% subjects, whereas the body portion of the canine shows A-3.5 as the most common shade in 23.1% followed by A-4 in 18.6% and C-3 in 11.2% of the subjects. These observations indicates that the incisal 1/3rd of anterior teeth have a lighter shades than the body portion of the same. Canines have darker shade when compared to incisors and do not have the same shade as that of the incisors. This shows the need to incorporate these factors in the restoration for more lifelike appearance of the restoration.

The most frequent shade observed for the incisal 1/3rd of mandibular incisors was found to be B-1 in 18.0% of the subject which was followed by A-1, and B-2 shades, whereas the most common shade for the body portion of the mandibular incisors was B-2 in 16.4% followed by A-2 and A-3. This shows that the mandibular incisors are slightly lighter than the maxillary incisors. It was observed that the most commonest shade for the mandibular canine was A-3.5 and A-4.

The result of this study highlights the shade variation seen in different locations of the maxillary and mandibular anterior teeth and it should be emphasized that these must be considered during the fabrication of anterior restorations so that the restoration appears life like.

The findings of the study also suggests that the usual procedure of matching uniform shade in a complete denture anterior setup is not desirable, as shown in the study there is a shade variation between the various teeth of the anterior arch and between the upper and lower teeth, likewise the canines are darker than the rest of the anterior teeth. This information should be incorporated in the complete denture. The procedure of selecting one uniform shade should be avoided but rather select different shades for the incisors and canines. Again some shade differences should be incorporated between upper and lower teeth, lower teeth are generally lighter than their upper counterpart. Therefore this observation would particularly useful in the shade selections for the young edentulous patients. This would also break the monotony of having a monochromatic shade distribution in complete dentures.

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ORIGINAL ARTICLE

# Study of Stress Pattern on Teeth in Obturator Patient – A Finite Element Analysis

Dr. Ravi Madan, Dr. Swatantra Kumar Agarwal, Dr. Dheeraj Kumar

**Abstract :** Statement of Problem: Excessive stress on abutment teeth adjacent to a maxillary resection defect during loading of partial denture obturator frameworks may shorten the life of the teeth.

**Purpose :** Aim of the present study was to perform finite element analysis and carry out a comparative stress analysis of the obturator on the teeth adjacent to the defect in splinted and unsplinted situations.

**Material and Method :** 3 dimensional finite element models were constructed of a human maxilla that had undergone radical maxillectomy. The abutment teeth included incisors, premolars, and second molar. Incisors and molars were restored with complete metal crowns, and removable partial denture frameworks were fabricated. Static loads of 12 lbs were applied in axial direction on: (i) canine and lateral incisor; (ii) premolar region at the defect site; the resultant stresses generated in the models were displayed digitally as color coded stress contours within the given domain. The 2 teeth adjacent to the resection were then stressed in splinted and unsplinted condition.

**Results :** In unsplinted condition under load, central incisor adjacent to defect (Aramany Class I) produced tipping in mesiolingual direction .

Following splinting there was reduction in tipping of the teeth adjacent to the resection and more uniform distribution of stress around the roots of the teeth.

**Conclusion :** The results of this in vitro study suggest that splinting 2 teeth adjacent to a resection defect improves stress distribution around the roots during loading. This could increase the clinical life of the abutment teeth.

**Clinical Implications :** Splinting the two anterior teeth adjacent to a maxillary resection defect may produce improved functional stress distribution to the supporting periodontal structures and prolong the life of these teeth.

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## Introduction

Surgical resection of tumors of the maxilla and paranasal sinuses results in loss of structures, including the teeth and bone. Following such resection, support, retention and stability of the removable partial denture (RPD) acting as an obturator depends on the remaining hard and soft tissues. Thus the objective of the framework design is to preserve the remaining structures[1,2]. The design at the same time has to be based on sound engineering principles[3-5]. This becomes essential when one considers the fact that structures in oral cavity are subject to complex masticatory forces[6-8].The stresses induced due to these masticatory forces if not minimized and uniformly distributed can have detrimental effect on teeth adjacent to defect leading to early loss of teeth.

To minimize stress Ronald P. Desjardins[9] suggested the use of multiple occlusal rest and while Guy E Fiebiger et al. advocated splinting[10] ,.K.M. Lyons et al. used photoelastic model to compare the force exerted on the supporting structure of abutment teeth and concluded that without splinting, loads closer to the defect produce lingual tipping of the teeth adjacent to the resection, while splinting produced more uniform stress around these 2 abutment tooth roots for all of the models[11].

Though photoelastic method has been used as method of experimental stress analysis it shows limitations in complex geometries and give relative stress values. On the other hand finite elemental analysis is useful for analyzing complex geometries and it can determine stress throughout a 3-dimensional component purely numerically.[12]

Purpose of the study was to use finite element analysis and carry out a comparative stress analysis of the obturator on the teeth adjacent to the defect, in splinted and unsplinted situations.

**Materials and Method**

3-dimensional finite element method was used to evaluate the effect of splinting anterior abutment teeth on changes in the pattern of stress exerted by a maxillary obturator on the teeth adjacent to the defect in Aramany Class I case, simulating a force magnitude of 12 lb at two different locations of the designed obturator.

Properties of various materials used in the study and their respective properties required to carry out the finite element analysis are shown in Table 1.

Two different designs were used namely: (1) adjacent teeth were given full veneer crowns; (2) adjacent teeth were given full veneer crowns and splinted together with connectors.

Four separate 3D models of obturators were used.

**Model 1 :** Central and lateral incisor unsplinted and force exerted in lateral incisor and canine area.

**Model 2 :** Central and lateral incisor unsplinted and force exerted in premolar area.

**Model 3 :** Central and lateral incisor splinted and force exerted in lateral incisor and canine area.

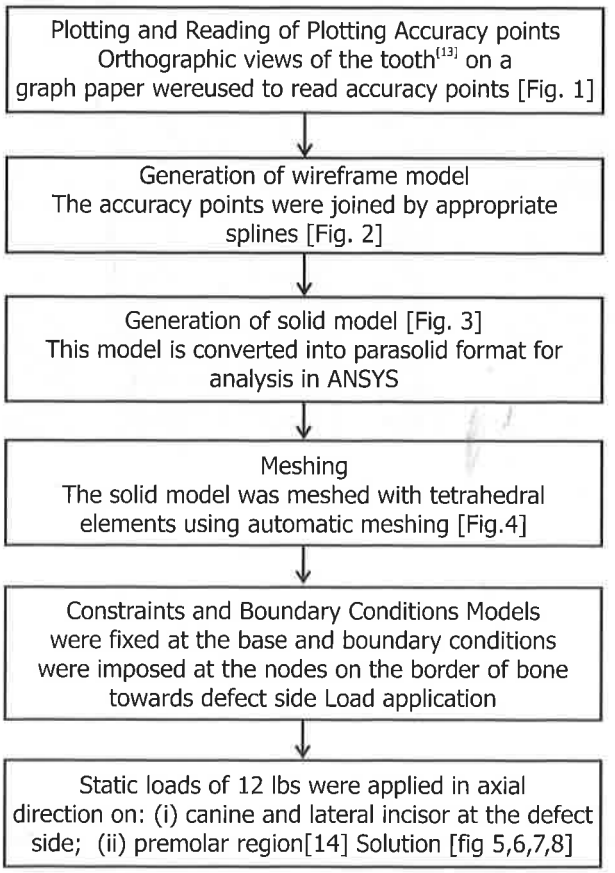
**Model 4 :** Central and lateral incisor splinted and force exerted in premolar area.

Standardization was achieved in this study by using the same master model for each situation. Partial denture designs were based on general principles.

Rests were given on central and lateral incisors and on second molar. Guide plane was placed anteriorly. Buccal retention was used on second molar. I bar was used on incisor[11].

Modeling was done using Unigraphics N x 1 and Finite Element analysis was done with ANSYS[8].

Fabrication and analysis of three dimensional finite element models of the designs under study took place in various stages, shown in the flowchart below :




**Results**

The resultant stresses generated in the models were computed and displayed digitally as color-coded stress contours within the given domain. The corresponding stress values for each color code were also displayed alongside. The von Mises stresses and the maximum and minimum displacements taking place in the model as a whole were also computed and displayed.

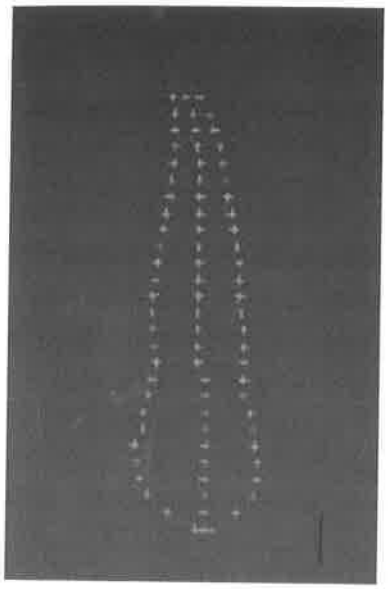


Fig : 1

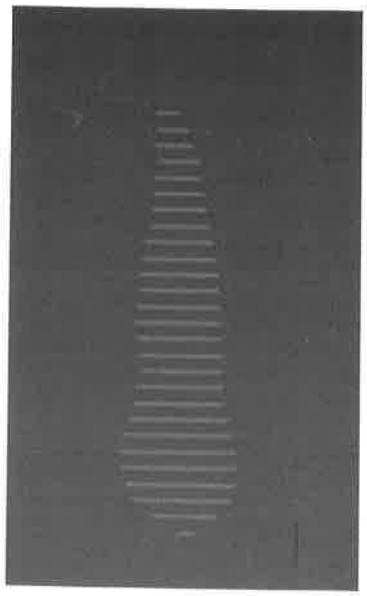


Fig : 2

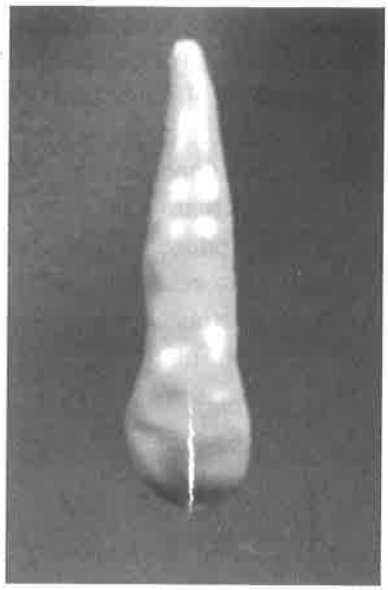


Fig : 3

Fig : 4

Fig : 5

Fig : 6

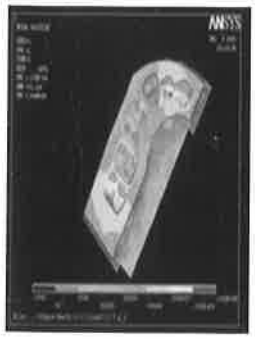


Fig : 7

Fig : 8

For ease of visualization, the obturator was removed to allow the investigator to analyze stress patterns on the prepared tooth surface.

Tables 2 through 5 showing maximum and minimum von Mises stress values in models.

**Discussion**

In this study the upper limit (12 lbs) of masticatory force in obturator patient was used. This is in accordance with the observation of Shipman who recorded the occlusal force in obturator patient and showed that the scores range from 1 lb to 12 lb [14]. Schwartzman et al also used a force of 12 lbs in two loading regions: (1) anterior zone (between central and lateral incisor) and posterior zone (at the first premolar region) [15].

The 3D models under study were loaded in axial direction, using 12 lbs force. Stress levels were calculated using the von Mises stress (or the equivalent stress) at each node as it helps in interpreting results of FEA research.

The equivalent stress at a node represents the total state of stress at that location. The magnitude of equivalent stress indicates the local sensitivity of the model to the load in question.

Each point in model had different compressive, tensile or shear stresses, which were described generally by means of X, Y and Z directions. The XX, YY, ZZ, XY, YZ and XZ stress components were also plotted and analyzed.

Standardization was achieved in this study by using the same master model for each situation. Partial denture designs were based on general principles.

Rest was given on central and lateral incisors and on second molar. Guide plane was placed anteriorly,

**Table I : Showing Materials Used**

| Material | E (Young modulus) MPa | Poisson's ratio |
|---|---|---|
| Enamel[17] | 84,000 | 0.34 |
| Dentin[18] | 18,000 | 0.31 |
| Dental pulp[19] | 0.2 | 0.45 |
| Periodontal ligament[17] | 69 | 0.45 |
| Cortical bone[17] | 10,000 | 0.30 |
| Cancellous bone[18] | 250 | 0.30 |
| Nickel chrome alloy[20] | 206,600 | 0.34 |
| Glass ionomer cement[21] | 12,500 | 0.35 |
| Cobalt Chrome[20] | 218,000 | 0.34 |

**Table II: Maximum and minimum von Mises stress values in model 1**

| Tooth | Stress | Value(N/mm$^2$) | Location |
|---|---|---|---|
| Central incisor | Maximum | 29.61 | Around the cervical aspect of the mesiopalatal area. |
| | Minimum | 0.31 | Around the cervical aspect of the labial area. |
| Lateral incisor | Maximum | 25.37 | Around the cervical aspect of the distopalatal area. |
| | Minimum | 0.95 | Around the cervical aspect of the labial area. |
| Second molar | Minimum | 1.13 | Around the cervical aspect of the distopalatal area. |
| | Minimum | 0.02 | Around the cervical aspect of the mesiopalatal area. |

**Table III: Maximum and minimum von Mises stress values in model 2**

| Tooth | Stress | Value(N/mm$^2$) | Location |
|---|---|---|---|
| Central incisor | Maximum | 23.09 | Around the cervical aspect of the mesiopalatal area. |
| | Minimum | 0.97 | Around the cervical aspect of the distopalatal area. |
| Lateral incisor | Maximum | 35.24 | Around the cervical aspect of the distopalatal area. |
| | Minimum | 1.44 | Around the cervical aspect of the labial area. |
| Second molar | Maximum | 2.53 | Around the cervical aspect of the distopalatal area. |
| | Minimum | 0.06 | Around the cervical aspect of the mesiopalatal area. |

**Table VI: Maximum and minimum von Mises stress values in model 3**

| Tooth | Stress | Value(N/mm$^2$) | Location |
|---|---|---|---|
| Central incisor | Maximum | 13.43 | Around the cervical aspect of the distal area |
| | Minimum | 0.24 | Around the cervical aspect of the mesiolabial area. |
| Lateral incisor | Maximum | 13.29 | Around the cervical aspect of the mesiolabial area. |
| | Minimum | 0.78 | Around the cervical aspect of the mesiolabial area. |
| Second molar | Maximum | 12.64 | Around the cervical aspect of the distopalatal area. |
| | Minimum | 0.31 | Around the cervical aspect of the mesiopalatal area. |

**Table V : Maximum and minimum von Mises stress values in model 4**

| Tooth | Stress | Value(N/mm$^2$) | Location |
|---|---|---|---|
| Central incisor | Maximum | 15.66 | Around the cervical aspect of the distal area |
| | Minimum | 0.45 | Around the cervical aspect of the mesiolabial area. |
| Lateral incisor | Maximum | 14.81 | Around the cervical aspect of the palatal area. |
| | Minimum | 0.93 | Around the cervical aspect of the mesiolabial area. |
| Second molar | Maximum | 14.85 | Around the cervical aspect of the distopalatal area. |
| | Minimum | 0.37 | Around the cervical aspect of the mesiopalatal area. |

buccal retention was used on second molar. I bar was used on incisor. This is in accordance with the observations of Schwartzman et al. who has shown that the use of an I-bar retainer with cingulum combination for transmitting occlusal forces along the long axis of the tooth in anterior region[15]. Parr et al and Aramany advocated that teeth adjacent to the anterior margin of the defect should have a positive rest seat and retainer for adequate retention and said that these ensure proper orientation of the prosthesis and help prevent rotation of the prosthesis out of the retentive area posteriorly[1-2].

Schwartzman et al. and Meyers et al. showed that buccal retention with palatal reciprocation induces less stress on the teeth than palatal retention and buccal reciprocation[15-16].

Use of guide plane 1-2 mm on teeth adjacent to defect have been shown to prevent rotation of prosthesis by Parr et al. and Schwartzman et al. [2, 15].

## Conclusion

The results of this in vitro study suggest that splinting 2 teeth adjacent to a resection defect improves stress distribution around the roots during loading. This could increase the clinical life of the abutment teeth.

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ORIGINAL ARTICLE

# Retentive Properties of Luting Cements on Metal and Porcelain Fused to Metal Copings : An In Vitro Study

Dr. Padmapriya Puppala, Dr. Ravindra C. Savadi, Dr. Surendra Kumar G.P

**Abstract :** The retention of indirectly fabricated restorations can be compromised by the luting agent. Retention of crowns also depends on factors such as the type of alloy used. This study evaluated the retentive properties of 4 luting cements on 2 types of base metal alloys used for metal and porcelain fused to metal (PFM) crowns. Eighty extracted mandibular premolars were prepared to receive full cast copings with a flat occlusal surface, ideal taper, and 4-mm axial length. Half of the standardized metal copings were cast in Wirolloy (nickel chromium alloy for full metal crowns) and the other half were cast in Bellabond (nickel chromium PFM alloy). Cementation was performed with four luting cements: Zinc Phosphate, Glass Ionomer, Resin-Modified Glass Ionomer and Resin cements. The specimens were thermocycled and vertical tensile force was applied in a universal testing machine with a constant speed until separation was noted. A 2- factor analysis of variance was used to analyze the data, with a significance level of $\alpha = .05$.

Within the limitations of this study, the resin cement showed significantly higher retentive strengths for both the alloy copings in comparison to the other cements tested.

**Keywords :** Metal crown; luting cement ; resin cement; retention.

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## Introduction

Dentists place full metal and PFM crowns with high frequency in their clinical practice, and the luting agents used to retain these castings are critical to their success and longevity of these restorations. The cements used in fixed prosthodontics include Zinc phosphate, Polycarboxylate, Glass ionomer, Resin-Modified glass ionomer [1] and Resin cements.

The "gold standard" luting cement for many dentists remains zinc phosphate since 1879[1]. Excellent clinical performance for fixed partial dentures cemented with zinc phosphate cement is attributed to its high fatigue strength [2]. Three other cements that clinicians have used with success during the last 40 years are zinc polycarboxylate, chemically cured GIC and conventional Resin in combination with a Dentin Adhesive system.

The development of Resin- Modified Glass-Ionomer cements in the late 1980s offered the benefits of glass-ionomer cements, adhesion and fluoride release, along with improved physical properties to reduce the chances of cement cohesive failure [3,4].

The biggest advantage of these cements is their ease of use, since multiple bonding steps are not required [4]. A disadvantage is its hydrophilic nature

due to the formation of poly-[hydroxyethyl methacrylate] during the setting reaction, resulting in increased water absorption and hygroscopic expansion [5].

Resin luting cements used with dentin bonding agents have been shown to enhance crown retention compared to other classes of cements. The ability to adhere to multiple substrates, high strength, and insolubility in the oral environment are its major advantages [6, 7].

The choice of metal may also affect retention of the cemented crown [8]. Base metal alloys contain less than 25 wt% noble metal according to ADA specification. Ni-Cr alloys possess good mechanical properties, such as high hardness, low density, and high tensile strength. Besides, the low cost and easy fabrication of Ni-Cr alloys have made them popular for fixed prostheses. These alloys generally contain ≥60% nickel. They may contain >20wt% chromium, <20% chromium with no beryllium or 1-2% beryllium. Porcelain–bonding alloys are distinct from full metal alloys largely because the former require melting ranges that can survive the application of porcelain. The anti-corrosive property and the porcelain/metal interfacial bonding characteristics of Ni-Cr alloys are of great importance [9]. The surface composition of metal–ceramic alloys is dramatically different from their bulk composition [10]. The presence of alloying additions is responsible for differences in castability, mechanical behaviour and oxide formatio [11]. Limited information is available concerning the retentive strengths of Ni-Cr alloys used for PFM restorations and that used for full metal restoration, cemented with different luting cements.

The purpose of this study was to evaluate the retentive properties of 4 different luting cements on 2 types of base metal copings used for metal and PFM crowns

## Material and methods

Eighty recently extracted caries-free mandibular premolars were embedded in acrylic resin blocks in MS cylinders (12x20 mm) 2mm below the cementoenamel junction. Standardized tooth preparations for full metal copings were performed using an air-rotor (NSK 2000,Korea) and a flat end tapered diamond bur (no.12 Mani Dia-burs) mounted on a custom made jig attached to the dental surveyor (Broken arm surveyor, Ticonium Company). The taper of the axial wall was standardized by keeping the bur in a fixed position within a custom made metal ring for all the preparations, Figure I. The occlusal surfaces were flattened perpendicular to the long axis of the teeth. The cone shaped preparations were at least 4-

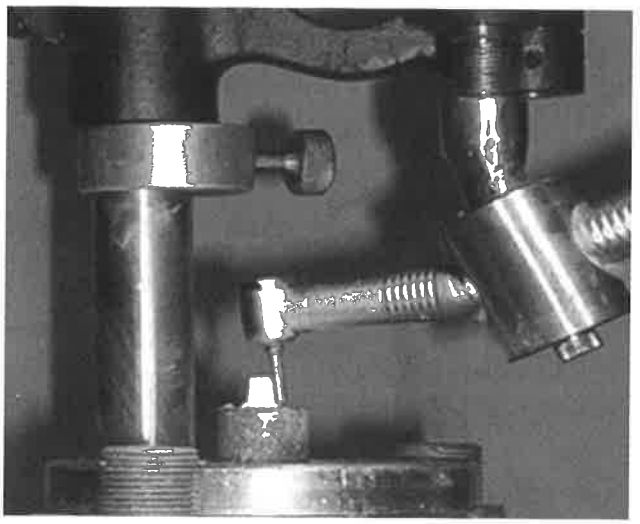

**Fig I : Air Rotor Handpiece mounted onto Surveyor for Standardized Crown Preparation with a custom made jig**

mm high, with an occlusal diameter of 4 mm, and prepared entirely in dentin. Silicone impressions (Provil Novo, Heraeus Kulzer, Germany) of the prepared teeth were made, and casts were poured in Type IV dental stone (Kalrock, India). The stone dies were trimmed and 2 coats of die spacer (Tru-fit, Geo. Taub Products and Fusion Co., Jersey City, N.J.) were applied to each master die. The wax patterns were fabricated by dipping the die in a molten wax (GC, Inlay Wax Medium, USA) to achieve a consistent thickness of 0.7 ± 0.025 mm. A wax ring was attached on the occlusal surface of the wax pattern parallel to the long axis of the tooth preparation to allow tensile testing. The wax patterns were invested with phosphatebonded investment (Bellasun, Bego, Germany). Half of the wax patterns were cast in Ni–Cr–Mo alloy (Ni-63.4, Cr-21.6, and Mo-9.5, Bellabond Plus, Bego, Germany) (Alloy 1) used for metal ceramic crowns , and the other half were cast in Ni Cr alloy (Ni-

63.2, Cr - 23, Mo 3.0, Wirolloy; Bego, Germany) **(**Alloy 2**)** used for metal crowns. Casting was performed according to standardized techniques in an Induction-Casting Machine (Bego, Germany). After the inferior surfaces of the copings were sandblasted with 50-µm aluminum oxide particles (Sandy Plus) for 20 sec, all copings were evaluated for accuracy of marginal fit. Before cementation, it was verified that all castings were not selfretentive by ensuring that the copings separated from the tooth preparation dies without any resistance when the specimens were held upside down.

**Grouping of specimen :** Table 1 lists the cements and alloys used in the study.

The 80 specimens were grouped into 2 groups of 40 each according to the alloy used as

1. Alloy1 (Bellabond)
2. Alloy 2(Wirolloy).

The castings were further divided into 4 groups of 20 specimens. 20 specimens were cemented with 1 of the 4 luting cements, 10 for each Alloy group.

Four cements were used for luting the copings

1. Group A - Adhesive Resin Cement (ARC, 3M ESPE, Saint Paul, MN, USA)
2. Group B – RMGIC (RELY X luting 2, 3M ESPE, USA)
3. Group C – GIC (GC, FUJI I, USA)
4. Group D - Zinc Phosphate cement (Harvard Cement, Richter and Hoffmann, Germany)

The ARC resin cement is a two-paste clicker system, which allowed equal quantities of base and catalyst to be dispensed for mixing. The RMGIC also is dispensed as two-paste clicker system. The powder-liquid ratios for the cements used were in accordance with the manufacturers recommendations.

Pre-treatment of the dentinal surfaces was required for crowns luted with the resin cement and was carried out following the manufacturers instructions. The dentin was etched for 15 seconds with 37% phosphoric acid (Scotchbond multipurpose etchant, 3M ESPE,USA) for specimens cemented with ARC. The preparations were rinsed for 20 seconds and moisture was removed till the dentin remained visibly moist, the dentinbonding agent (Adper single bond adhesive, 3M ESPE, Saint Paul, MN, USA) applied in 2-3 consecutive coats for 15 seconds and air thinned for 5 seconds. The bonding agent was light cured (Heraeus Kulzer, Germany) for 20 seconds. Pretreatment of bonding surface of the casting was also required. The metal bonding surfaces were roughened with round diamond burs (Mani Dia, no 10.). Silane agent (RelyX Ceramic Primer, 3M ESPE, Saint Paul, MN, USA) was applied to the bonding surface of the metal casting and air dried for 5 seconds [12, 13].

**Cementation:** A thin, even layer of each of the mixed cements was applied to the fitting surface of the coping and seated on its respective preparation by hand pressure. A static load of 50N was applied and maintained for 10 minutes at 90% relative humidity in a humidifier. Excess cement was removed, and specimens were then stored in distilled water at 37°C for 24 hours and Thermocycled (C M Equipments & instruments, Bangalore) between 5°C and 55°C for 500 cycles, with a dwell time of 30 seconds, Fig II. A vertical Uniaxial tensile load (5000 N load cell) was applied to each casting with a Universal TESTING machine (Monsanto Tensometer Type 'W', Hounsfield, UK) with a constant speed of 3mm/min, and separation forces were recorded, Fig IIIa and Fig IIIb.

**Fig II: Thermocycled samples**

**Table 1: Description of the cements and alloys used**

| Product Name | Producer | Composition | Dispensing method/ P:L ratio |
|---|---|---|---|
| Zinc phosphate (Harvard) | Richter & Hoffman, Germany | P: 10% MgO. 90% ZnO<br>L: 67% Phosphoric Acid<br>Buffered 33% Water with Aluminium and Zinc. | 3:3 |
| Glass Ionomer Cemnet (GIC) (Fuji I) | GC, America | P: Calcium Fluroalumino Silicate Glass L: Conc. Aqueous Solution Of Polyacrylic Acid | 1:2 |
| Resin Modified GIC (Rely X Luting 2) | 3M ESPE<br><br>Saint Paul, MN, USA | Clicker dispenser system<br>Paste A: Fluoroaluminosilicate glass , HEMA ,Water<br>Paste B: Methacrylated polycarboxylic acid, BisGMA, HEMA, Water, Potassium persulfate, Zirconia silica filler | 2 clicks for crown |
| Dual cure Adhesive resin crowncement (RelyX ARC) | 3M ESPE, Saint Paul, MN, USA | Clicker dispenser system<br>Paste A: BisGMA , Zirconia/silica filler, Amine Photoinitiator system. , Pigments<br>Paste B: TEGDMA , Zirconia/silica filler, Benzoyl peroxide<br>Etchant: 37% phosphoric acid<br>Adhesive : Scotchbond 1- BisGMA, HEMA, Dimethacrylates, polyalkenoic acid, initiator, water, ethanol<br>Ceramic Primer: Prehydrolyzed silane-coupling agent (gammamethacryloxypropyl trimethoxysilane), ethanol and water | 3 clicks for |
| Bellabond plus | Bego, Germany | Nickel- 63.4% , Chromium- 21.6% ,Mo-8.4% , Nb-4.2% , Fe-2.2%, Al-0.2% | |
| Wirolloy | Bego, Germany | Nickel-63.2 % ,Cr-23.0%, Mo-3.0% ,Si-1.8%, Fe-9.0 %, C < 1.0% | |

**Table 2: Mean value of separation forces in newtons [ Data are given as mean (SD)]**

| Cements | Alloy1- Bellabondplus | Alloy2- Wirolloy |
|---|---|---|
| A-RelyX ARC | 437.56 (77.58) | 469.02 (100.84) |
| B-RelyX Luting 2 | 432.44 (122.95) | 414.37 (65.61) |
| C- GC Fuji | 370.02 (86.89) | 395.46 (84.84) |
| D-Zinc Phosphate- Harvard | 336.78 (125.32) | 406.29 (128.15) |

**Table 3 : Two way analysis of variance**

| Source of variation | df | Sum of squares - SS | MS | F ratio | pvalue | F crit |
|---|---|---|---|---|---|---|
| Cements | 3 | 85119.93 | 28373.31 | 2.75 | 0.048 | 2.731 |
| Alloys | 1 | 14671.94 | 14671.94 | 1.42 | 0.236 | 3.973 |
| Interaction | 3 | 19303.50 | 6434.502 | 0.62 | 0.601 | 2.731 |
| Within | 72 | 742374.45 | 10310.76 | | | |

**Table 4 : Descriptive for cements**

| | N | Mean | SD | Minimum | Maximum |
|---|---|---|---|---|---|
| A | 20 | 453.29 | 89.04 | 352.3 | 681 |
| B | 20 | 423.41 | 96.36 | 205.9 | 654 |
| C | 20 | 382.74 | 85.59 | 265.4 | 587 |
| D | 20 | 371.54 | 128.41 | 199.1 | 594 |
| Total | 80 | 407.74 | 104.43 | 199.1 | 681 |

**Table 5: Distribution of mode of cement failure in percentages**

| | Adhesive failure (cement on tooth) | Adhesive failure(cement on casting) | Cohesive failure | Dentinal fracture |
|---|---|---|---|---|
| | | Group A | | |
| Alloy1<br>Alloy2 | 25%<br>20% | 5%<br>5% | 10%<br>5% | 15%<br>15% |
| | | Group B | | |
| Alloy1<br>Alloy2 | 15%<br>- | 5%<br>10% | 20%<br>20% | 10%<br>10% |
| | | Group C | | |
| Alloy1<br>Alloy2 | 25%<br>- | 10%<br>10% | 15%<br>20% | 10%<br>10% |
| | | Group D | | |
| Alloy1<br>Alloy2 | -<br>- | 45%<br>15% | 15%<br>5% | 15%<br>15% |

The fitted surfaces of the separated castings were examined visually to determine the mode of cement failure, Fig IV and Fig V. All specimens were fabricated and measured by the same examiner. Separation force data were analyzed statistically by use of 2-way analysis of variance ($P < .05$). Duncan multiple range test analysis was also used to distinguish statistically significant groups.

## Results

Mean and SD values of the luting cements for the 2 metal alloys are presented in Table 2. The lowest mean values were recorded for Group D cement for Alloy1 (336.78 N) and Group C for Alloy2 (395.46 N). The SD values observed for Group D cement were relatively higher in comparison to those for the other

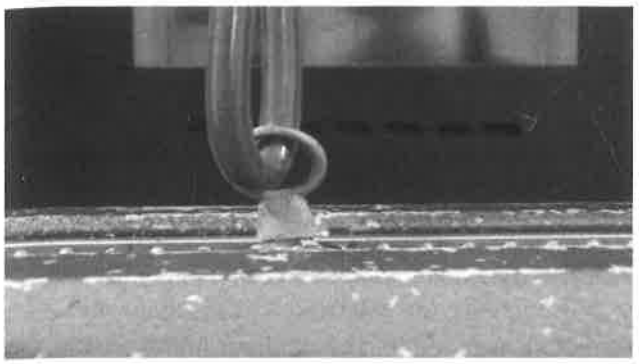

**Fig III a: Fracture load**

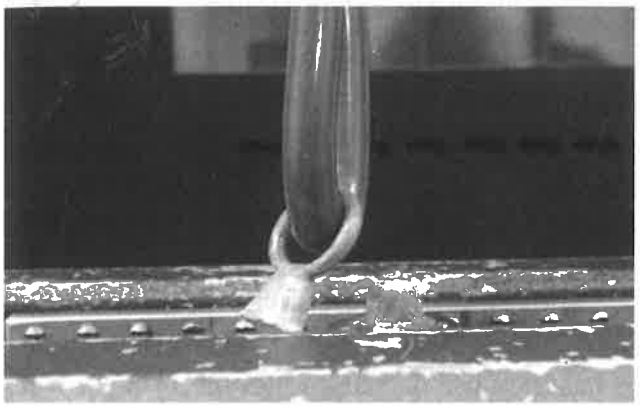

**Fig III b: Fracture load**

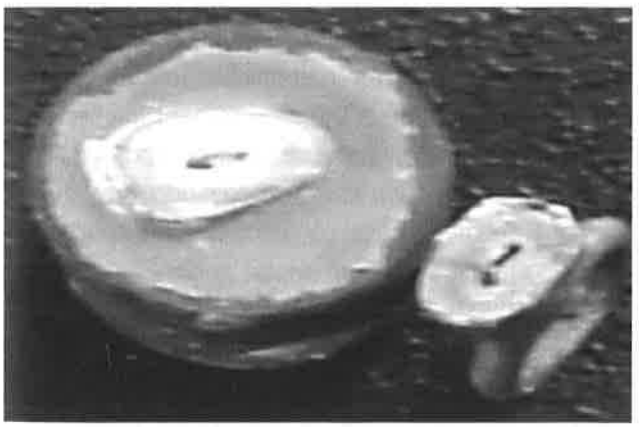

**Fig IV: Dentin Fracture**

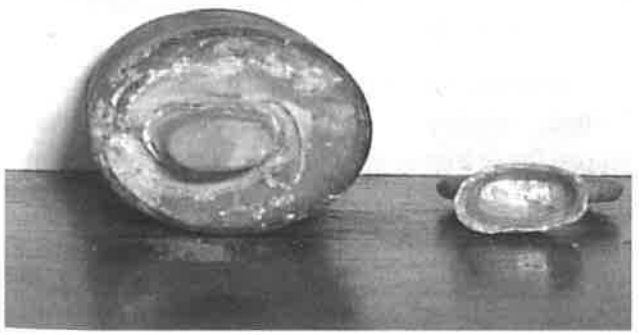

**Fig V: Adhesive failure - cement on tooth**

luting cements tested. The highest value of mean retentive force (469.02) was observed for GroupA cement for the Alloy2.

There were no significant differences among the mean values of the cement within each group and further there was no interaction between Alloy1 and Alloy2. The comparison of mean values of the four types of luting cements showed no statistically significant difference within the alloy groups. However when all the eight groups under both the alloys were combined the differences in the mean values across the groups showed a statistically significant difference, Table 3 ($F=2.75$, $p<0.05$).

The one-way analysis of variance showed a significant difference in the mean values of the luting cements ($F=2.78$, $p< 0.05$). Duncan's Multiple range test showed that this difference is mainly due to the Group D cement and Group A cement ($p<0.05$) The Group A cement showed significantly higher retentive strengths to both the alloy groups than the other cements tested. The Group B cement and the GroupC cement showed higher retentive strengths than the Group D cement though they did contribute to the significant difference. The Group D cement showed the lowest retentive strength than all the cements tested

The results obtained in this study demonstrated no significant difference between the alloys used and between the cements-alloy combinations. The data indicates that the Group A cement had the highest retention with either of the alloy and Group D had the lowest retention. Between the alloys, highest retention was found for the Alloy2) and lowest for Alloy2 though it was not statistically significant.

The distribution of the mode of cement failure with Alloy1 and Alloy2 is given in Table 5. Horizontal fracture of coronal dentin occurred in 15% of both Alloy1 and Alloy 2 specimens with Group A cement. 45% of the Alloy1 specimens cemented with Group D cement showed adhesive failure between the tooth and the cement. 30% of Alloy2 specimens cemented with GroupC showed cohesive failure.

## Discussion

Failure of retention of crowns occurs under a combination of masticatory forces repeated over a period of time. In this study a direct tensile force was applied axially to the crowns and it may be suggested that this force is rarely applied to a crown in vivo, except when masticating high viscosity foods that adhere to the occlusal surfaces of the opposing teeth. However, failure of crowns as a consequence of extreme transient conditions cannot be discounted.

The in vitro studies that evaluated the retention of luting cements on crowns were performed mostly by direct tensile loading without considering the cyclic loading considered to simulate clinical conditions [15-18].

In a recent study, Yim et al [17] pointed out that inconsistent results were obtained in past research that has not controlled preparation surface area when examining the retentive strengths of cemented cast crowns. They showed that the use of standardized crown preparations in combination with a carefully designed tensile testing method produced remarkably lower variation in crown retention values.

Because the adhesive and mechanical properties of luting cements were shown to be highly affected by the existence of humidity and thermal effects [6], the existence of humidity in the oral environment should also be considered in the in vitro testing of luting cement retention. For this reason, all luting agents were allowed to set under humid conditions; the specimens were thermocycled before tensile testing according to the ISO amendment 10477 [8].

Two conventional (acid-base) cements, zinc phosphate and GIC, and adhesive resin-based luting agents were selected for this study to represent 2 distinct groups of luting agents. The RMGIC group was included in this study because it overlaps both the acid-base group and resin-based luting agent groups. The results of this study showed that when subjected to a tensile pull-off test, the crowns failed in a manner which is commonly found clinically that is, by adhesive and/or cohesive failure of the cement.

Clinical observation shows that PFM crowns rarely fail by dentin fracture, but frequently fail by cement failure, and thus it may be concluded that application of an axial tensile load is a logical method by which to evaluate the likely performance of each of the cements.

Table 4 shows the necessary load (Newtons) for crown failure luted with the cements independent of the alloy type. The results showed that there was a significant difference between the mean values of retention recorded for the different luting agents. No statistically significant difference between agents was observed for each type of alloy tested.

The present study also shows that the zinc phosphate and the conventional GIC are not different from a retention standpoint. Both cements performed a traditional luting function. Conventional GIC interacts interfacially with the tooth structure creating covalent bonds. Gorodovsky and Zidan [3] showed that the role of these bonds was not significant in increasing retention.

Ergin et al [8] showed that the adhesive resin cements exhibited comparable tensile bond strengths. The highest bond strengths were achieved with base metal alloys and the lowest with high-noble alloys. It is evident that the factor responsible for the greater crown retention shown by resin cement in this work was the hybrid layer produced during impregnation, diffusion, and monomer polymerization into dentin previously etched by acid conditioners. The application of the ceramic primer to metal surfaces , a silane primer in this study, was probably an additional feature explaining the higher bond strength values reached by the resin cements, as the use of a catalytic agent may increase the wettability of the luting material to treated surfaces. Silane coupling agents have the ability to form a durable bond between organic and inorganic materials.

Following hydrolysis, a reactive silanol group is formed, which can condense with other silanol groups,for example, those on the surface of siliceous fillers, to form siloxane linkages. Stable condensation products are also formed with other oxides such as those of aluminum, zirconium, tin, titanium, and nickel [12, 14]. Water storage and thermal cycling increased the bond strength of all resin cements [19]. These results

may be attributed to a postpolymerizing of the resin-based agents leading to increased bond strength.

The relatively lower performance of the RMGIC in comparison to the resin cement can be attributed to the lack of any surface conditioning procedure before luting [8]. Thus it appears that resin-based or modified cements should be used in combination with surface-conditioning agents or adhesive to obtain the best results.

The distribution of mode of cement failure revealed that fracture occurred at both the cement-metal and cement-tooth interfaces for copings luted with the zinc phosphate and GIC. Only in 25% of specimens of glass-ionomer and 15% of RMGIC luted to Alloy1 was the cement observed to completely remain on the prepared tooth.

However, cement was completely retained on the prepared tooth for 25% Alloy1 copings and 20% of Alloy2 copings luted with the resin cement. The adhesive bond of resin cement to tooth structure appeared to enhance superior bond of resin cement to tooth structure. On the other hand, in Alloy1 copings luted with the zinc phosphate cement, cement was observed to be retained totally on the metal surface for almost half the specimens. This shows that the inadequate bond of phosphate cement to the dentinal surface, most likely resulting from lack of adhesion to the tooth structure, causes the weak link of the cemented coping assembly to occur at the cement-tooth interface during tensile debonding. Cohesive dentin fracture was observed for more than 35% of the copings cemented with the RMGIC and the conventional GIC was in agreement with the higher retentive values recorded for these cements.

The relative ability of each cement to retain full-coverage PFM and metal crowns and their modes of failure concur with what is already known of the physical properties of the cements. Mitchell et al [20] measured the fracture toughness of conventional, RMGIC and composite luting cements. They found that the fracture toughness of the RMGIC was significantly higher than the conventional GIC tested and the resin cement was significantly higher than that of the resin-modified glass-ionomer cement. The glassionomer cements in this study failed cohesively which may be anticipated from their relatively low fracture toughness values. The resin composite and RMGIC failed in a mixed cohesive adhesive pattern reflecting their significantly higher fracture toughness which meant that some of the stress of the displacing force was applied to the adhesive interface between the cement and the dentin resulting in adhesive failure.

Relatively lower SD values recorded for GIC could be attributed to the assumption that handling was less technique-sensitive. The higher SD values recorded for resin and RMGIC indicate that the luting system becomes more technique-sensitive as the adhesive bond to tooth structures is enhanced.

In this study the lowest mean retentive strength was recorded for the glass ionomer cement luted to Alloy2. The values for zinc phosphate were not significantly lower than either the RMGIC or the conventional GIC for both the alloy groups.

The values of the tension resistance, dependent on the cement factor, were not statistically significant when Alloy1 (Bellabond) and Alloy2 (Wirolly) were compared.

Table 3 shows that there were no statistical differences between the mean retentive values for the cements and the type of alloy used ($p>0.05$), that is Ni-Cr alloy for PFM restorations and Ni-Cr alloy used for full metal restorations. This fact probably occurred because the influence of the type of base metal alloy used for the fabrication of the crowns was least during the crown retention test, due to the mechanical properties of the cements that promoted smaller interaction among the two Ni-Cr alloys.

All cements were statistically different independent of the base metal alloy type in which the greatest value was obtained with the resin cement and the smallest by the zinc phosphate cement. The resin cement showed the greater tensile strength values, followed by RMGIC, conventional GIC and zinc phosphate cement independent of base metal alloy type. When the base metal alloy type was considered, there were no significant differences in the tensile strength values among cements, and the resin cement showed the greater means differing from the zinc

phosphate, RMGIC and the GIC between the alloys, both with almost similar values.

Therefore a crown cemented with either zinc phosphate or the resin composite cement is unlikely to fail at very low loads, even though the resin cement is significantly more retentive than zinc phosphate cement.

The strength of the cement joint is the function of the quality of the bond and the mechanical properties of the cements. If the cement is nonadhesive or weak mechanically, preparation taper plays the main role in the ability of the crowns to resist the dislodging forces. Ni-Cr crowns with ideal taper can be either luted with conventional cements or with resin cements without affecting the clinical outcome.

RMGIC appears to possess most of the characteristics desired by most clinicians and is an excellent choice for routine cementation of most metal and PFM crowns.

When additional cement strength, translucence or a choice of cement colors is required, resin cements can fulfill those needs[21, 22].

## Conclusion

Within the limitations of this in-vitro study, the following conclusions were made:

- The adhesive resin cement showed significantly high retentive strengths to both the alloys.
- The mean retentive strength of RMGIC was higher than the GIC and the zinc phosphate cement.
- Cohesive dentin fracture occurred with RMGIC and the GIC on coping separation
- No correlation was observed between the retentive qualities of cements for the alloys used.
- All four test cements can be used satisfactorily when they are prepared according to the manufacturers' recommendations for any of the base metal alloy restorations.
- However, RMGIC still is an excellent choice for routine cementation of most indirect restorations.
- Attempts to remove crowns cemented with resin or RMGIC are usually futile and can easily be harmful to abutment teeth. Removal of crown cemented with GIC is difficult. Crowns cemented with zinc phosphate are the easiest to remove.

The results of this study may be helpful when making the clinical decision of which cement to choose when cementing a full metal or PFM crown. It can be anticipated that overall the probability of survival of a crown cemented with zinc phosphate will be equal to that of crowns cemented with the conventional GIC. If fluoride release is thought to be important to the individual patient, the clinician must choose between the conventional GIC and the RMGIC. Unless the anticipated displacing forces are low, such as opposed by a denture, the conventional GIC is a poor choice as the probability of failure in function is high.

Conversely, choice of the RMGIC risks fracture of the tooth if trauma is sustained, due to the high loads this cement can withstand prior to failure. Additionally, if the crown requires removal at some time in the future this will probably necessitate its destruction by drilling of the casting, as opposed to a crown cemented with zinc phosphate cement where flexure of the casting is often sufficient to break the cement lute enabling the crown to be removed intact and re-used if required.

A comparison of the properties of the RMGIC and the resin shows that overall they are both likely to survive a given load, but that the resin is less likely to fail at very low loads. However, this advantage is offset by the ability of RMGIC to release fluoride and the increased number of clinical steps and consequent time required to cement a crown with the resin cement.

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ORIGINAL ARTICLE

# The Effect of Water and Water Substitutes on The Compressive and Tensile Strength of Commonly used Die Materials

Dr. Dhaded Sunil, Dr. Neha Dhaded

**Abstract :**

**Purpose :** This study was designed to evaluate and compare the effect of water and water substitutes (slurry water, double distilled water and tap water) on the compressive and tensile strength of commonly used die materials.

**Materials and methods**

Standard cylindrical metal dies were fabricated with an internal diameter of 15mm and length 10mm. A total of 480 putty wash impressions were made using double mix double impression technique. The impressions were grouped in 2 categories of Ultra rock and silky rock samples (240 each). Further this was divided into 3 groups based on the different water substitutes (80 each). Standard universal testing machine was used for testing the compressive and tensile strength, at a cross head speed of 0.5 cm/min. The readings were recorded for the load of failure and when the specimens were splint in two fragments and all the results were subjected to statistical analysis.

**Results**

Slurry water imparts the maximum compressive and tensile strength to the material at the end of the 1 hour and 24 hours when compared with tap water and double distilled water.

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## Introduction

Gypsum is one of the most commonly mined minerals of the world and has been used since time immemorial. In dentistry it served mainly for the purpose of making models, and as an adjunct to various dental laboratory operations that are involved in the fabrication of various oral and maxillofacial prosthesis.

In fixed prosthodontics precision is very vital. Indirect method of fabrication of inlays, crowns and bridges demand gypsum products that are of the higher quality with respect to accuracy and strength1.

Therefore the present study was taken up to evaluate and compare the effect of water and water substitutes on the compressive and tensile strength of commonly used die materials.

## Material and Methods

### List of Materials

1. Ultra Rock : Super hard die stone –Type IV(Kalabhai, made in India Karson, Mumbai)
2. Silky Rock : Type IV (whipmix, USA)
3. Caulk Tray Adhesive (Caulk Dentsply)
4. Aquasil Quadrafunctional siloxane impression material- soft putty and low viscosity. (Dentsply Germany)

5. Double Distilled Water
6. Slurry Water
7. Tap water.

**Operating protocol :** Tests related to this study were performed between 8.30 am to 5.00pm and the temperature ranged between 25-30°c.

Standard cylindrical metal dies were fabricated with an internal diameter of 15mm and length 10mm. A hook was soldered on to the superior aspect of the metal die to facilitate removal of the die from the impression.

Plastic cylindrical trays were painted with a uniform layer of tray adhesive. The putty wash impression were made using double mix double impression technique. Equal amounts of base catalyst of putty material were mixed and placed in the selected tray, and then the specimen with the spacer (cellophane paper) was inserted into the putty material to make an impression. After 10 minutes the metal dies were retrieved from the impression and checked for voids.

Both gypsum and non-gypsum materials are used for making dies. Non- gypsum die materials like acrylic resin, epoxy resin and polyester have been used but their use was limited since they are incompatible with certain impression materials and also exhibit curing shrinkage. Therefore gypsum materials enjoy the popularity because of the ease of manipulation and cost.

Irrespective of popularity, these materials tend to fracture while separating from elastomeric impression especially made of long and narrow tooth preparations. Therefore the exact time period for the retrieval of the cast from the impressions is critical, at the same time casts are subjected to considerable flexural constraints when removed from impressions. All the above factors are dependent ultimately on the strength of the die material.

It was reported that die stones mixed with water substitutes resulted in significantly increased surface hardness and compressive strength. The strength and consistency of dental gypsum products were found to be highly affected by the type and amount of mixing water that was added.

Later the light body was auto mixed and syringed directly onto the metal die, the specimen is seated onto the preloaded putty impression. After 10 minutes the metal die was retrieved and the impression was rechecked.

A total of 480 impressions were made and grouped accordingly: Group A- Ultra Rock (240 impressions) Group B- Silky Rock (240 impressions). These 240 impressions were further subdivided into 3 sub groups depending upon the different water substitutes as sub group 1, 2 and 3 respectively (tap water, double distilled water, slurry water) each 80 samples.

**Specimen preparations**

Throughout the experimental procedure it was observed that all test samples were manipulated under the same conditions of water/ powder ratio and mixing time. All samples were vacuum mixed and method of manipulation of the die material was strictly followed:

Group-I Ultrarock 20ml of water in 100 gms of powder

Group–II Silky rock 23 ml of water in 100 gms of powder with mechanical mixing of 30 secs.

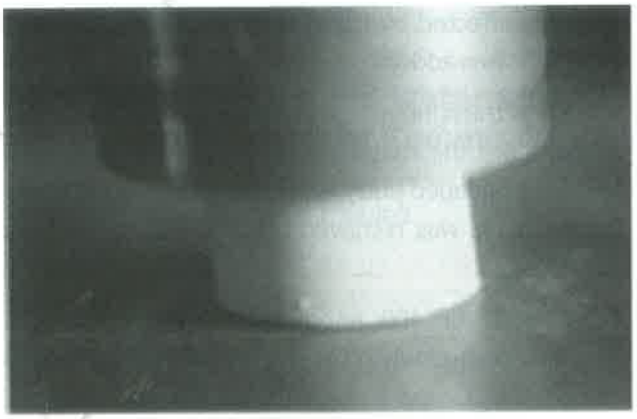
**Testing procedure**

Universal testing machine was used for testing the compressive strength of the specimens.

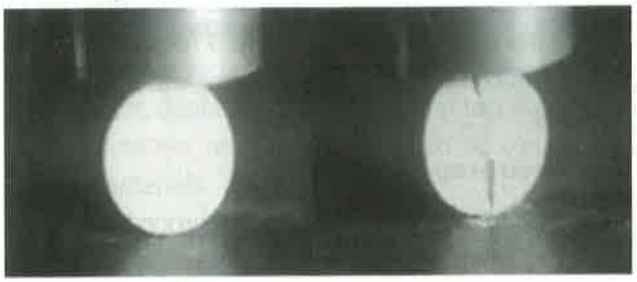
Compressive strength was tested by using a flat plate against the centre of the specimen at cross head speed of 0.5cm/minute and the reading of the load of failure was recorded. The same machine was used for testing the tensile strength in the same way except the test samples were placed on the platform diametrically. The readings were recorded when the specimen were split into two fragments. The tensile strength is directly proportional to the compressive load and its magnitude is given by $TS=2p/\Pi xDxT$

Ts- Tensile strength

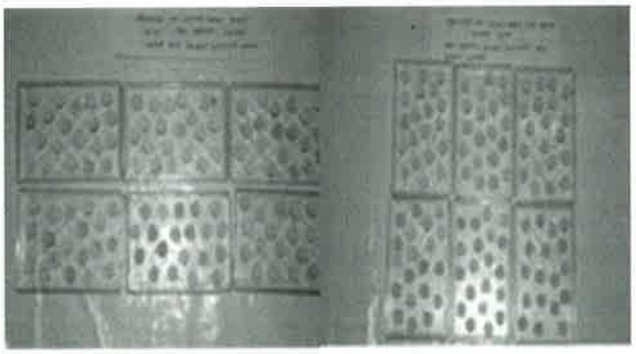
p- Load applied



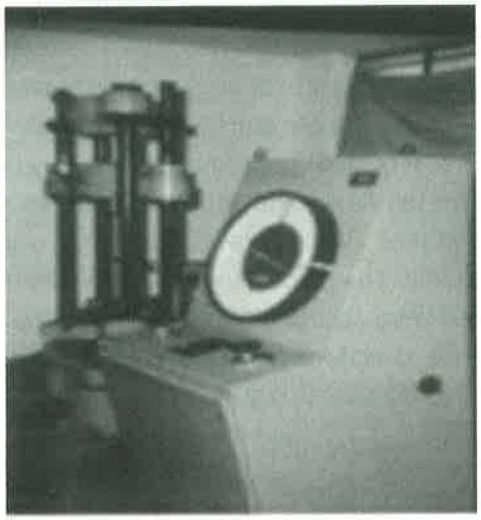
Display Unit of UTM of Compressive Strength



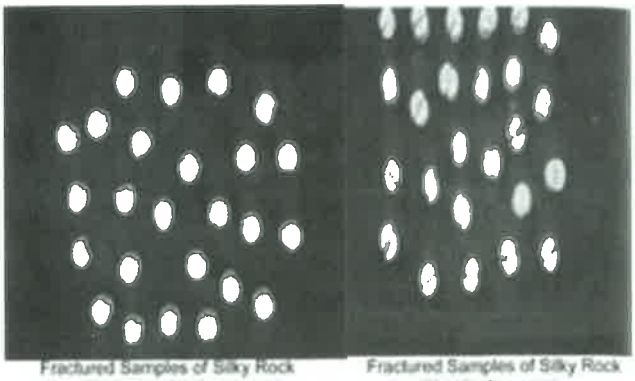
Display Unit of UTM of Tensile Strength



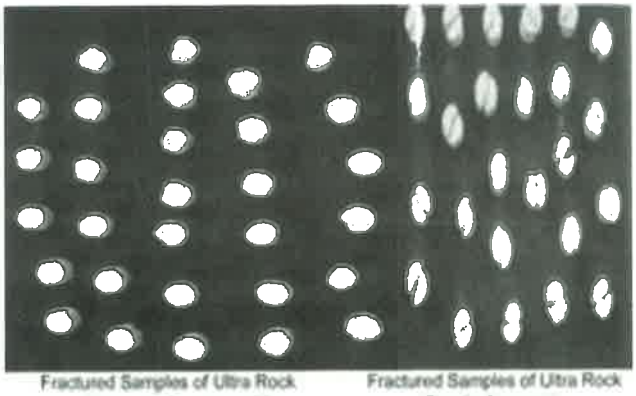
Poured Samples of Ultra Rock Poured Samples of Silky Rock



Universal Testing Machine

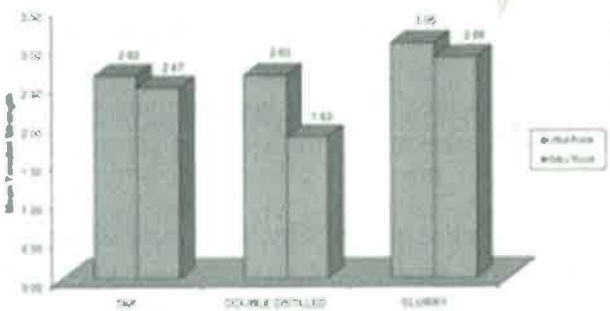


Fractured Samples of Silky Rock (Compressive Strength) Fractured Samples of Silky Rock (Tensile Strength)



Fractured Samples of Ultra Rock (Compressive Strength) Fractured Samples of Ultra Rock (Tensile Strength)

GRAPH NO.2 : COMPARISON OF TENSILE STRENGTH OF ULTRA ROCK AND SILKY ROCK AT 24 HOURS (TENSILE STRENGTH)



GRAPH NO.1 : COMPARISON OF COMPRESSIVE STRENGTH OF ULTRA ROCK AND SILKY ROCK AT 24 HOURS (COMPRESSIVE STRENGTH)

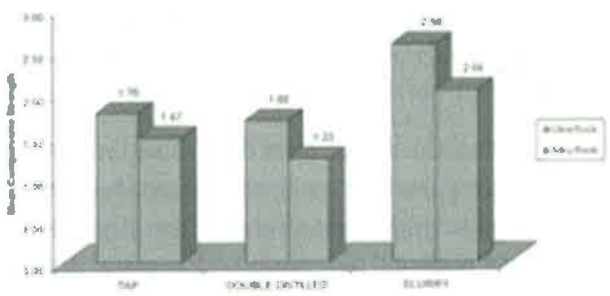


**Table No.1 : Comparison Between Ultra Rock And Silky Rock (Compressive Strength)**

| S.N. | 1 Hour | | | 24 Hours | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 |
| Ultra rock | 1.1065 | 1.1140 | 1.3340 | 1.7625 | 1.6765 | 2.5775 |
| Silky rock | 0.9980 | 0.9930 | 1.2460 | 1.4745 | 1.2250 | 2.0365 |
| t-value | 1.0933 | 2.3960 | 2.3178 | 2.0037 | 2.3658 | 3.3183 |
| Inference | NS | * | * | * | * | *** |

* → Slightly significant.
** → Moderately significant
*** → Highly significant.

1 → Tap water
2 → Double distilled water
3 → Slurry water.

**Table No.2 : Comparison Between Ultra Rock And Silky Rock (Tensile Strength)**

| S.N. | 1 Hour | | | 24 Hours | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 |
| Ultra rock | 2.6855 | 2.7295 | 2.9700 | 2.6215 | 2.6290 | 3.0450 |
| Silky rock | 2.4835 | 2.3170 | 2.8280 | 2.4690 | 1.8330 | 2.8590 |
| t-value | 2.3538 | 2.1202 | 2.4071 | 3.7806 | 1.2428 | 1.2349 |
| Inference | * | * | NS | *** | NS | *** |

* → Slightly significant.
** → Moderately significant
*** → Highly significant.

1 → Tap water
2 → Double distilled water
3 → Slurry water.

D&T- diameter and thickness of specimen

The above formula was used for calculating the tensile strength of the test specimen

## Results

Table No 1 compares the t-value of ultra rock and silky rocks when mixed with sub group 1 was 1.0933, with sub group 2 was 2.3178 at the end of 1 hour and t value at the end of 24 hours of ultra rock and silky rock when mixed with sub group1 was 2.0037, with sub group 2 was 2.3658 and sub group 3 water substitute was 3.3183.

Table No2 compares the t value of ultra rock and silky rock when mixed with sub group 1 was 2.3538, with sub group 2 was 2.1202 and sub group 3 was 0.4071 at the end of 1 hour and the t value at the end of 24 hours between ultra rock and silky rock when mixed with sub group 1 was 3.7806, with sub group 2 substitute was 1.2428 and with sub group 3 water substitute was 1.2349.

## Discussion

The ultimate clinical success of restorations fabricated by indirect means is dependent on the die material used. Among the different materials used the most popular ones are stone die materials irrespective of their inherent low strength. Several investigations were done to improve the strength of these materials by adding additives and alternative water substitutes.[1]

The present study was done to evaluate the effect of water substitute on the compressive and

tensile strength of gypsum products. During removal of stone casts from long and narrow tooth preparations from elastomeric impressions there is a risk of fracturing the stone die.[5], Aiach Daniel, William F.P. Malone and James Sandrik[2]. (1984). There is also the risk of handling the working casts prematurely if the die stone has not reached its full setting strength[3].

Gypsum and its product are brittle materials and their tensile strength is markedly lower than the corresponding compressive strength because of their inability to deform under tensile stresses.

Since fracture of the gypsum cast typically occurs under tension, tensile strength is a better guide to determine the fracture resistance.

Two popular die stone materials were used in the study one ultra rock (Indian) and one silky rock (foreign) which were easily available in the market .the differing water requirements for each die stone was because of the difference in the apparent density of the powder density which in turn is dependent on the adhesiveness of the particles in the dry water state which persists even when they are suspended in water. For this reason dry calcined plaster with its low apparent density produces a flocculated suspension and needs a relatively high proportion of mixing water to give a mix of workable consistency.

Theoretically, the stoichiometric amount of water needed for setting reaction is 18.6 ml as stated by Rosenstein. Therefore at the completion of the reaction in normal mixes there is always some excess unreacted water remaining in the set mass. This residual water weakens the cast as time progresses due to this loss of residual water; there is an increase in the strength[4].

The results of the present study indicate that the use of water substitutes especially slurry water resulted in significantly increased compressive and tensile strength which is in accordance as stated by R.L.Schneider and T.D.Taylor, and the strength increased as a function of time which is in accordance with the study carried out by Schweldhelm and Lepe[5].

On comparison of the two products with ultra rock (Indian) and silky rock (foreign), it was observed that ultra rock was stronger than silky rock. A statistically significant difference in values were shown at the end of 1 hr and 24 hrs.

Among the water substitutes used slurry water proved to impart maximum compressive strength and tensile strength with ultra rock and silky rock.

Irrespective of the water substitutes used it is advised to wait for 24 hrs so that the material reaches its full dry strength rather than handling the cast prematurely and accidental fractures of the casts.

**Conclusion**

Within the limitations of this study, both the products used ultra rock and silky rock demonstrated an increase a compressive and tensile strength as a function of time.

1. The compressive and tensile strength values of both the products were lower when tested at 1 hr time interval.
2. Among the water substitutes used slurry water imparts maximum compressive and tensile strength to the material at the end of the 1hr and 24hrs.
3. Among tap water and double distilled water, both the water substitutes did not show statistically significant differences in their compressive and tensile strength.
4. Over all slurry water demonstrated superior compressive and tensile strength when compared with tap water and double distilled water with time interval of 1 hr and 24 hrs.
5. Within the limits of this investigation it is suggested to use slurry water and to wait for a period of 24 hrs before separating casts, especially of long and narrow tooth preparations, poured in any of these products from their elastomeric impressions.

ORIGINAL ARTICLE

# A Comparative Evaluation of Tissue Response to Commercially Available Denture Adhesives - An Invivo Study

Dr. Samarth Kumar Agarwal, Dr. Praveen G, Dr. Saurabh Gupta, Dr. Romil Singhal

**Abstract :** Denture adhesives are materials designed to aid in retention of dentures and are frequently used by denture wearers for their satisfaction and comfort. These are available in the form of powder, cream, adherent bandage, and paste. Since the denture adhesives remain in direct contact with tissues when used by a denture wearer, they should be biocompatible, non toxic and non irritant. Statement of problem: Denture adhesives may have effect on tissues due to their leachable components ingested and absorbed by the oral mucosa. Aim: To evaluate and compare the tissue response to commercially available four denture adhesives. Materials and method: Metrodent powder, Fixon powder, Dentiro powder and Fixon cream were selected. To evaluate the cytotoxicity, subcutaneous injections of these denture adhesives, were given to sixteen mice at four fixed sites. Four mice were injected with normal saline at determined sites and were evaluated as control group. Gross observation of injected sites was done and biopsies were taken and processed at 2,7,15, 30 days. Histological sections were analysed under light microscope and inflammatory response of host tissue to the injected materials was observed. Microscopic findings were graded as mild, moderate, severe and no inflammation. Tissue necrosis, oedema, fibrosis and extent of inflammation were also evaluated for each material.

**Results :** Histological sections of all tested denture adhesives showed varying degrees of inflammatory response which increased at 7 to 15 days and gradually subsided. Dentiro Powder and Fixon powder showed moderate inflammatory response at the thirtieth day that extended into the muscle tissue. There was evidence of necrosis only with Fixon powder, while fibrosis was observed with Fixon powder, Metrodent powder and Fixon cream. Oedema subsided in all specimens after seven days.

**Conclusion :** Fixon powder appears to show more marked tissue response followed by Dentiro powder, Fixon cream and Metrodent powder.

**Keywords :** Tissue response, Denture adhesive, Inflammation, Oedema, Necrosis, Fibrosis

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## Introduction

Denture adhesives are materials used to adhere a denture to the oral mucosa by few denture wearers to improve retention thereby enhancing comfort, satisfaction and confidence of the patient. In a survey on complete denture wearers, it was concluded that 12% of women and 10% of men were using or had used denture adhesives. [1,2] These are commercially available, soluble materials in the form of powder, cream, adherent bandage, paste or liquid that mainly

contains materials that swell, gel or dissolve in water and show increasing and varying degree of viscosity, e.g. Karaya gum, Tragacanth gum, Pectin, Gelatine, Methylcellulose and the Synthetic Polymers (Polyetylene oxide, Acrylamides). They also contain some additional materials like fillers, preservatives, wetting agents, antiseptic, antimicrobial, antimycotic and flavoring agents (Hexa chlorophane, Sodium borate, Oil of wintergreen).[3] Most modern powder denture adhesive are made up of Methylcellulose, Sodium carboxymetyl cellulose or Synthetic Polymers while cream form of denture adhesive consist of Polymetyl vinyl ether maleic anhydride. When applied on a denture, they swell producing a highly viscous layer to obliterate the space between the base of the denture and the oral mucosa and increase the coefficient of surface tension of the fluid film thereby aiding in adherence of denture to mucosa. The denture adhesives used by the denture wearer should be biocompatible, non toxic and non irritating to oral mucosa.

Denture adhesives remain in contact for longer duration and certain leachable components are ingested and absorbed by the oral mucosa that may lead to local or systemic reactions.[4,5,6] In this study, the tissue response of four commercially available denture adhesives was evaluated by injecting denture adhesives in subcutaneous tissues of mice because this is a standard screening test. [7]

The aim of the present study is to evaluate and compare the tissue response to four commercially available denture adhesives.

## Materials and Method

Four commercially available denture adhesives, three in powder form and one in cream form, were selected (Table -1). Twenty Swiss albino mice weighing 140-160 grams were taken. To evaluate the tissue response of the denture adhesives, subcutaneous injection of prepared denture adhesives in mice were given. Solution of all the denture adhesives was preparation just before subcutaneous injection, by mixing five grams of denture adhesive with 20 ml of distilled water in a petridish to make a paste which was easily injected by 18 gauge needles.

Four areas, left and right scapular area and left and right pelvic area on dorsal surface of each animal was selected and marked (Table-2). All the 20 mice that were taken for the study were anaesthetized by ether, dorsal hairs shaved and site was disinfected by methyl alcohol and divided into two groups – sixteen in experimental group and four in control group. Both the control and experimental group mice were injected on the same day.

Experimental group mice were injected with 0.1 ml solution of prepared denture adhesive at each site by disposable syringe. The site for injecting each prepared denture adhesive was maintained constant in all the 16 mice. The site for Metrodent powder was left scapular area, Fixon powder was right scapular area, Dentiro powder was right pelvic area and Fixon cream was left pelvic area (Table -2) (Figure-1,2). Control group mice were injected with 0.1 ml solution of normal saline at all four sites. Four mice were caged together and were fed with commercial pellet diet and water containing vitamin C.

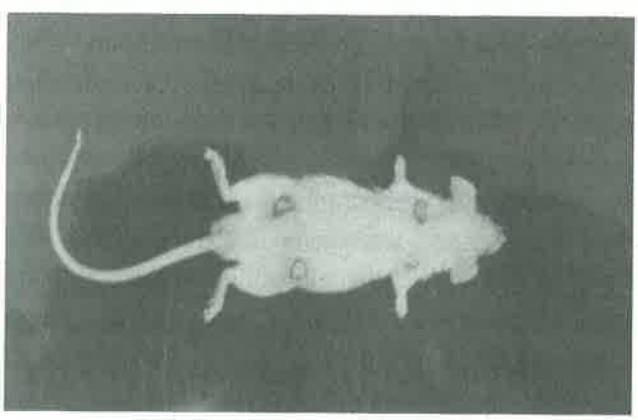

**Figure-1 Marking at injection sites**

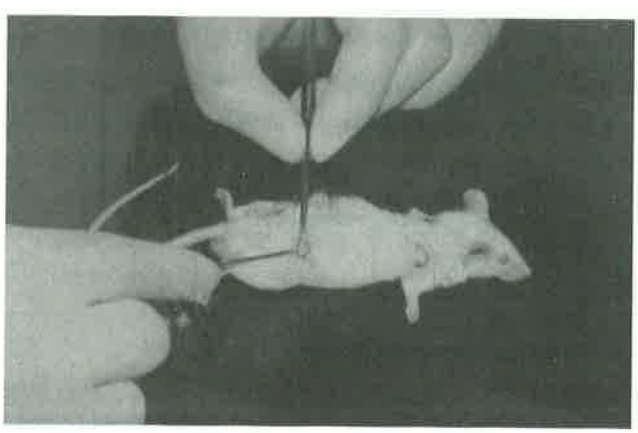

**Figure - 2 Showing injection technique**

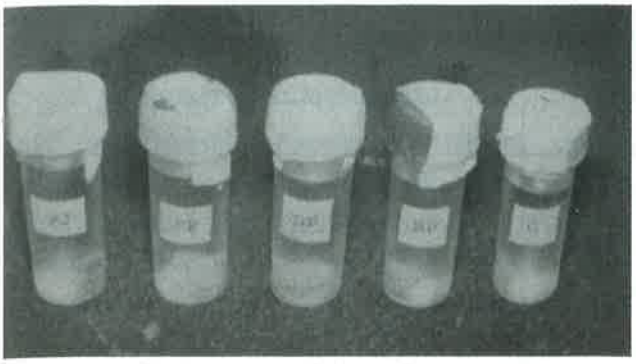

**Figure - 3 Vials containing biopsy specimen**

At 2, 7, 15, 30 days, lethal dose of ether was given for one mice from control and four mice from experimental group, dorsal hairs shaved and gross observation of the injection site was done. Then the biopsies of marked sites were taken which included skin, subcutaneous tissue and underlying muscle tissue. All biopsies were then fixed by placing them in separate vials containing 10% formalin solution (Figure-3) left for 48 hours and processed using standard histological procedures. Sections were cut at 5μ, and stained with hematoxylin and eosin.

Microscopic analysis was done under light microscope using low power 10x magnifications. The inflammatory response of the host tissue to the injected materials was the primary consideration in the evaluation of the microscopic finding and was graded as no, mild, moderate and severe based on the relative type and number of inflammatory cells, degree of vascularity, oedema, necrosis and fibrosis (Figure-4,5,6,7). Entire operative procedure was performed under aseptic condition by using standard equipments and materials. All the procedures were undertaken in accordance with the institutional research ethical committee.

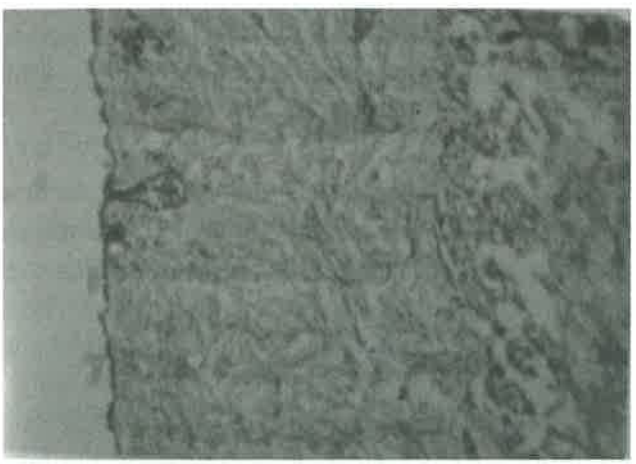

**Figure- 4 No inflammatory Response**

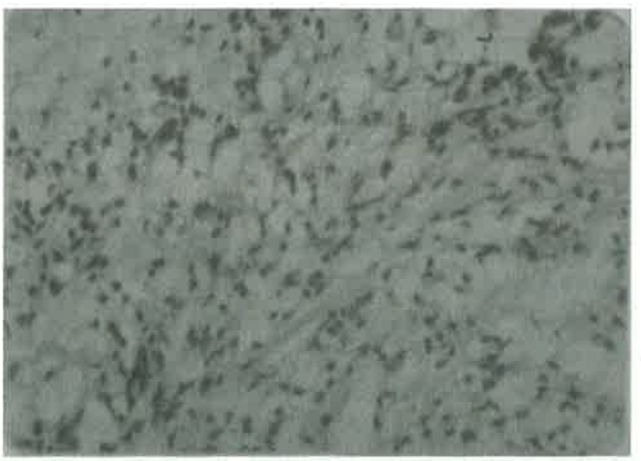

**Figure- 6 Moderate Inflammation**

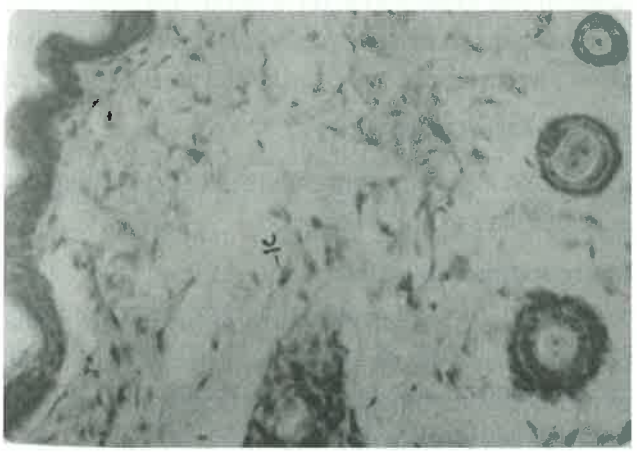

**Figure- 5 Mild Inflammation**

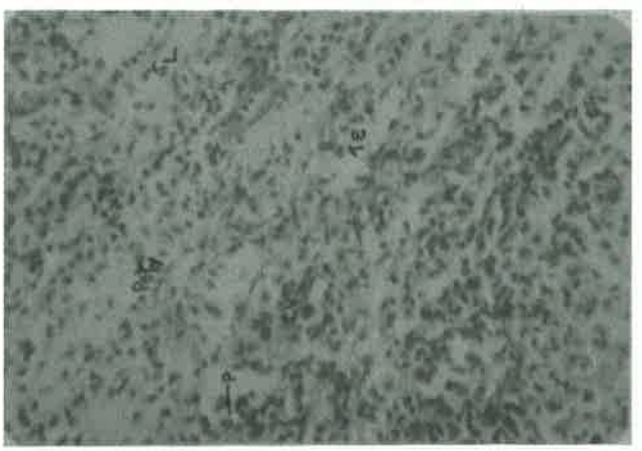

**Figure- 7 Severe Inflammation**

**Table – 1 Denture Adhesives Used in the Study**

| Serial No. | Brand Name | Form | Manufacturers Name |
|---|---|---|---|
| A) | Metrodent Powder | Powder | Metro international corporation, Delhi, India |
| B) | Fixon Powder | Powder | ICPA Health Products Pvt. Ltd, Ankleshwar, India |
| C) | Dentiro Powder | Powder | MDM Corporation, Delhi, India |
| D) | Fixon cream | Cream | ICPA Health Products Pvt. Ltd, Ankleshwar, India |

**Table – 2 Various Areas Showing Site of Injection**

| Sl. No. | Site of injection | Normal Control Group | Experimental Group |
|---|---|---|---|
| 1. | Right Scapular Area | Normal Saline | Dentiro Powder |
| 2. | Left Scapular Area | Normal Saline | Metrodent Powder |
| 3. | Right Pelvic Area | Normal Saline | Fixon Powder |
| 4. | Left Pelvic Area | Normal Saline | Fixon Cream |

**Results –**

**Gross clinical observations at the time of sacrifice -**

**1) Metrodent Powder (MP)**

In left scapular area, at the end of second day small, indurated, subepithelial mass of approximately 0.5mm × 0.5mm was observed, which increased to about 1mm × 1mm in size on the seventh day. Observation on fifteenth day also revealed subepithelial indurated mass of size 1mm × 1mm, which became normal by the thirtieth day.

**2) Fixon Powder (FP)**

In right pelvic area, at the end of second day, a swelling of approximately 1mm × 1mm was observed that increased to about 2mm × 2mm in size at seventh day and remained same on fifteenth day which decreased to 1mm × 1mm on the thirtieth day.

**3) Dentiro Powder (DP)**

In right scapular area, at the end of second day, a swelling of approximately 1mm × 1mm in size was observed that increased to 2mm × 2mm on the seventh day which decreased to 1mm × 1mm on fifteenth day that further decreased to 0.5mm × 0.5mm on the thirtieth day.

**4) Fixon Cream (FC)**

In left pelvic area, at the end of second day, a swelling of approximately 2mm × 2mm in size was observed, that increased in size to 3mm × 3mm on seventh day. Observation on fifteenth day showed the swelling, which decreased to 2mm × 2mm that further decreased to 0.5mm × 0.5mm on the thirtieth day.

**5) Control Group (CG)**

No changes were observed clinically in all the four specified sites at any time period.

**Microscopic Evaluation**

Microscopic evaluation for interpretation of tissue response was done by preparing the histological slides of the biopsy specimens obtained on second, seventh, fifteenth and thirtieth day.

**Metrodent Powder**

Histological slide showed mild infiltration of inflammatory cells mainly polymorphs at second day. Mild to moderate inflammatory changes started appearing at seventh day, which intensified at fifteenth day. There was thickening of epidermis, severe congestion and lymphocyte infiltration and moderate infiltration of polymorphs, plasma cells, and macrophages. Inflammation resolved by thirtieth day in some subjects while others showed mild fibrosis and chronic inflammatory cells.

**Fixon Powder**

Histological slide showed mild to moderate inflammation with infiltration of polymorphs and congestion of vessels by the second day. By the seventh day, this had intensified in some of the subjects with severe infiltration of polymorphs, congestion, oedema and some amount of tissue damage while in some, it remained moderate. By the fifteenth day, acute inflammatory cells were replaced by chronic inflammatory cells with several numbers of macrophages. There was thickening of vessels, intense collection of lymphocytes and plasma cells. Epidermis and dermis were also thickened; some polymorphs were also present in muscle layer. By the end of the thirtieth day, some subjects showed moderate response, and some also showed presence of mild fibrosis. In some subjects there was necrosis and intense infiltration of lymphocytes, plasma cells and macrophages.

**Dentiro Powder**

Histological slide showed mild amount of congestion with mild infiltration of polymorphs in dermis at the second and the seventh day. By the fifteenth day, some showed moderate while others showed severe chronic inflammation. There was severe congestion, moderate infiltration of plasma cells, lymphocytes, polymorphs (occasional) and macrophages in dermis as well as below muscle layers. By the thirtieth day, moderate lymphocytes, mild plasma cells and some macrophages infiltration was seen below the muscle layer. There was no necrosis or fibrosis at any stage.

**Fixon Cream**

Fixon cream showed severe acute inflammation by the second day. There was mild to severe amount of congestion and severe infiltration of polymorphs mainly in dermis. It continued till the seventh day, with severe infiltration of polymorphs, plasma cells and lymphocytes mainly in dermis. Acute inflammation subsided by the fifteenth day and was replaced by mild to moderate chronic inflammation which persisted on the thirtieth day also.

The inflammation was confined only in epidermis. There was no necrosis at any time interval but mild amount of fibrosis was observed in some of the sections.

**Control**

No inflammatory changes were observed at any time interval (Table -3,4,5).

**Discussion**

The denture adhesive used by the denture wearer should be biocompatible, non toxic and non irritant to oral mucosa.

The present study was performed by injecting the prepared denture adhesives in subcutaneous tissues as a standard screening test. Those materials that showed favourable result after standard screening tests are subjected to usage test on humans.

In this study, animal test was performed because of its ability to allow an intact biological system to respond to a material. The material may interact with complex biological system within the animal and a more complete biological response is therefore measured. The needle injection technique was used for implanting denture adhesives subcutaneously to minimize the surgical trauma instead of using incision technique which was used by previous workers.[7,8,9,10] The solution of denture adhesive was prepared just before the injection to simulate the clinical conditions. The animals were observed for any gross clinical changes and sacrificed at 2nd day, 7th day, 15th day and 30th day. These intervals were selected because past workers [8,9,10] stated that the acute reaction to the

**Table – 3 Inflammatory Cells Shown At Different Time Intervals**

| Denture Adhesives | TIME INTERVAL | | | |
|---|---|---|---|---|
| | 2 days | 7 days | 15 days | 30 days |
| Metrodent Powder | PMN++ | PMN++ | L++, P++ M++, PMN+ | L+, P+, M+ |
| Fixon Powder | PMN++ | PMN+++ | L+++, P+++, M+++ | L++, P++, M++ |
| Dentiro Powder | PMN+ | PMN+ | P++, L++, M+ | L++, P+, M (occasional) |
| Fixon cream | PMN+++ | PMN+++, L+++, P+++ | L++, P++, M+ | PMN+, L+, P+ |
| Control | P (occasional) | No inflammatory cells present | No inflammatory cells present | No inflammatory cells present |

PMN – Polymorphonuclear leukocytes + Mild
L - Lymphocytes ++ Moderate
M - Macrophages +++ Severe
P - Plasma Cells

**Table-4 : Comparison of Oedema, Necrosis and Fibrosis**

| Denture adhesives | Oedema | | | | Necrosis | | | | Fibrosis | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 days | 7 days | 15 days | 30 days | 2 days | 7 days | 15 days | 30 days | 2 days | 7 days | 15 days | 30 days |
| MP | + | + | - | - | - | - | - | - | - | - | - | + |
| FP | + | + | - | - | - | + | + | + | - | + | + | + |
| DP | + | + | - | - | - | - | - | - | - | - | - | - |
| FC | + | + | - | - | - | - | - | - | - | - | + | + |
| C | + | - | - | - | - | - | - | - | - | - | - | - |

**Table - 5: Total Inflammatory Response**

| Denture Adhesives | 2 days | 7 days | 15 days | 30 days |
|---|---|---|---|---|
| Metrodent Powder | Moderate | Moderate | Moderate | Mild |
| Fixon Powder | Moderate | Severe | Severe | Moderate |
| Dentiro Powder | Mild | Mild | Moderate | Moderate |
| Fixon Cream | Severe | Severe | Moderate | Mild |
| Control | No | No | No | No |

implanted material could be observed between 2-7 days, chronic reaction at 15th day and the reparative or chronic reaction at 30th day.

The microscopic examination of histological sections was observed for inflammation and an arbitrary classification of mild, moderate and severe was made based on the presence and type of relative number of specific cells, i.e. polymorphonuclear leukocytes, lymphocytes, macrophages and plasma cells, degree of vascularity of tissue, extent of inflammation, necrosis, oedema and fibrosis. To know the type of inflammation past workers [8,9,10,11,12,13] used only the criteria of type and relative number of leukocytes, degree of vascularity and fibrosis while working on other dental materials. In the present study oedema, necrosis and extent of lesion was also taken for consideration in an attempt to make the results more precise.

Histological sections of injected sites revealed (Table-3,4,5) (Figure-4,5,6,7) that each tested denture adhesive caused some degree of tissue reaction which was characterized by varying degree of inflammation. The extent of inflammation varied as time progressed and was different in every tested denture adhesives. In Metrodent Powder it was in epidermis, in Fixon Cream and Dentiro Powder it was in epidermis and dermis while it was within the muscle layer in Fixon Powder.

The above findings may be due to the change in the form and composition of denture adhesives. Results showed that all tested denture adhesives used for the experiment showed varying degree of tissue response. Literature review provides little information on tissue response of denture adhesives. Only few Studies [14,15] have shown that certain denture adhesives containing Zinc caused serious neurological problems. In their study of Abdelmelak and Michael[16] showed that denture adhesives alter the histology of the oral tissues. Terbet, Grossman,and other workers Al RH, Dahl JE, Morisbak E, Polyzois GL[17],[18] reported that mucosal irritation was present at the start of the study and was eliminated after regular use of denture adhesives, this study is suggestive of our study.

Various other studies [19],[20],[21] on denture adhesives have also reported that they are cytotoxic in nature.

Further research needs to be conducted on why these denture adhesives proved to be irritant and which component in them is responsible for the tissue reaction to make the denture adhesives biocompatible using large sample size.

**Conclusion**

On the basis of the methodology used in the study, the following conclusions may be drawn:

Metrodent powder produced moderate inflammatory response to begin with mild oedema and congestion which remained moderate in nature after fifteen days, then gradually decreased to mild with scattered fibroblasts and no necrosis was present. Dentiro powder produced mild inflammatory response to begin with which became moderate after fifteen days, then became mild after one month. Dentiro powder showed no oedema, necrosis, or fibrosis at any time period.

Fixon powder produced moderate inflammatory response to begin with oedema and congestion which became severe at the end of seventh and fifteenth days with necrosis and mild scattered type of fibroblasts. It remained moderate after a month.

Fixon cream produced severe inflammatory response to begin with which subsided by the end of fifteen days and became mild after thirty days. Oedema was present at seventh day which subsided later. Necrosis was not seen at any time period but there was presence of fibroblasts at fifteenth and thirtieth day.

Based on the severity of inflammation it can be concluded that Fixon powder was more irritant followed by Dentiro powder, Fixon cream and Metrodent powder.

It is suggested that denture adhesive should be used cautiously because they are affecting the tissues even after a month.

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ORIGINAL ARTICLE

# Evaluation of Relationship between Systemic Osteoporosis, Dietary Ca Intake and Reduction of Residual Ridges in Edentulous Patient: A Clinical Study

Dr. Usha Radke, Dr. Deshpande Saee

**Abstract :** In edentulous patients, reduction of the residual ridge (RRR) is one of the most important factors affecting denture support, retention, stability and masticatory function. The etiology can be multifactorial, eg dietary Ca intake, hormonal, etc.

**Purpose :** This study investigated the relationship between systemic osteoporosis, dietary Ca intake and RRR in elderly edentulous patients.

**Methodology :** Systemic osteoporosis was evaluated by measuring BMD by ultrasound. Residual Ridge Resorption was evaluated by OPG (Wical & Swoop Analysis) and Dietary case history was taken to evaluate Ca intake.

**Result :**

1. Residual ridge height in women was lower than that of men, with statistical significance at 0.01 level (p=0.0063)
2. With ageing RRR increased the co-relation coefficient was 0.42 which was statistically significant (at 0.0 1 level).
3. RRR increased according to severity of osteoporosis. The co-relation coefficient was 0.34 between degree of osteoporosis and RRR which was statistically significant at a 0.01 level.
4. Osteoporosis is more common in females while osteopenia in males.
5. Dietary Ca Intake of all the patients was below 1000 DU
6. There was lack of Awareness also regarding need of Ca intake.

**Conclusion :** Residual ridge resorption was found to be directly proportional to age of the patient and degree of osteoporosis; inversely proportional to dietary Ca intake and is more common in females.

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## Introduction

In recent years, there has been an obvious increase in the older population. Osteoporosis, a systemic disease in the elderly, shows a decrease in the skeletal mass without alteration in the chemical composition of bone. It is a progressive systemic skeletal disease characterised by low bone mass and micro –architectural deteorioration of bone tissue with a consequent increase in bone fragility and susceptibility to fracture. Osteoporosis has variety of risk factors such as age, sex, diet, smoking, some systemic conditions.

Osteoporosis is thought to have effect on systemic bone condition, (including mandible) and increased chances of bone resorption. Thus following study was carried out at VSPM's Dental College & Research Centre in Jan.2010 that revealed the

relationship between osteoporosis and residual ridge resorption & dietary Ca intake.

**Aim & Objectives :** To evaluate the co-relation between Age , Sex, Degree of Osteoporosis, Dietary Ca Intake and Residual Ridge Resorption in Geriatric Patients wearing Complete Denture.

**Procedure :** In all 84 completely edentulous patients without any signs of systemic or oral pathology were included, three basic procedures were carried out for each patient viz.-

- ☐ Measurement of systemic osteoporosis:
  - o Bone mineral density- by ultrasound.
- ☐ Measurement of Residual Ridge Resorption :
  - o OPG (Wical & Swoope Analysis)
- ☐ Dietary case history: For Ca intake

**Sample size :** Total No of Patients: 84

Males : 42

Females : 42

| Age groups | No. of males | No. of females |
|---|---|---|
| 55-65 yrs | 14 | 14 |
| 65-75 yrs | 14 | 14 |
| 75-85 yrs | 14 | 14 |

1. **Densitometric test**

Assess the density and structure of the skeleton and appears to predict fracture risk in the elderly. The apparatus is relatively inexpensive, portable, and uses no radiation but can be used only in peripheral sites (eg, the heel), where bone is relatively superficial. Ultrasound devices measure the speed of sound (SOS), as well as specific changes in sound waves (broadband attenuation or BUA) as they pass through bone. These measurements provide information on fracture risk by providing an indication of bone density and possibly also information on the quality of the bone. Thus the t-score of each patient was assessed and inference was made about osteoporosity or osteopeniacity of the patient.

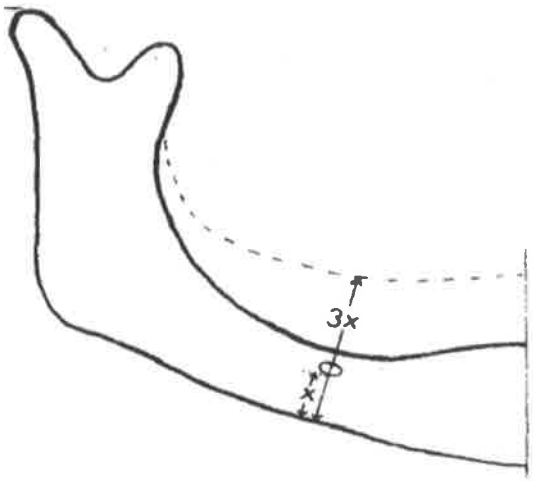



**Fig 1: OrthoPantomoGram of patient**

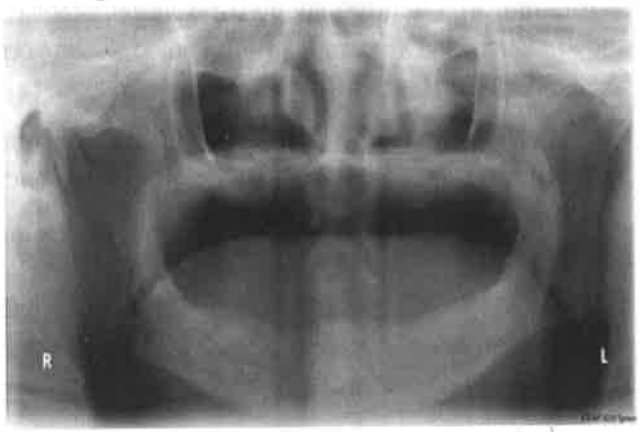



**Fig 2: Wical & Swoop Analysis**

| T-score | What the score means |
|---|---|
| 2.5 to -1 SD | Normal bone density |
| Between | |
| -1 and -2.5 | Osteopenia (low bone density) |
| Below -2.5 | Osteoporosis |

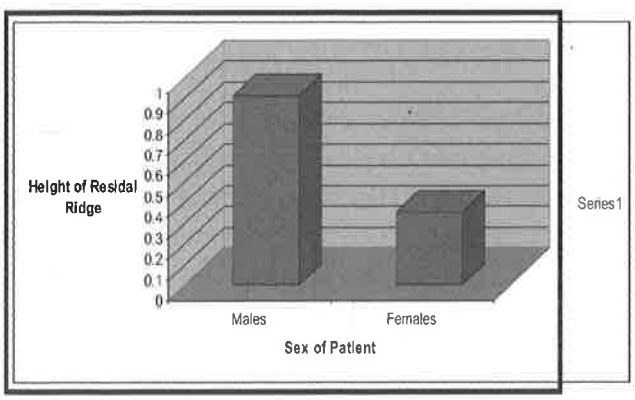
2. **Wical and Swoope Analysis**

- Mental foramen is recommended as a reference point for measurement of amount of bone loss
- Distance from lower border of mandible to lower level of mental foramen is measured (x) and 3x is considered as the actual ridge height
- Distance from lower border of mandible to crest of ridge is measured (y),which is present ridge height.
- 3x-y gives ridge resorption (Fig 2)

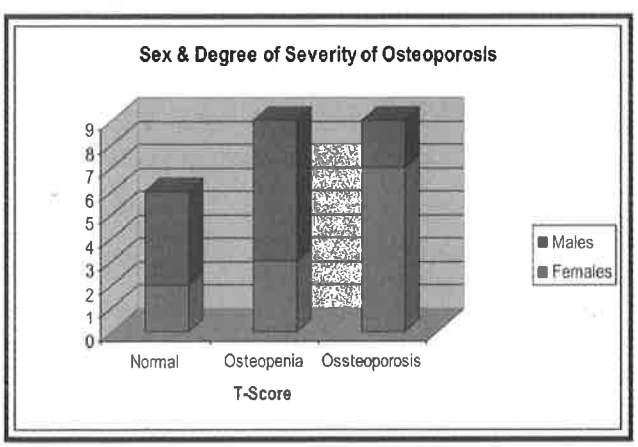
**Case history proforma to evaluate dietary Ca intake**

- Name: Age: Sex:
- Occupation: Address:
- Cause of tooth loss: Periodontal infection/ Periapical infection
- Period of edentulousness: Number of dentures made:
- How many were satisfactory?
- Other systemic illness-
- Whether there is any s/o o-porosis: Joint pain/ restricted movements
- Menopausal history :
- Source of Ca in diet & its frequency :

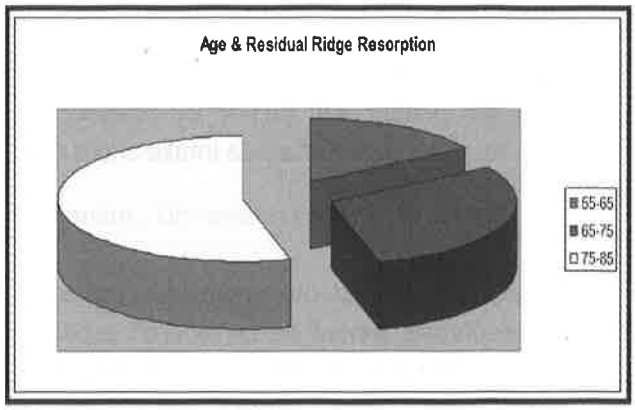
**Observations**



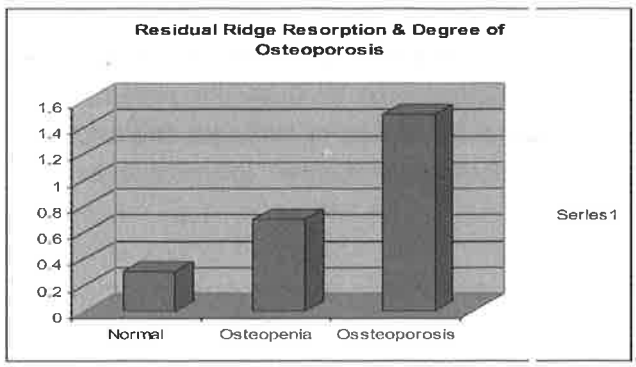

**Graph 1: Relationship of Height of Residual Ridge & Sex Of Patient**




**Graph 2: Relationship of Degree of Severity of Systemic Osteoporosis & Sex Of Patient**




**Graph 3: Relationship of Age and Residual Ridge Resorption**




**Graph 4: Relationship of Degree of Severity of Systemic Osteoporosis & Residual Ridge Resorption**

**Inference**

1. Residual ridge height in women was lower than that of men, with statistical significance at 0.01 level (p=0.0063)
2. With ageing RRR increased the co-relation coefficient was 0.42 which was statistically significant (at 0.0 1 level).
3. RRR increased according to severity of osteoporosis. The co-relation coefficient was 0.34 between degree of osteoporosis and RRR which was statistically significant at a 0.01 level.
4. Osteoporosis is more common in females while osteopenia in males.
5. Dietary Ca Intake of all the patients was below 1000 DU
6. There was lack of Awareness also regarding need of Ca intake.

## Conclusion

Residual ridge resorption is directly proportional to age of the patient and degree of osteoporosis; inversely proportional to dietary Ca intake and is more common in females.

## Clinical Implication

In patient whose edentulous residual ridges are lower, osteoporosis should be considered especially women. In the patient with osteoporosis, rapid reduction of residual ridge is predicted as compared to normal patient. Massler (1979) has reported that Prosthodontists are in a strategic position to intercept early evidence of osteoporosis and educate the geriatric patient towards good nutrition. Thus, without assessing osteoporotic level of the patient if one intervenes in fabrication of complete denture, there are high chances of denture failure due to ridge resorption.

Further investigation with larger sample size is currently underway in our department.

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ORIGINAL ARTICLE

# Comparative topographic changes around submerged and non submerged two piece implants

Dr. Satheesh Simha Reddy, Dr. K. Murugesan, Dr. Ponsekar A Abraham., Dr. Vasantha Kumar

**Abstract :** Among various forms of dental implants the two piece root form intra osseous dental implants have gained popularity with clinical success rate of over 90%. The original two stage surgical protocol (submerged procedure) for implants suggested by Branemark has been modified by Schroeder into a single stage surgical protocol (nonsubmerged procedure). This study was under taken to evaluate the topographic changes around submerged and nonsubmerged 2 piece implants.

**Methodology :** A total of 5 subjects with bilateral missing molars were selected and a two piece implant was placed in submerged procedure in one quadrant and in non submerged procedure in other quadrant respectively. The outcome of the treatment was evaluated by measuring marginal gingival levels (MGL) and marginal bone levels (MBL) at 2, 6,12,14,18 weeks after placement of implants and 2 months after placement of super structure.

**Results :** The gingival index, bleeding index and probing depth changes were not statistically significant for both submerged and non submerged procedures. In non submerged procedure a mean of 1.4±0.2 at mesial side and =1.5±0.2 1.4±0.2 mm at distal side bone loss was observed at T2 stage 2 months after placement of super structure when compared with base line. In submerged procedure no crestal bone changes were observed when they were submerged. As soon as the permucosal extension abutments were connected, a mean of 1.3±0.2 mm at mesial and a mean of 1.3±0.3 mm at distal side of bone loss was observed within a 2 months time.

**Conclusion :** The actual surgical technique of submerged and non submerged does not have marginal gingival & marginal bone level consequences.

**Keywords :** Two piece implants, submerged surgical procedure, non submerged surgical procedure, Marginal gingival levels and Marginal bone levels.

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## Introduction

The replacement of missing teeth is carried out frequently with the help of implants in most surgically indicated cases. Dental rehabilitation of partially or totally edentulous patients with dental implants has become common practice in recent decades. Current trends and demands have revealed the need for faster restoration of dental function using implant, which led to the introduction of non submerged surgical procedure of two piece implants.

One stage implants have been considered advantageous by the dentist with reduced number of surgical intervention, better patient compliance, reduced treatment time and reduced treatment cost.

Further during the osseointegration period, the implants are accessible for clinical monitoring of osseointegration [1]

However, correction of bone defects with bone augmentation procedure and guided bone regeneration would require the wound to be closed tightly over the implant fixture to prevent bone or membrane exposure for which a two stage submerged protocol is desirable. Further, undesirable loading of the implants is prevented during osseointegration period. The coronal part of the implant is located at the crestal level, giving the possibility for a more flexible emergence profile of the transmucosal part. The reported clinical and radiographical outcomes suggest that the frequently cited rational for using two stage approach is to minimize the risk of the infection and prevent apical down growth of mucosal epithelium [2-4].

The present study was undertaken to evaluate the marginal gingival level and marginal bone level of two piece implants placed in submerged and non submerged procedure over a period of time.

## Methodology

The current study was conducted with the approval of the medical ethical committee of the hospital. 5 partially edentulous subjects comprising of both male and female with a mean age of 30yr with bilateral missing molar teeth who were willing to the treatment of implant supported fixed partial dentures were included in the study. A case record sheet was formulated and utilized for all cases and a written informed consent form was obtained from all the subjects participating in the study. Pre treatment clinical examination and patient selection was performed which included a through medical and dental history.

## Pre- Surgical Phase

Diagnostic casts where prepared from diagnostic alginate impressions and mounted on mean value articulator to analyze the inter-arch factors. Bone mapping procedure with an acrylic template was done to identify the soft tissue covering of bone and the available bone width. The implant surgery was performed with a surgical stent to locate the ideal direction position of the fixture.

## Surgical Phase

For all the selected subjects a submerged protocol was planned in mandibular left quadrant and non submerged protocol in right quadrant. Inferior alveolar, lingual and buccal nerve block was administered with 2 of xylocaine with 1:200000 epinephrine at the proposed implant site areas. An off crested (slightly towards the lingual) incision was made with no: 15 bard parker blade and handle. Vertical relieve incisions in the mesial and distal aspects of the buccal side was made and a full thickness flap was raised to access the alveolar bone.

The exact position of the implant was marked using the surgical template and drill guide. The pilot drill was used to mark and penetrate the cortical plate into the cancellous bone through the initial access. Progressive osteotomy to place an endosseous root form Uniti D4.3 and L13mm implant was done. A standard straight Uniti D4.3 permucosal-healing extension was screwed to the implant body in the right quadrant. The left quadrant implant was submerged using a cover screw. The flap was repositioned and sutures were placed. For submerged implants a second surgical procedure was performed after 3 months (fig 1) and a standard straight Uniti D4.3 permucosalhealing extension was placed for three weeks for mucosal healing.

## Prosthetic Phase

After healing period of 3 weeks, in the first restorative appointment the permucosal healing

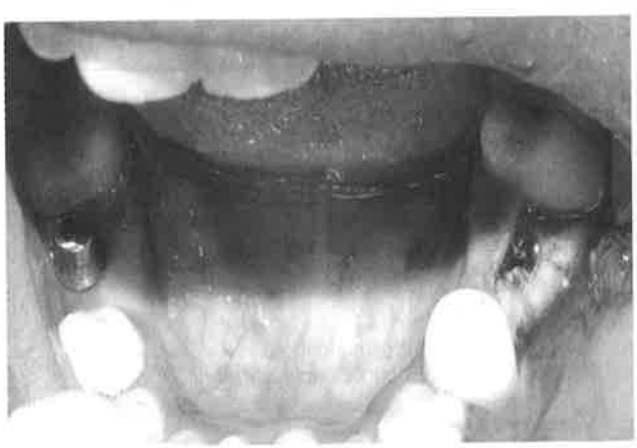

**Fig 1: Intraoral view of implants at the time of second stage surgery in the region 36.**

extension was replaced with the Uniti D4.3 straight abutment and checked for occlusal clearance. Conventional impressions with putty, light body by closed tray technique was made. Die stone casts were made with the impression. Ni-Cr metal copings for metal fused ceramic restoration were fabricated using the lost wax technique by conventional casting procedures.

Copings were tried to confirm passive fit over the abutment and the application of ceramic to complete the crown was done by conventional brush on technique (IPS D'sign) (Ivoclar Germany).The finished restoration was cemented to the implant abutment using GIC type I cement.

**Data Collection & Analysis**

Data collection was performed during osseointegration & after superstructure was placed as summarized in Table 1.

Data which collected at H2 (2 weeks after implant placement) is considered as baseline results. The data collection was done for all the subjects by a single observer to avoid inter observer differences.

**Scoring pattern**

Complications during evaluation period were scored under the following subdivisions.

Div1 : Implant loss. Removal of loose implants any time after placements

Div2 : Refasten the healing abutment or cover screw. It includes loose healing abutment or cover screw

Div3 : Replace healing abutment or cover screw

Div4 : Peri-implant mucosal correction. It includes correction of overgrown soft tissue around perimucosal extension or abutment with gingivectomy.

**Gingival index** [7, 8]**:** Peri implant mucosa was evaluated using modified Löe & sillness gingival index.

Score 0 = normal peri implant mucosa;

Score 1 = mild inflammation, slight change in color, slight edema

Score 2 = moderate inflammation, redness, edema, and glazing

Score 3 = severe inflammation, marked redness, edema, ulceration

**Bleeding index (Mombelli)** [9]**:** Bleeding around the implant was evaluated using Mombelli bleeding index.

Score 0: No bleeding

Score 1: Visible isolated bleeding sports

Score 2: Confluent red line of blood along the mucosa margin

Score 3: Heavy or profuse bleeding.

**Sulcus depth** [8]**:** The depth of the peri-implant Sulcus measured mesial and distal to the implant to nearest mm using pressure indicating periodontal probe (fig 2). The distance between the marginal border of the gingiva and tip of the probe at sulcus was measured, that is considered the probing pocket depth. The deepest pocket depth was considered for scoring.

**Marginal bone level** [10]**:** Radiographic examination was carried out using Radio Visio Graphy taken with

**Fig 2: Measuring sulcus depth using pressure indicating periodontal probe.**

RINN Xray holders (Rinn Corp Com, Dentsply, Eligin, III) using a paralleling long-cone technique(fig 3). First thread of the implant and the alveolar crest were used as reference points. Measurements of the distance between 2 reference points were performed at mesial and distal aspects digitally, 3 times per implant, using SOPRO digital imaging software (SOPIX, La Ciotat, France) ( fig 4).

**Results**

None of the implants were lost during osseointegration period. The gingival index, bleeding

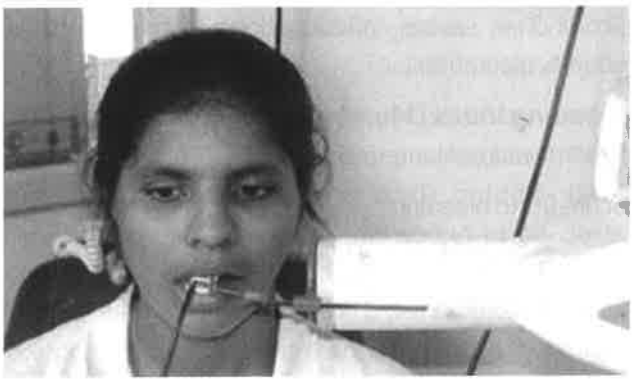

**Fig 3: Digital radiographs using RINN device**

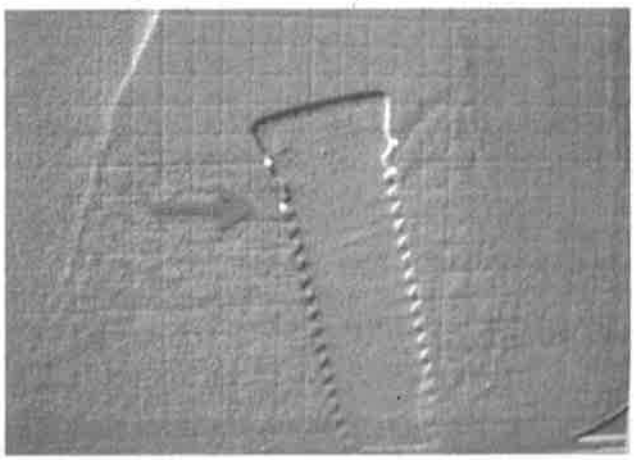

**Fig 4: Computer-assisted measurement of digitalized radiograph showing reference points for bone level.**

index and probing depth was considered not significance for both submerged and non submerged procedures. (Table 2)(Fig 5, 6&7)

Mean and standard deviation were estimated from the samples for different time points. Mean values were compared between different time points

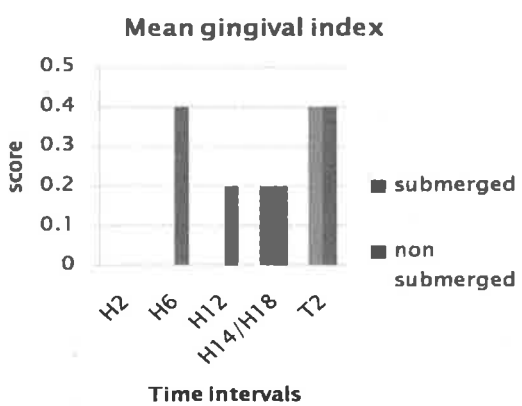


**Fig 5: Mean gingival index**

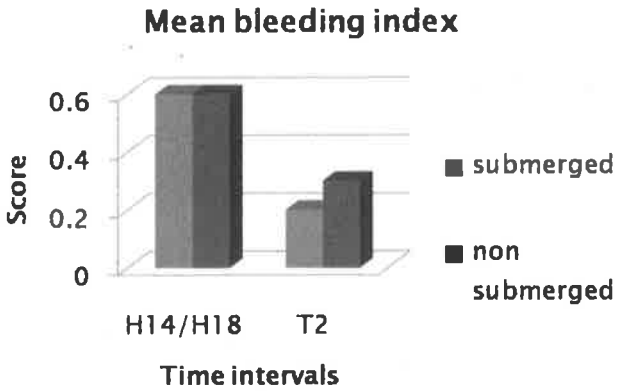


**Fig 6: Mean bleeding index**

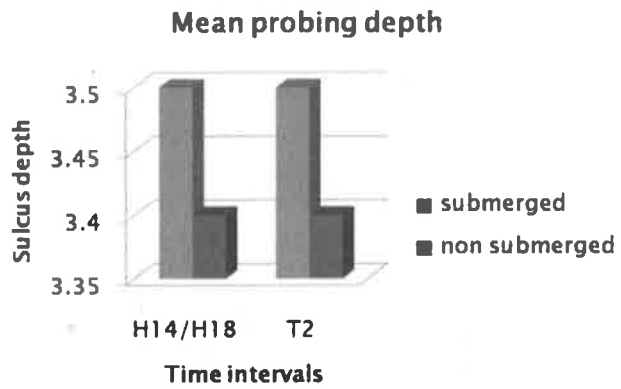


**Fig7: Mean probing depth level**

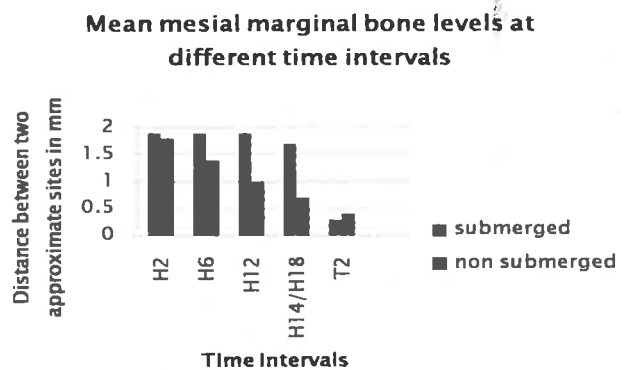


**Fig 8: Mean mesial marginal bone level**

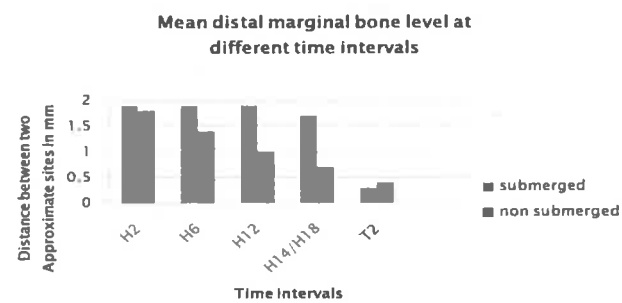


**Fig 9: Mean distal marginal bone level.**

**Table 1 : Schedule for Data Collection**

| Stage | Interval |
|---|---|
| H2 | 2 weeks after implant placement |
| H6 | 6 weeks after implant placement |
| H12 | 12 weeks after implant placement |
| H14 | 14 weeks after implant placement & start of functional period for non submerged implants |
| H18 | 18 weeks after implant placement & start of functional period for submerged implants |
| T2 | 2 months after placement of super structure |

**Table 2 : Marginal Gingival Levels At Different Time Intervals**

| | **Parameters** | **Case 1** | **Case 2** | **Case 3** | **Case 4** | **Case 5** | |
|---|---|---|---|---|---|---|---|
| H2 | Gingival index | 0 | 0 | 0 | 0 | 0 | Non Submerged |
| | | NA | NA | NA | NA | NA | Submerged |
| H6 | Gingival index | 0 | 1 | 0 | 0 | 1 | |
| | | NA | NA | NA | NA | NA | Submerged |
| H12 | Gingival index | 0 | 1 | 0 | 0 | 0 | Non Submerged |
| | | NA | NA | NA | NA | NA | Submerged |
| H14 | Gingival index | 0 | 1 | 0 | 0 | 0 | Non Submerged |
| | | 0 | 0 | 0 | 0 | 0 | Submerged |
| | Bleeding index | 0 | 1 | 0 | 1 | 1 | Non Submerged |
| | | 1 | 0 | 0 | 1 | 0 | Submerged |
| | Probing depth | 2mm | 4mm | 3.5mm | 4mm | 3mm | Non Submerged |
| | | 3mm | 2mm | 4mm | 4mm | 3mm | Submerged |
| T2 | Gingival index | 0 | 1 | 0 | 0 | 1 | Non Submerged |
| | | 0 | 1 | 0 | 1 | 0 | Submerged |
| | Bleeding index | 0 | 1 | 0 | 0 | 0 | Non Submerged |
| | | 0 | 1 | 0 | 0 | 0 | Submerged |
| | Probing depth | 2mm | 4mm | 3.5mm | 4mm | 3mm | Non Submerged |
| | | 2mm | 3mm | 4mm | 3mm | 3mm | Submerged |

**Table 3 : Marginal Bone Levels at Different Time Intervals for Non Submerged Implant Protocol**

| Case Name | At H2 (In mm) | At H6 (In mm) | At H12 (In mm) | At H14 (In mm) | At T2 (In mm) |
|---|---|---|---|---|---|
| 1 | M 2.09<br>D 2.36 | M 1.92<br>D 2.12 | M 1.67<br>D 1.97 | M 1.19<br>D 1.27 | M 1.08<br>D 1.22 |
| 2 | M 1.47<br>D 1.40 | M 1.1<br>D 1 | M 0.5<br>D 0.8 | M 0.2<br>D 0.5 | M -0.1<br>D -0.2 |
| 3 | M 1.97<br>D 1.82 | M 1.36<br>D 1.2 | M 1.09<br>D 0.9 | M 0.9<br>D 0.3 | M 0.5<br>D 0.0 |
| 4 | M 1.9<br>D 2.1 | M 1.23<br>D 1.5 | M 1.0<br>D 1.32 | M 0.8<br>D 1 | M 0.6<br>D 0.8 |
| 5 | M 1.39<br>D 1.31 | M 1.2<br>D 1 | M 0.9<br>D 0.6 | M 0.4<br>D -0.2 | M 0.2<br>D -0.3 |

**Table 4 : Marginal Bone Levels at different time Intervals for Submerged Implant Protocol**

| Case Name | At H2 (In mm) | At H6 (In mm) | At H12 (In mm) | At H14 (In mm) | At T2 (In mm) |
|---|---|---|---|---|---|
| 1 | M 2.09<br>D 2.36 | M 2.09<br>D 2.36 | M 2.08<br>D 2.30 | M 1.19<br>D 1.27 | M 1.08<br>D 1.22 |
| 2 | M 1.92<br>D 2.12 | M 1.91<br>D 2.10 | M 1.90<br>D 2.00 | M 1.3<br>D 1.8 | M 0.1<br>D 0.8 |
| 3 | M 1.47<br>D 1.40 | M 1.47<br>D 1.40 | M 1.45<br>D 1.37 | M 1.40<br>D 1.32 | M 0.8<br>D 0.3 |
| 4 | M 1.23<br>D 1.5 | M 1.20<br>D 1.5 | M 1.20<br>D 1.4 | M 1.8<br>D 1.3 | M 0.6<br>D 0.8 |
| 5 | M 1.47<br>D 1.40 | M 1.45<br>D 1.34 | M 1.39<br>D 1.29 | M 0.5<br>D 0.8 | M -0.1<br>D -0.2 |

by wilcoxon signed rank test for marginal gingival levels (MGL).

The mean marginal bone loss from the base line (H2) to 6 months for submerged protocol at mesial side= 1.3±0.2 and at distal side=1.3±0.3 (Table 3).The mean marginal bone loss from the base line (H2) to 6 months for non submerged protocol at mesial side= 1.4±0.2 and at distal side=1.5±0.2 (Table 4)

Mean and standard deviation were estimated from the samples for different time points. Comparison of the mean values was made between different time points by wilcoxon signed rank test. In the present study, P-value have revealed that both system types have highly predictable outcomes. The choice of one or two stages is the concern of both the surgeon and the prosthodontist because advantages and disadvantages affect the working fields of both.

When both system types are combined, there are two additional advantages namely the surgeon only needs to have a two stage implant system in stock for executing both submerged and non submerged procedures and there is possibility to switch from a non submerged procedure to submerged procedure pre-operatively or during the osseointegration period on

When both system types are combined, there are two additional advantages namely the surgeon only needs to have a two stage implant system in stock for executing both submerged and non submerged procedures and there is possibility to switch from a non submerged procedure to submerged procedure pre-operatively or during the osseointegration period on the basis of preference.

Soft and hard tissue that surrounds the implant requires long term maintenance for successful implant therapy. Soft tissue (peri-implant mucosa) can be clinically assessed and is referred as marginal gingival level (MGL) assessment.

Bone–to-implant contact (Osseointegration) is a histological outcome and cannot be clinically ascertained in patients. Therefore surrogate clinical variables must be used. One such surrogate variable that has been used is the level of the osseous tissue mesial and distal of the implant as determined by radiographic evaluation. This is commonly referred as the marginal bone level (MBL) [5, 6].

Radiographic evaluation of the peri-implant bone, in addition to assessment of several clinical parameters, has become one of the prerequisite for estimating implant success. Grondahl and Lekholm[11] showed a high predictive value of radiographs for the identification of implant stability using Branemark system. Bone-level determination based on evaluation of radiographs lacked sufficient precision because of the methodologic difficulties in obtaining standardized and reproducible radiographs, excentric beam guiding, and inaccessibility of labial and lingual or palatal aspects. The method of computer-assisted measurement of digitalized radiographs was associated with similar problems. The amount of distortion of the measuring scale could be determined taking into account the known length and diameter of the radio-opaque implant, thus serving as a measuring reference. Several options for optimizing the images in contrast and brightness made it easier to evaluate and measure the radiograph. Use of the Rinn device also helps standardize radiographs.

It has been stated that marginal bone loss (MBL) is more extensive around two stages implant. The micro gap between the implant and the abutment at the crestal level has been suggested to play a prominent role in the development of this bone loss. The condition of the soft and hard tissue around dental implants play a major role in its success. To objectively evaluate the soft and hard tissue changes the marginal gingival level (MGL) and marginal bone level (MBL) are important. The comparison of these parameters is a reliable tool in assessing the stability of the implant. The MGL is usually assessed by clinical measurement of actual site, and standardized intra oral Radio Visio Graphy using a paralleling long-cone technique can be used to assess MBL around dental implant.

No significant marginal gingival changes were observed when two piece implants were placed in submerged and non submerged procedures. Significant marginal bone changes were observed in submerged and non submerged procedure. In non submerged procedure a mean of 1.4±0.2 mm of bone loss was observed when compared to the base line, and the results coincided with the results of Jones and Cochran [10] (1.5 in 1 month), Adell et al (1.5 in one yr) and Cox and Zarb[12] (1.6 in one yr) In submerged procedure no crestal bone changes were observed when they were submerged. As soon as the permucosal extension/ abutment is connected, a mean of 1.3±0.2 mm of bone loss was observed within a 2 months time, and the results coincided with the results of Jones and Cochran (1.5 in 1 month). In submerged procedure bone loss is delayed until the abutment is connected to implant. Once the abutment is connected the bone loss was identical to non submerged procedure. The connection of abutment and implant creates a micro gap [13-20], which may be colonized by oral bacteria and leads to bone loss. So the micro gap between the abutment and implant may be the reason for the bone changes

## Conclusion

Within the limits of my study the clinical and radiographic parameters of two stage implants placed in submerged and non submerged procedures are comparable during the healing period. In submerged the bone changes are simply delayed until the perimucosal extension/abutment connected and micro gap is created but at the end the resultant changes are identical to non submerged procedure. The actual surgical technique of submerged and non submerged does not have marginal gingival & marginal bone level consequences.

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ORIGINAL ARTICLE

# Tissue Response to Dental Casting Alloys-an Invitro-vivo Study

Dr. R. Sridharan, Prof. Dr. T.V. Padmanaban, Prof. Dr. C. Subramanium

**Abstract :** Corrosion of alloys occurs when elements in the alloy ionise, thus the elements that are initially uncharged inside the alloy lose electrons and became positively charged. From a biocompatibility stand point ,the corrosion of an alloy indicated that some elements are available to affect the tissues around it .Adverse tissue reactions of the gingiva close to the metal restorations may be caused by the effects of the leached metal elements and may also depend upon the amounts of elements leached which are the results of corrosion.

Clinical observations of local adverse tissue reactions such as, enhanced gingivitis and periodontitis in direct vicinity of dental casting alloys may be related to the elemental release into the oral cavity. The purpose of this study was to correlate the cytotoxicity of different alloys with the elements released from each alloy. By correlating the elemental release with the cytotoxic effects, the elements that were known to cause this toxicity were identified.

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## Introduction

The release of metallic elements from dental casting alloys is a potential health problem to the dental patients. Metals are known to cause toxic, allergic and mutagenic reactions .Elements that are released from dental casting alloys have been detected in tongue scrapings, saliva and in the gingiva adjacent to the restorations, in spite of their presence in the tissues and the potential to cause biologic damages, the effect of these elements on the tissues remain largely uninvestigated.[1,2,6,9] Clinical observations of local adverse tissue reactions such as, enhanced gingivitis and periodontitis in direct vicinity of dental casting alloys may be related to the elemental release into the oral cavity.

The purpose of this study was to correlate the cytotoxicity of different alloys with the elements released from each alloy. By correlating the elemental release with the cytotoxic effects, the elements that were known to cause this toxicity were identified.

## Materials and Methods

The release of elements from casting alloys is a continuing concern because of the potentially harmful effects The surface of the alloy appears to be the most important factor in controlling the release of the elements.

The local effects of these elements are largely unknown, in spite of evidences that they are potent disrupters of cellular metabolism and are present in the gingival tissues adjacent to the restorations.

The alloys selected for the study were based on those that are commonly used in clinical practice. The

alloys that are used normally in day to day practice in India namely,

1. NICKEL CHROMIUM ALLOYS-(ni-cr high fusing alloys used for ceramic facing)

Composition –

Ni-60%

Cr-20%

Co-5%

Mo-5%

2. NICKEL CHROMIUM ALLOYS-(ni-cr low fusing alloys used for ceramic facing)

Composition –

**Ni-80.5%**

**Cr-7%**

**Cd-2%**

**Zn-2%**

Others-4.5%


**Fig. 1 High Fusing Alloy**

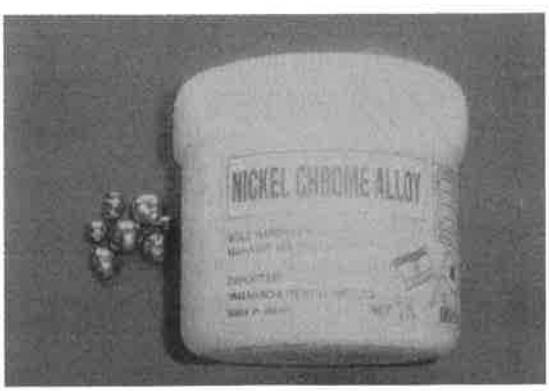


**Fig. 2 Low Fusing Alloy**

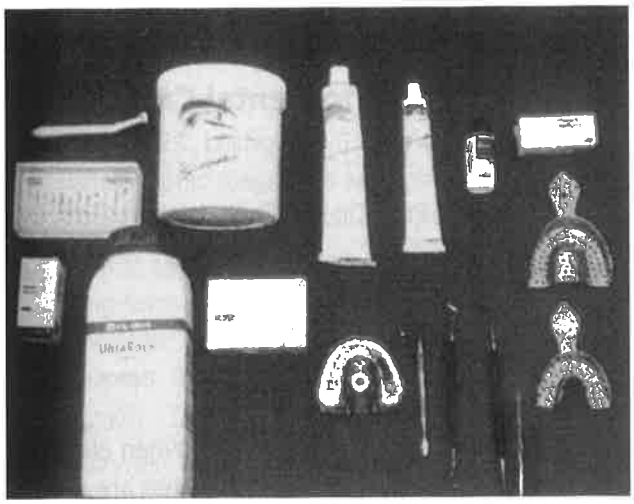

**Fig. 3 Impression Materials**

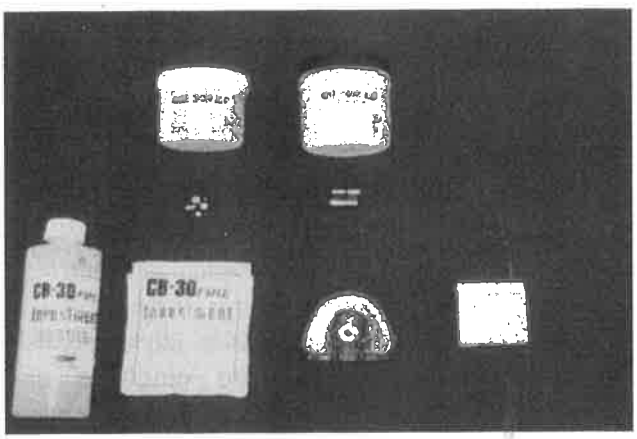


**Fig. 4 Investments Materials**

**Patient Selection**

The patients selected for the study required replacement of maxillary or mandibular 1st molars.

A group of ten patients were selected between the ages of 25-30 yrs. The selected group of patients were all males, this would eliminate the possibility of altered tissue response due to hormonal changes in female subjects .

Patients included in the study were non hypertensive, nondiabetic and had no signs of any systemic diseases and were not under any medications. Patients consent to this study was also taken.

The patients samples were divided into two groups of 5 each, and all the subjects exhibited negative response to skin tests for both alloys.

**Pre-operative Sampling**

The patients selected for this study were subjected to biopsy of the edentulous area between the 2nd and 1st molar, and the tissue samples were removed from the crest of the edentulous area.

Simultaneously the salivary samples of these patients was also collected and preserved in an incubator, for comparison with the results of the study.

The tissue samples that were taken from the patients was fixed on to a slide and preserved for histopathological study .The patients were recalled after 6 weeks for tooth preparations and fabrication of fixed partial dentures .

**Tooth Preprations and Impression Procedures**

The tooth preparations for the patients included in the study were done according to the basic principles with supragingival finish lines .After the tooth preparations were done, the retraction cords were placed and the impressions were made.

**Fabrication of The Fixed Partial Dentures**

The Fixed partial dentures were fabricated by lost wax casting method. The casted fixed partial dentures were trimmed and polished, later they were cleaned and cemented in the patient's mouth with zinc polycarboxylate cement. Five patients received fixed partial dentures made of high fusing Ni-Cr (ceramic) metal and other five received low fusing Ni-Cr (acrylic) metal.

The patients with these fixed partial dentures were instructed to follow good oral hygiene practice like regular brushing and flossing.

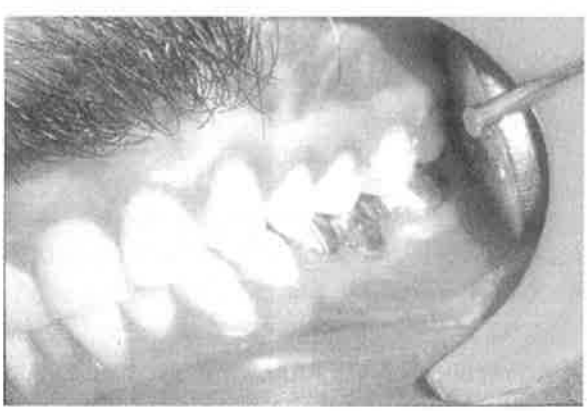

**Fig 5. Low Fusing Metal**

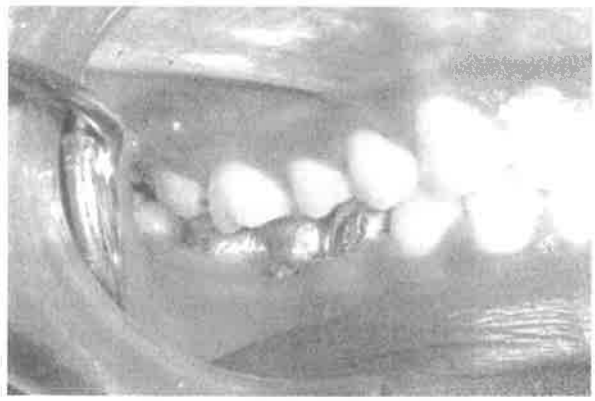

**Fig 6. High Fusing Metal**

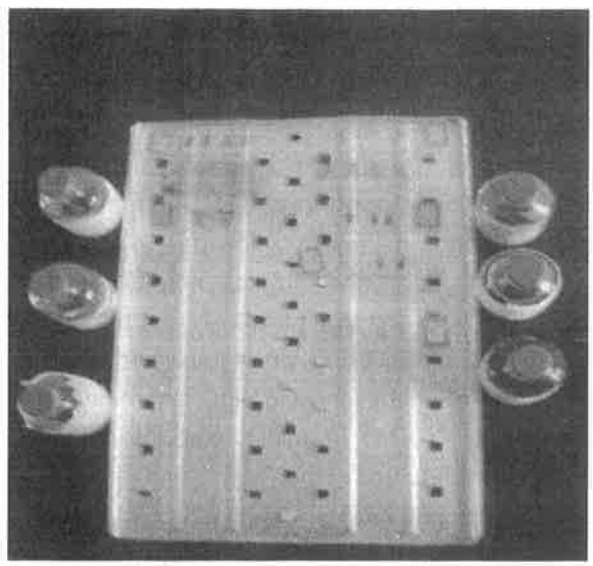

**Fig. 7 Tissue Samples Mounted On Slides**

**Postoperative Harvesting Samples**

After a period of two months, the patients were recalled, and the tissue samples were taken from the site which was in contact with the ridge lap area of the pontic,after the removal of the bridge. The tissue samples were fixed on a slide for histopathological study.

The salivary samples of the same patients after a period of two months were collected .The salivary samples were evaluated for traces of metal ions by atomic absorption spectrograph

**Histopathological Section of Normal Tissue Atomic Absorbtion Spectrography-( AAS)**

It is a highly sensitive technique used to analyse various elements especially metals, including aluminium, arsenic, beryllium, nickel, chromium and

**Fig. 8 Histopathological Section of Normal Tissue**

other metals. In this procedure the atoms are excited above the ground state by flame vaporization and the radiations emitted, as molecules return to a ground state and is measured in unexcited non-ionized molecules .The intensity of the radiation absorbed is directly proportional to the concentration of the metal ions .Specific metal ions in trace amounts i.e; in parts per million can be quantitatively estimated from unknown samples using pre-established calibrated curves. In AAS metal ions like Ni, Cr are major portion and Ir, Mg, Cu, Mo in minor portions, both from references and from the test samples may be estimated quantitatively.

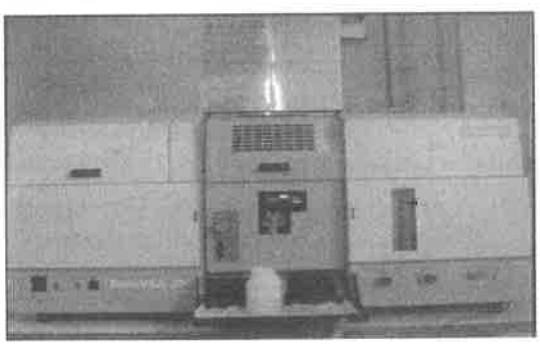

**Fig. 9 Invitro Analysis of Leaching out of Elements in Artificial Saliva**

In this invitro study artificial saliva was used Composition of artificial saliva:

Sodium carboxymethyl cellulose glycerine -0.5w/v

Glycerine-30.0%w/v

The same metals which were used for the in vivo study namely nickel chromium for high fusing and nickel chromium for low fusing are used .These alloys were casted in the shape of discs of 2inches thick and 1 inch in diameter .

The casted samples were polished in the same manner and cleaned up with distilled water. Later these samples were immersed in 95% ethanol for a period of 5 min, this was done in order to remove the impurities, which might be present after polishing. Once the samples were cleaned, they were immersed in the artificial saliva and preserved in the incubator at 37.c.

The metal ions leached out were found by AAS.The artificial saliva, which contains the leached metal ions, was subjected to spectrograph after a period of 60days, and the results were compared with the results of the patients to evaluate quantitatively and qualitatively.


**Fig. 10 Artifical Saliva**

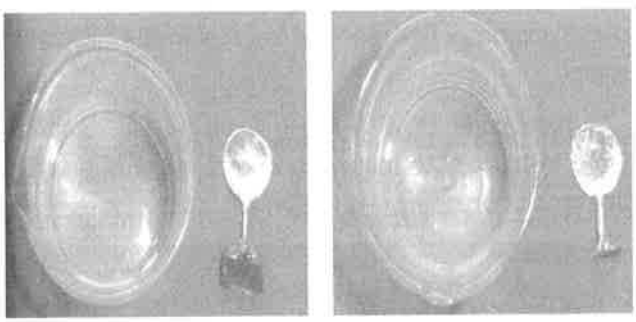

**Fig. 11 Low Fusing Alloy Sample** **High Fusing Alloy Sample**

**Results :**

The effect of two commercially available dental casting alloys on the gingival tissue was studied .The patients selected for this study were divided into two groups. One group were given restorations made from low fusing alloy other group were given restorations made from high fusing alloys.

The selected groups of patients were given full conventional metal fixed partial dentures, with modified ridge lap pontics. The area adjacent to the contact area of the metal and tissue was sectioned.

The incised tissues were then subjected to H/E staining and were studied under a high power microscope.

The normal gingival showed the presence of parakertinized stratified squamous epithelium with normal spinous, basal cell layers and elongated retepegs invaginating into the underlying connective tissues. The underlying connective tissues showed the presence of collagen fibres, fibroblasts and a few inflammatory cells.

After a period of two months ,the patients were recalled and the tissues were incised from the contact area.

The patients with high fusing alloy showed parakeritinization and acanthosis of a stratified squamous epithelium.

The epithelium appeared hyperplastic with retepegs into the underlying connective tissues, which showed presence of collagen fibroblasts and few inflammatory cells.

The patients with low fusing alloy showed presence of hyperparakertinzed stratified squamous epithelium. The spinous cell layer and the basal cell layer appeared normal with elongated retepegs invaginating into the underlying connective tissues and large numbers of inflammatory cells were present.

**Fig. 12 Low Fusing Alloy Fig. 13 High Fusing Alloy**

Simultaneously the elemental release from the dental casting alloys was also tested .This was done by immersing the two types of dental casting alloys namely Ni-Cr (high fusing and low fusing) alloys in artificial saliva and preserved in an incubator. The artificial salivary samples were subjected to atomic absorption spectrograph after 60 days, similarly the human samples from the patients selected for the study was also tested. The samples of 5 patients in each group was tested.

The readings obtained from spectrograph for low fusing alloy in artificial saliva showed Ni and Cr to the maximum and Cd and Zn in traces.

The readings obtained from spectrograph for high fusing alloys in artificial saliva Ni and Cr leached in more concentration when compared with Mo and Co.

The readings from spectrograph for human salivary samples of low fusing alloys have more concentrations of nickel and chromium and fewer concentrations of cadmium and zinc.

The readings from spectrograph for human salivary samples of high fusing alloys have more concentrations of nickel and chromium and fewer concentrations of molybdenum and cobalt.

**Histological Interpretation;**

The histopathological sampling showed that the low fusing alloy showed significant changes when compared with the high fusing alloy. The changes being that of more number of inflammatory cells and acanthosis of stratified squamous epithelium, and high fusing alloy showed less number of inflammatory cells and not much changes in the blood vessels. The changes in the low fusing tissue samples were not due to the release of nickel and chromium but may be due to the traces of metallic ions like cadmium and zinc ,which were not present in the high fusing alloys.

**Disscussion :**

An important consequence of elemental release from the dental casting alloy is cytotoxicity of the adjacent tissues. Tissue reactions depend upon the elements leached out.

In yesteryears, the alloy of choice was gold. Gold being x "noble" was assumed not to leach ions and histological studies were under taken to disapprove this misconception. When selecting an alloy for a specific condition, three factors influence the clinician's selection; they are cost, physical properties and biocompatibility.

Compared with gold alloys, Ni based alloys feature low cost, low dentisty, greater stiffness, greater hardness and comparable resistance to tarnish and corrosion Cost factors have become more inflective over the last two decades, as a result of an increase in the price of gold Physical properties of the base metal alloys are found to be comparable to that of gold.

The marginal adaptation, flexural strength and modulus of elasticity proved better. Base metal alloys used for fixed partial dentures are usually Ni-based. The chromium part imparts corrosion resistance, which makes the use of these alloys in the oral cavity possible based on their fusion temperature these alloys Ni-Cr alloys are of two types, they are high fusing and low fusing .The low fusing alloys are used in conjunction with acrylic facing, whereas the high fusing alloys are used in conjunction with ceramic restorations. To lower the fusion temperature of the Ni-Cr alloys, zinc and cadmium are added.

Inspite of these, local manifestations due to inflammation /allergic reactions have been investigated. These reactions are often attributed to metal ions leached. Since the alloys constitute different metals and in different concentration, the amount of leached metal ions and their influence over the soft tissue needed investigation.

Though extensive studies have been done on the metal ions leached and reaction of these alloys to soft tissue2, a correlation study of leached metal ions in the saliva and its reaction to the soft tissues has not been dealt in detail.

So a study was done to investigate quantitative and qualitative measures of elements leached out from the alloys used for fixed partial dentures and their reactions to adjacent soft tissues. As these reactions are a reflection of the metal ions leached, the amount and the type of ions leached was also evaluated.

The fabricated wax patterns were divided into two groups at random; one group was casted with high fusing in conjunction with ceramic facing and other with low fusing alloy in conjunction with acrylic facing. The casted fixed partial dentures were then cemented with glass monomer cement.

The study period of 60 days (2 months )was carried out due to the fact that initial toxicity of the dental casting alloys is more. Elemental release in artificial saliva was tested using atomic absorption spectrograph, which involved flowing of salivary samples on the platform that was illuminated with halogen lamps of specific wave lengths.

The results of the study showed release of Ni-Cr in both high fusing and low fusing alloys. The low fusing alloy showed the release of Ni -0.879 and Cr -0.739 ppm, the high fusing alloys showed the release of Ni-0.680 and Cr 0.684 ppm in the artificial saliva these were not statistically significant.

The low fusing alloys released Cd -0.008 and Zn-0.018, whereas high fusing alloys released Co-0.016 and Mo -0.015.

After 60 days of placement of the fixed partial dentures in the patient's mouth, a sample of saliva was collected and analysed using atomic absorption spectrograph. It was found that mean value of Ni-0.8502, Cr-0.7398, Cd-0.015, Zn-0.0138, in cases of patients with low fusing alloys. The salivary samples of the high fusing alloys showed Ni-0.6922, Cr-0.6812, Mo-0.0122, and Co-0.0124. These values do not correlate well with the test using artificial saliva.

In case of specimen in the artificial saliva the amount of element present were for all the four weeks period, whereas the saliva collected from the patients ,the amount of elements present were for the instance only. This means that in the oral cavity the elemental release is much more than in lab situations. This could be attributed to the salivary PH of the patients.

The other possible reason could be the varied brushing techniques, dentifrices, type of tooth brushes and the dietary habits of the south. Histopathological

evaluation of the tissue samples which were in contact with the high fusing alloy showed mild parakeratinization, elongated retepegs and a few inflammatory cells in connective tissues. those that were in contact with the low Fusing alloys showed hyperparakeratinzation, acanthosis of the spinous cell layer and more number of inflammatory cells.

This difference in the histopathological picture could be due to the trace elements released from low fusing alloy like Zn and Cd, these were the also found to produce acute inflammatory responses Ni and Cr are not the reason for this response as they were found to be statistically comparable between the two alloys.

**Conclusion :**

The tissue response of two dental casting alloys was studied over a period of 60 days .An analysis of elemental release form these alloys was also done to correlate with the tissue response. The alloys used in the study were Ni Cr high fusing and low fusing.

On testing for elemental release in the saliva the metal ions released were Ni and Cr. Low fusing alloys released zinc and cadmium in addition to nickel and chromium whereas high fusing alloys released cobalt and molybdenum. The amount of nickel and chromium from both the alloys was statistically not significant.

The histopathological picture of the tissue samples under high fusing alloys showed minimal changes, whereas the tissues under low fusing alloys showed acute inflammatory responses with hyperparakeratinization, acanthosis of spinous cell layer and the presence of acute inflammatory cells in the connective tissues, this could be due to the release of zinc and cadmium in the low fusing alloys.

So it is desirable to use high fusing NiCr alloys for intraoral restorations, but further studies have to evaluate the exact nature of ion release and their influences on oral tissues are to be dealt with in future.

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ORIGINAL ARTICLE

# Relevance of Incisal Reference Notch on Hanau Articulator In Indian Subjects

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**Abstract :** Incisal notch in the Hanau articulator is most commonly used third point of reference by the clinicians for transfering the face bow relation. Anterior points of reference in Hanau articulator is incisal reference notch which is calibrated at 54 mm below the Frankfort horizontal plane which was recommended by Lauciello and Appelbaum from a study which was conducted on other races. In Indian subjects the same average might not be found, the present study is trying to establish an average Orbitale-maxillary incisal edge distance in Indian subjects.

This study was designed and carried out to evaluate the anterior point of reference (incisal notch) relavance in Indian subjects.

This study concludes that incisal edges are 43.9mm below the frankfort horizontal plane in INDIAN subjects which is significantly different form the earlier studies hence the incisal notch created in Hanau articulator is not relevant in indian subjects.

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## Introduction

The maxillary arch has a definite three dimensional relationship to all condylar motions of the mandible. The face-bow transfer is the procedure in recording the relationship of the maxillary arch to the condylar paths. An accurate transfer in all three dimensions is the most essential factor to obtain best result from any articulator. Recordings in horizontal direction are relatively transferred easily, but superior inferior position of the cast has most ambiguity.

In the face-bow transfer, the anterior reference point together with the two posterior reference points form the axis orbital plane. The face-bow transfer allows the maxillary cast to be transferred to an articulator so that the occlusal plane has a relationship to the opening axis that is similar to that in the patient's skull[1].

Two recommended third point of reference for the Hanau Semiadjustable articulator are[5] -

1. Orbitale
2. Incisal reference notch

Incisal reference notch as a third point of reference is transfer to the cast as recommended in the arbitrary method by Hanau articulator instruction manual, Initially in Hanau articulator the incisal reference was located at 37mm below Frankfort horizontal plan which has no anatomical correlation (Fig 1). Lauciello and Appelbaum[2] determined the orbitale – maxillary incisal edge distance and to compare this measurement to the incisal reference notch of Hanau articulator which is located at 37 mm below Frankfort horizontal plane. They did the study

on three races and found the average orbitale-maxillary incisal edge distance to be at 54mm below Frankfort horizontal plane. They recommended this incisal reference notch at 54 mm to be calibrated on Hanau articulator which can be used as third point of reference (Fig 1), which will mount the maxillary cast based on a mean value distance of incisal position below the Frankfort horizontal plane.

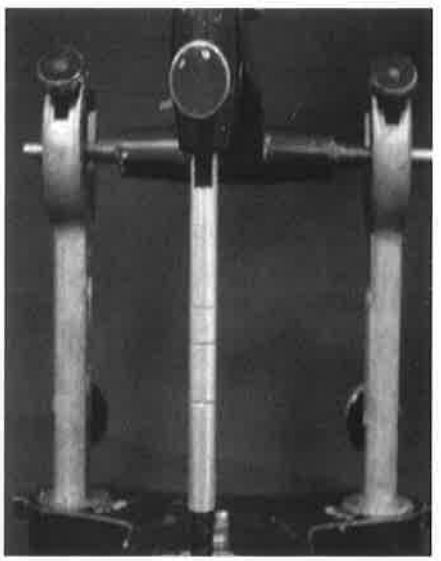

**Fig. 1**

Lauciello and Appelbaum did their study on Whites, Blacks and Orientals and found an average which might not be the same for Indians.

The Aim of this study was to determine the average orbitale –maxillary incisal edge distance in Indian subjects and to compare these measurements to the incisal reference notch on Hanau articulators.

The objective of this study is to find the average distance between the orbitale and the maxillary incisal edge among Indian subjects and evaluate the existing incisal reference notch as arbitrary third point of reference.

**Review of Literature**

**Weinberg**[4] stated that the orientation of occlusal plane is primarily related to the accurate transfer of the eccentric condylar inclinations rather than the centric relation record.

Elevation of the occlusal plane decreases the condylar readings; lowering the occlusal plane increases them. With any of the commonly used anterior points if orientation of the degree of variation produced is in the magnitude of 0.2mm at the second molar balancing cusp and less anteriorly.

**Brill**[6] and associates described a perception experiment and reported that patients with complete maxillary and mandibular dentures were able to distinguish thickness down to a 0.18mm threshold.

**Lundeen**[7] reported an average value of the condylar guidance as 45° relative to orbital plane.

The condylar guidance obtained by the orbitale method is significantly greater than those obtained by the incisal notch method and the average condylar values of dentulous patients.

This evaluation led to the conclusion that the non kinematic Facebow mounting is an essential step in the construction of restorations that will require the least intraoral correction

**Juan B. Gonzalez** and **Richard H. Kingery**[3] determined that the axis orbital plane was the least variable and maxillary plane was the most variable.

**Frank R. Lauciello** and **Marc Appelbaum**[2] determined the Orbitale-Maxillary Incisal Edge distance and compared this measurement to the incisal reference notch of the Hanau articulator.

They recommended the following suggestions

a. The incisal reference notch on Hanau articulators should be calibrated at 47mm below the Condylar plane.

b. The use of the orbital pointer when making the face bow transfer and adjusting the pointer 7mm above the condylar plane of the articulator is the most accurate method of anatomically orienting the maxillary cast to the articulator McCollum first introduced the Frankfort horizontal plane to Prosthodontics in 1939. This plane has been cited as easily accessible, well defined, and coinciding well with the true horizontal plane relative to natural head position. Natural head position is the position of the head most comfortable for a patient gazing at the horizon

Fig. 2

Fig. 3

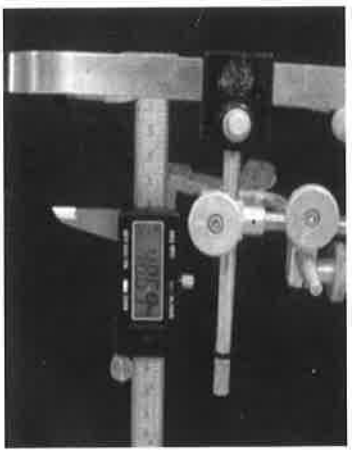

Fig. 4

**Noel D. Wilkie**[8] reviewed various anterior points of references (orbitale, orbitale minus 7mm, nasion minus 23mm, incisal edge plus articulator midpoint to articulator axis horizontal plane distance) and the rationale for the selection of each.

**Bailey** and **Nowlin**[5] evaluated the third point of reference for mounting maxillary casts on the Hanau articulator. They concluded that

1. The Frankfort plane-maxillary occlusal plane relationship that exists in a subject is not transferred to the Hanau articulator with the two third points (orbitale and incisal notch on incisal pin) of reference studied

2. Use of middle groove on the incisal guide pin as a third point of reference positions the maxillary cast on the Hanau articulator as accurately as the orbital pointer does.

**Spencer J. Nute and James P. Moss**[10] did a three dimensional facial growth studied by optical surface scanning and concluded that the

1. Males were generally larger than females although the difference in the mid-facial region was small.
2. Both males and female face height increased annually in the order of 3-4 mm on average.
3. Midfacial prominence altered little with age, whilst mandibular width increased with age.

**Methodology**

One hundred and twenty subjects were selected according to age and sex to give a representative sample of the population. Subjects for this study are

Males below 25 years – 30 subjects

Males above 25 years - 30 subjects

Females below 25 years – 30 subjects

Females above 25 years – 30 subjects

The first variable chosen was age; half of the individuals were under 25 and half over 25 years of age. The categorization by age was a further attempt to assure a varied population, since Edwards et al longitudinal study has confirmed that most of the vertical growth completed by the 18 years of age. So all subjects in this study were above 18years, and 25 years was used as a benchmark for 100% growth completion.

Inclusion criteria –

1. Above 18 years of age
2. Complete natural dentition

Exclusion criteria –

1. Crowding of teeth, and malocclusions
2. Orthodontic treatment
3. History of trauma
4. Periodontal disease
5. Restored anterior teeth
6. Cranio mandibular surgeries
7. Severely abraded incisal edges
8. Orthodontically treated patients.

**Frankfort horizontal plane :** A horizontal plane represented in profile by a line between the lowest

point on the margin of the orbit to the highest point on the margin of the auditory meatus; adopted at the 13th General Congress of German Anthropologists.

**Orbitale :** The lowest point on the inferior rim of the orbit

**Porion :** The most superiorly positioned point of the external auditory meatus located by using the ear rods of the cephalostat.

The orbitale is located utilizing Salzmann's description, which states that the orbital point is accepted as the lower most point on the lower margin of the orbit which is directly below the pupil when the eye is open and the subject looks straight ahead. The right orbitale is consistently located by palpating with small T-burnisher and a dot is made on the skin at the located point with an indelible pencil (Fig 2).

Measuring the distance between orbitale and incisal edge directly on the patient may have an error as both the points are not in the same line. So a Hanau Face-bow was used in this study to measure the distance between the orbitale and incisal edge.

The face bow recording is done using a Hanau spring face bow on each patient with the compound as occlusal index on the dentulous bite fork following the Hanau instruction manual (Fig 3). The orbitale indicator is positioned on the premarked infra-orbital notch and the thumb screw is tightened to secure the position of the indicator. The complete assembly was removed from the mouth after the ascertaining that all the three thumb screws are secured tightly and the bite fork index is rigidly attached to the bow. The excess compound present facial to incisal indentations was removed up to the incisal edges. Digital vernier calipers was used to measure the distance between the incisal edge indentations present on bite fork to orbitale pointer of the Facebow to the nearest tenth of millimeter (Fig 4).

**Results :**

In the present study, the average orbitale-maxillary incisal edge distance determined from the representative population used in this study is 49.36 with a Standard deviation of 4.15. (Table I).

The means, standard deviation and T values were determined for each subject category.

Group 1 – Male and Female

Group II- Above 25 and Below 25

Group III- Males above 25 and below 25

Group IV- Females above 25 and below 25

The Mean Orbitale-maxillary Incisal edge distance in males is 50.83mm with standard deviation of 3.84mm and in females is 47.90mm with standard deviation of 3.96.(Table II, Graph 1). There was a significant difference between the measurements for males and females. ($P<0.001$).

The mean Orbitale-Maxillary Incisal edge distance in age groups above 25 is 49.09 with standard deviation of 4.61 and in age group below 25 are 49.62 with standard deviation of 3.69. (Table III, Graph 2). The difference between the measurements for two age groups is not significant. (P - 0.495).

The Mean Orbitale-Maxillary Incisal edge distance in males below 25 years is 51.42 with standard deviation of 2.90 and in males above 25 years is 50.24 with standard deviation of 4.57. (Table IV, Graph 3). The difference between measurements for two age groups in Males is not significant. (P - 0.236,).

The Mean Orbitale-Maxillary Incisal edge distance in Females below 25 years is 47.93mm with standard deviation of 3.59 and in Females above 25 years is 47.86 mm with standard deviation of 4.41. (Table V, Graph 3). The difference between measurements for two age groups in females is not significant. ($P - 0.953$).

**Discussion :**

Incisal reference notch which is calibrated at 54 mm below the Frankfort horizontal plane which was recommended by Lauciello and Appelbaum2 from a study which was conducted on Caucasians is one of the anterior reference points in Hanau articulator . In Indian subjects the same average might not be found and the present study is trying to establish an average Orbitalemaxillary incisal edge distance in Indian subjects.

**Table 1 : Mean Orbitale - Maxillary Incisal edge distance of the Representative Population**

| Variable | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|
| Age | 19 | 44 | 25.47 | 4.65 |
| Central to Orbitale | 37.5 | 61 | 49.36 | 4.15 |

**Table 2 : The Mean Orbitale - Maxillary Incisal edge distance of the Representative Population**

| Variable | Sex | N | Mean | SD | p-value |
|---|---|---|---|---|---|
| Central to Orbitale | Male | 60 | 50.83 | 3.84 | <0.001 |
| | Female | 60 | 47.90 | 3.96 | |

**Table 3 : The Mean Orbitale-Maxillary Incisal edge distance in Below 25 and above 25yrs age groups**

| Variable | Age | N | Mean | SD | p-value |
|---|---|---|---|---|---|
| Central to Orbitale | Below 25 | 62 | 49.62 | 3.69 | 0.495 |
| | Above 25 | 58 | 49.09 | 4.61 | |

**Table 4 : The Mean Orbitale-Maxillary Incisal edge distance in Males Below 25 and above 25yrs age groups**

| Sex | Variable | Age | N | Mean | SD | p-value |
|---|---|---|---|---|---|---|
| Male | Central to Orbitale | Below 25 | 30.00 | 51.42 | 2.90 | 0.236 |
| | | Above 25 | 30.00 | 50.24 | 4.57 | |

**Table 5 : The Mean Orbitale-Maxillary Incisal edge distance in Females Below 25 and above 25yrs age groups**

| Sex | Variable | Age | N | Mean | SD | p-value |
|---|---|---|---|---|---|---|
| Female | Central to Orbitale | Below 25 | 32.00 | 47.93 | 3.59 | 0.953 |
| | | Above 25 | 28.00 | 47.86 | 4.41 | |

The subjects who were included in this study were inhabitants of a particular geographic region of India (Ranga Reddy District in Andhra Pradesh). The present study establishes the basal values for Orbitale -Maxillary incisal edge distance.

The present study reveals that Mean distance between Orbitale-Maxillary incisor edges (49.36 mm) is less in Indians compared to values (53.99mm) obtained by Lauciello and Marc Appelbaum from White, black and oriental races.

The results of this study showed a significant difference between the average Orbitale-maxillary incisal edge distance in Indians and the 54 mm incisal reference notch on the Hanau Incisal guide pin. The average difference was approximately 4.7 mm for the representative population selected.

The present study reveals that Orbitale-Maxillary incisal edge distance is more amongst Indian males compared to Females. But there is no significant difference in measurements between the different age groups.

A balanced occlusion is necessary for the stability of complete dentures and for the health of the oral tissues. An accurate plane of orientation is an essential step in the construction of complete dentures with a well balanced occlusion and good esthetics.

The goal of the face-bow transfer record is to record the anteroposterior and vertical relationship of the maxillae to the transverse horizontal axis and to transfer this relationship to the articulator.

Failure to transfer accurately result in substantial error in the final occlusion of a prosthesis, while failure to transfer the correct vertical relationship can result in esthetic errors[9].

Variations exist in the selection of the anterior point of the orientation with which the transverse hinge axis forms the horizontal plane of reference. The two recommended anterior points of reference which orient the maxillary cast to the Frankfort plane are the Orbitale and Incisal reference notch, for Hanau articulator (H2, Wide view)[5].

A planned choice of an anterior point of reference will allow the dentist and auxiliaries to visualize the anterior teeth and the occlusion in the articulator in the same frame of reference that would be used when looking at the patient.

The objective is usually to achieve a natural appearance in the form and position of the anterior teeth.

It has been reported that improper orientation of the maxillary cast does indeed affect the balancing cusp angle[3]. However, raising or lowering the Face-bow orientation has no appreciable effect on the protrusive (mesiodistal) cusp inclines, since the change of condylar inclination recording is compensated by the simultaneous change in angulation of the occlusal plane.

According to Weinberg[4], these anterior points of orientation raise or lower the anterior part of the face-bow with in 16mm. This raising or lowering of the face-bow has no effect on centric occlusion but does affect the eccentric condylar readings which influence cusp inclines. He concluded that elevation of occlusal plane decreases condylar readings whereas lowering the occlusal plane increases them. If the face-bow mounting is oriented 16mm too high on the articulator, a disocclusion of 0.2mm will be noted on the balancing occlusal side.

The present study reveals the average Orbitale-Maxillary incisal edge distance at 49.3 mm which is well above the incisal reference notch present on the articulator at 54mm. When we orient the face-bow at this anterior point of reference for Indian subjects there will be increase in the condylar readings because we are lowering the occlusal plane and interferences on the cuspal inclines[5].

Taking this information into consideration the average Orbital Maxillary incisal edge distance should be calibrated at 42.2 mm from axis orbital plane, thus more accurately paralleling the axis-orbital plane and Frankfort horizontal plane.

Therefore if an "incisal reference notch" is to be used as third point of reference for orienting the maxillary cast with a face-bow "in Indian subjects" it should be calibrated at 49.3 mm below the Frankfort horizontal plane".

## CONCLUSION

The average orbitale – maxillary incisal edge distance for the representative population used in this study was found to be significantly greater than the 30mm incisal reference notch on the incisal guide pins of Hanau articulator. Using the data gathered from this study the following suggestions are recommended:

1. The average Orbitale-Maxillary incisal edge distance for the representative population used in this study was found to be significantly less than 54 mm incisal reference notch on the incisal pin of Hanau articulator.
2. According to present anatomic data the incisal reference notch on Hanau articulator should be calibrated at 49.3 mm below the Frankfort horizontal plane in Indian subjects.

3. Further investigations are recommended to confirm findings of this study.
4. The hypothetical clinical implications of this study also need further investigation.
5. Further multi-centric studies are necessary to obtain the mean incisal distance in vertical direction in Indian population.

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ORIGINAL ARTICLE

# Orientation of Occlusal plane to the reference plane of an Articulator-A Comparative study

Dr. Satish Babu.C.L., Dr. Nalinakshamma.M., Dr. Rani.M.S., Dr. Shilpa Shetty, Mr Tejasvi Venkatesh Murthy

**Abstract :** Orbitale and Nasion are the two commonly used third point references of face bows used to orient the maxillary cast to the articulator. This study was undertaken to assess the accuracy of transferring the orientation relation on two different Articulators using their respective Face bows, one which uses orbitale and the other, which uses the Nasion as a third point of reference.

Thirty subjects in age groups between eighteen to thirty were included in the study. Two sets of maxillary casts were made for each of the subjects. One set of thirty Maxillary casts were transferred onto the articulator using Orbitale as the third point of reference. The second set of thirty Maxillary casts were transferred onto another articulator using Nasion as a third point of reference to orient the casts. To facilitate measuring the cant of the occlusal plane to the horizontal plane accurately a custom made device was designed and used in the study. Lateral Cephalograms of all the thirty subjects were made. The inclination of the occlusal plane to the horizontal reference plane (FH plane) on the tracings of lateral Cephalogram was also measured. The cant of the occlusal plane of the casts was compared with that of the tracings of respective subjects.

The results were subjected to statistical analysis. There was no statistically significant difference in two groups studied. The observed results showed that the inclination of the occlusal plane of the casts transferred to the Articulator using Orbitale was closer to that of the patient.

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## Introduction

Face bows are used to transfer the orientation relation from the patient to the Articulators. Some of the face bows use orbitale as third point of reference, whereas the others use Nasion as third point of reference[1].

From the review of literature it was observed that there were no studies undertaken to compare the cant of the occlusal plane to the horizontal reference plane i.e, F-H plane when the maxillary cast is oriented to the articulator, either by using orbitale or Nasion as a third point of reference.

Hence the present study was undertaken to compare the Hanau spring bow which uses orbitale as a third point of reference to the Gnatus face bow which uses Nasion as third point of reference to orient the maxillary casts to their respective Articulators.

To determine the accuracy of transferring the orientation relation, the cant of the occlusal plane of the maxillary cast transferred using two different face bows was compared with the cant of the occlusal plane[2] as measured on the tracings of the lateral cephalograms of the subjects[3].

## Materials And Methods

Material; Thirty subjects were included in the study.

### Inclusion criteria

1. Subjects in the age group between eighteen to thirty years.
2. Presence of all natural teeth (Presence or absence of third molar was not considered).

### Exclusion criteria

1. Subjects with temporomandibular joint problems.
2. Subjects with extensive restorative work and history of orthodontic treatment.

### Methods

Two sets of maxillary casts were made for each subject. One set of thirty casts were transferred onto the Hanau articulator using orbitale as the third point of reference to orient the maxillary casts.

The second set of thirty casts was transferred onto the Gnatus articulator using Nasion as the third point of reference to orient the maxillary casts. The mounted casts from both the articulators were transferred onto a customized apparatus to measure the cant of occlusal plane to the horizontal reference plane. (Fig.1 & Fig.2)

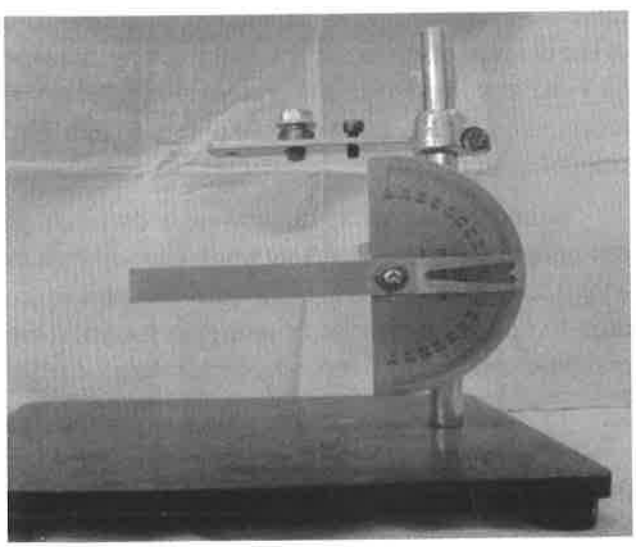


**Fig. 1 Custom designed apparatus to measure the cant of the occlusal plane of the casts.**

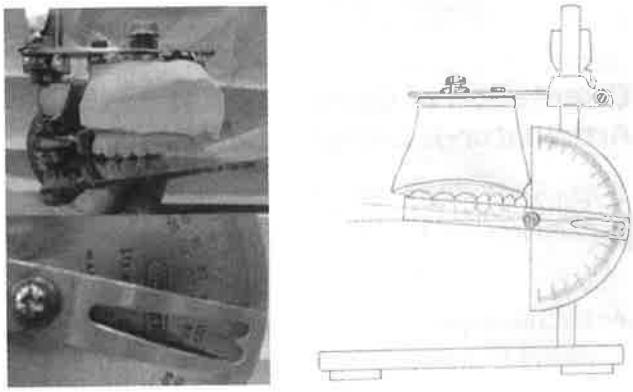
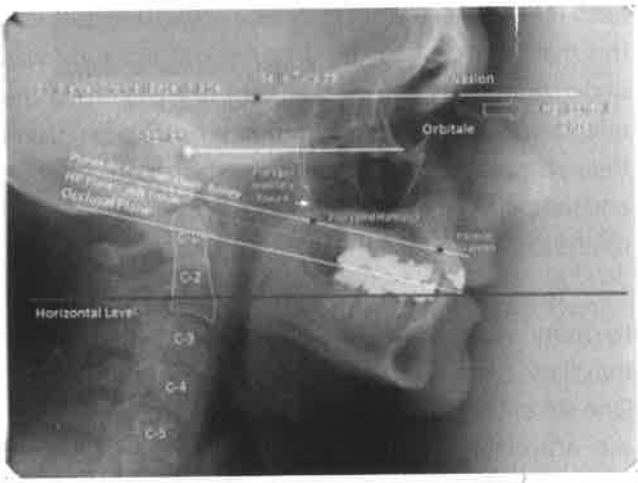
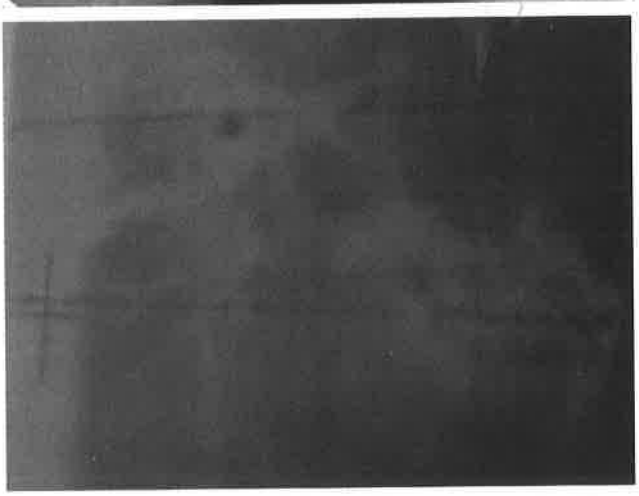


**Fig. 2 Measuring the cant of the occlusal plane using the Customized apparatus.**



**Measuring the cant of a occlusal plane tracing of the on a lateral cephalogram.**

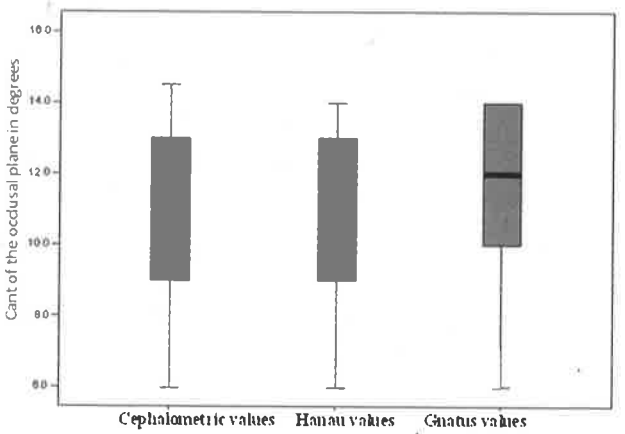
Lateral cephalograms of all the thirty subjects were made. The inclination of the occlusal plane to the horizontal reference plane (FH plane) was measured on tracings of the lateral cephalograms of all the subjects.

## Results

Table 1 shows the mean, standard deviation and standard error of the cant of the occlusal plane to the horizontal plane (F H plane) of the three groups studied.

Table 2 shows the results of the Anova test between the groups and within the groups.

Table 3 shows the results of the mean difference between the different types of measurements.




Box plot 1-depicts the cant of the occlusal plane in degrees to the occlusal plane of the three groups studied.

## Discussion

Orientation relation is one of the most important phases in transferring the jaw relation to an articulator. Some of the face bows uses Orbitale as third point of reference whereas the others uses Nasion as third point of reference to orient the maxillary casts to the articulator[1].

Since the literature did not reveal any studies conducted to determine the accuracy of orienting the casts either by using Orbitale or Nasion as third point of reference, this study was undertaken to determine the same.

Since the purpose of this study was to determine the cant of the occlusal plane of the casts transferred onto the articulator to that of the lateral cephalograms[3], it was necessary to identify the occlusal plane which could be measured on the casts and as well as lateral cephalograms.

Subjects with normal occlusion in the age group of 18-30 yrs were selected for this study to standardize the comparison of the cant of the occlusal plane. Hence for the purpose of this study, the occlusal plane was considered as a plane passing through the tip of the maxillary anteriors and the cusp tips of maxillary molars[3].

**Table 1 - Mean cant of the occlusal plane to the Horizontal plane**

| | N | Mean | Std. Deviation | Std. Error | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Cephalometric values | 30 | 10.867 | 2.5661 | .4685 | 6.0 | 14.5 |
| Hanau Values | 30 | 10.967 | 2.5795 | .4710 | 6.0 | 14.0 |
| Gnatus Values | 30 | 11.433 | 2.4450 | .4464 | 6.0 | 14.0 |

**Table 2 - Results of the Anova test**

| | Sum of squares | Df | Mean square | F | Sig. |
|---|---|---|---|---|---|
| Between groups | 5.489 | 2 | 2.744 | .428 | .653 |
| Within groups | 557.300 | 87 | 6.406 | | |
| Total | 562.789 | 89 | | | |

**Table 3 - Mean difference between the different types of measurements**

| Measurement (i) | Measurement (ii) | Mean difference |
|---|---|---|
| Cephalometric Values | Hanau Values | -0.100 |
| | Gnatus Values | -0.567 |

Subjects with loss of teeth, extensive restorative work, Orthodontic treatment and TMJ problems which influence the cant of the were excluded from the study.

Hanau spring bow which uses orbitale as a third point of reference[4] and Gnatus face bow which uses Nasion as third point of reference to orient the maxillary casts to their respective Articulators[5], were the two instruments which were used in this study because they are available locally and are commonly used in Prosthodontic work.

To facilitate the measuring of the cant of the occlusal plane a customized apparatus was designed for this study. The design of the apparatus was such that the maxillary cast along with mounting plates of either of the articulators could be transferred onto the horizontal member of the apparatus corresponding to the upper member/ FH plane of the articulator.

A protractor with a rotatable long arm to measure the cant of the occlusal plane of the casts was used as a part of the apparatus. A glass plate passing through the tip of the incisors and the molars was used to establish the occlusal plane of the casts.

Cephalometric tracings of all the subjects were made and on the tracings, a plane passing through the tip of the maxillary anteriors and the cusp tips of maxillary molars was used to determine the cant of the occlusal plane of the lateral cephalogram.

The cant of the occlusal planes of the casts transferred using Orbitale as third point of reference6 and Nasion as third point of reference[7,8] was compared with the cant of the occlusal plane as determined on the tracings of the lateral cephalogram.

From the results of the study, it was observed that: The cant of the occlusal plane of the casts transferred onto either of the articulators was similar to that of the lateral Cephalogram tracings, with a variance of 0-2 degrees. The limitations of this study was that only 2 articulators and their respective face bows were used, instead of a large number of instruments to determine the cross instrument accuracy.

Another limitation of this study was that it was confined to dentate subjects who had normal occlusion and were in the age group of 18-30 years.

## Conclusions

From the results of this study the following conclusions were drawn.

1. The cant of the occlusal plane as compared to the cant of the occlusal plane as measured on the tracings of lateral cephalograms was in the range of 0-2 degrees which using either of the reference points to transfer the orientation relation.
2. Transferring the orientation relation from the patient to the articulator was closer to that of the patient when using orbitale as the third point of reference as compared to transferring the orientation relation when using Nasion as the third point of reference.
3. Statistically there was no significant difference in the observed values when the orientation relation was transferred using either orbitale or Nasion as third point of reference.

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ORIGINAL ARTICLE

# A Study to Determine Location, Number and Extent of Occlusal Wear Facets in Various Eccentric Occlusion Among Three Different Age Groups.

Dr. M. Mitha Shetty, Dr. Sridhar Nailady Shetty, Dr. Chethan Hegde, Dr. Adarsh N.

**Abstract :** The most common sign associated with functional disturbances of the dentition is tooth wear.This is Observed as shiny flat areas of the teeth. The main purpose of this study was to determine Location, Number and extent of occlusal wear facets among three different age groups of 18-25,26-35 and 36-45. The study was conducted on subjects who were classified as having canine protected occlusion, group function occlusion and anterior guided occlusion. Any contact that occured on the non working side was considered as an interference. All tooth contacts were recorded using a blue and a red articulating foil which was 8 micron in thickness. The two color method was followed to distinguish the tooth contacts in centric and eccentric occlusion. The wear facets on the tooth was identified and recorded on a proforma, these contributed the basic data for the study. The results showed canine protected occlusion had least number of wear facets followed by group function and group function with interferences. In all age groups, subjects with canine protected occlusion showed least number of wear facets. With increase in age there was increase in number of wear facets and with increase in age there was increase in number of wear facets extending onto dentine.

**Key Words** : Wear facets, canine protected occlusion, group function, group function with interference, anterior guided with interference.

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## Introduction

The term occlusion is one that brings most of the branches of dentistry together. Occlusal wear facets are considered to be evidences of malfitting teeth. Ricketts[1] 1969 suggested that the occlusal wear occur when the natural resistance of tissues break down. According to Reynolds[2] (1970) this wear results from two possible defects:

1) Disagreement between centric relation and centric occlusion.

2) Lack of organized disocclusion of the multi cusp teeth in eccentric occlusion.

The three main types of eccentric movement made by the mandible are the

1. Canine guided occlusion
2. "Group function" and
3. Mutually protected occlusion

The amount of wear caused by these different types of eccentric movements have been contradictory so far.

Canine guidance as D'Amico[3] (1961) presupposes vertical masticatory pattern due to canines that limit the horizontal component of mandibular movement,

either through contact or indirectly through proprioceptive mechanisms, this prevents occlusal and incisal tooth wear.

Schuyler[4] (1928) describes group function as contact on several teeth in lateral excursive and protrusive mandibular movements. The resultant occlusal wear is considered physiologic and desirable.

Beyron[5] (1969) demonstrated that the group function, progressive occlusal wear and functional harmony were interdependent which could be attributed to other factors.

Clinicians philosophically believed there was no evidence to confirm that maximum interference and centric occlusal interferences are either harmful or beneficial[6].

Sato Yuuji[7] (2002) describes the use of two colors of articulating paper to discern the static from the dynamic contacts.

Many studies suggested the role of parafunctional, environmental and dietary factors in the degree and severity of occlusal wear. In view of this, a study was planned among young adults with class I occlusion to find out the;

1. Location, number and extent of occlusal wear facets in eccentric occlusion.
2. The variance in the location, number and extent of occlusal wear facets among three different age groups.

**Material and Method**

Hundred subjects belonging to 3 different age groups of 18-25yrs, 26-35yrs and 36-45yrs comprising of both sexes were selected from patients, students and persons visiting ABSMIDS.

The investigation was planned in the following manner.

I Selection of subjects :

II. Recording nature of occlusion during
   a) Lateral excursion
   b) Protrusion

III Recording of tooth contact at
   1) Right and left lateral eccentric position
   2) Protrusive eccentric position.

IV Observation of occlusal wear facets for
   1. Number
   2. Extent
   3. Location

**Selection of Subjects :**

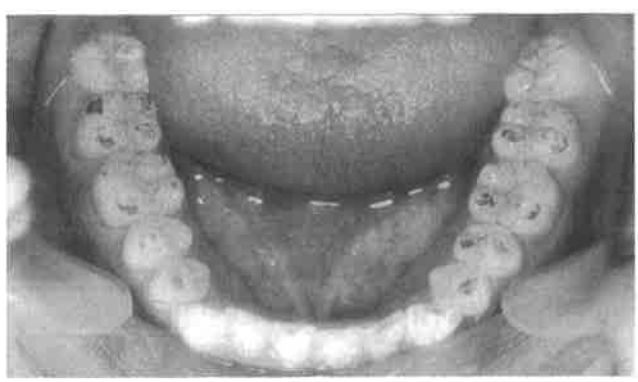
They were selected according to the following criteria.

1. All subjects having angles class I occlusal relationship.
2. No advanced periodontal diseases
3. No traumatic injury
4. Absence of congenital or acquired defects
5. No history of orthodontic correction
6. Absence of habits like bruxism, nail biting, thumbsucking

**Recording nature of occlusion;** Subject was made to sit on a dental chair in upright position with adequate illumination.

They were asked to make right and left lateral movement till the tips of the maxillary and mandibular canines were brought into contact with each other. Upon doing this movement if all posterior teeth on working side were discluded, then the subject is classified as having "canine protected occlusion", if on lateral movement, along with the canines other posterior teeth also made contacts with their antagonists then it was considered as "group function occlusion". Any contact that occurred on non working side was considered as an interference (Fig-4).

These contact were detected using a silk floss



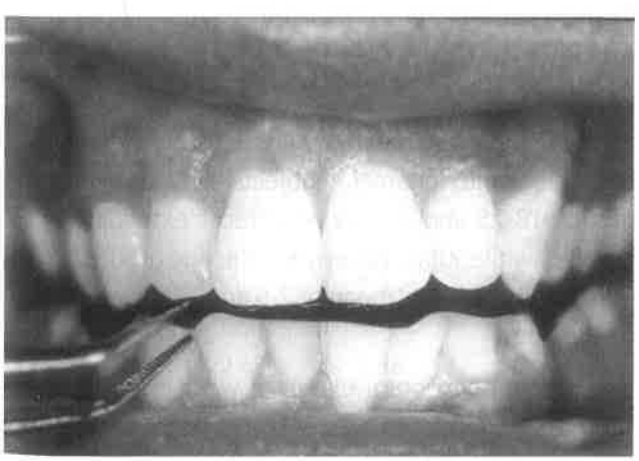
**(Fig-4) Wear facets seen as contact areas in group function with interference**

which was looped around distal teeth on both sides and was withdrawn anteriorly holding two ends of the floss. If the floss is held in place, it indicated the presence of tooth contact on the working side and as an interference on the non working side. Similarly the subject was made to bring about protrusive movement till the incisal edges of the mandibular teeth occluded against the incisal edges of the maxillary teeth, if edge to edge contact of the maxillary and mandibular anteriors result in disclussion of posterior teeth the subject was said to have "anterior guided occlusion". Any contact of posterior teeth along with the contact of anterior teeth were considered as an interference.

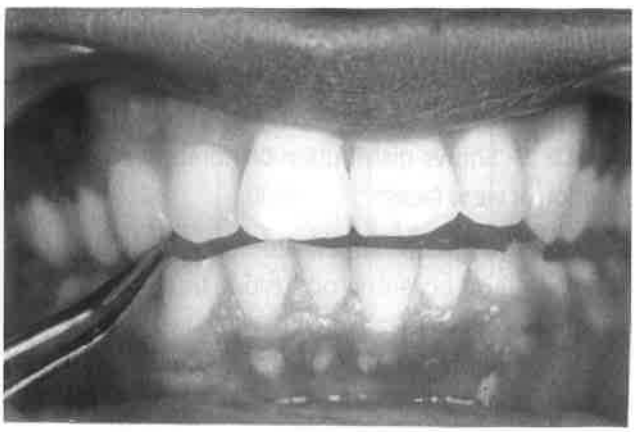
**Recording Tooth Contacts at Lateral Eccentric Position**

"A two colour method" was followed for recording laterotrusive contacts. To locate these tooth contacts the patient was trained to move the mandible sidewards till the tip of the lower canine alignes with the tip of the upper canine or buccal cusps of maxillary and mandibular teeth meet on that side. Teeth were dried and isolated

A blue articulating foil (fig 3) of 3 inches in length was placed in either quadrants between upper and lower teeth with the help of a film holder. Patient was asked to close the mouth in intercuspal position and then the mandible was moved slowly to the predetermined laterotrusive position. Tooth contacts were observed as blue marks on the surface of contacting teeth. The vertical stops are then marked with red articulating foil by having the patient to tap his/her teeth together in intercuspal position (Fig-2). This clearly distinguished blue laterotrusive contacts from red intercuspal position tooth contacts.



**(Fig-3) Recording eccentric occlusion using blue articulating foil**



**(Fig-2) Recording centric occlusion using red articulating foil**

**Recording tooth contacts at protrusive eccentric position.**

Blue articulating foil is placed and the subject is asked to make several protrusive glide to edge to edge position. Intercuspal position teeth contacts are then marked using red articulating foil as mentioned earlier.

**Observation Of occlusal wear facets;** They are identified as broad area contacts recorded by blue articulating foil on the rounded inclines of tooth. These contact areas are visualized and their location was noted in each quadrant for various lateral and protrusive eccentric occlusion. Their total number was counted and noted.

To record extent of occlusal wear facet on tooth following scale was used, 0- No visible facet in enamel

1 - Marked facet in enamel

2 - Wear into dentine

3 - Extensive wear into dentine

Location, of wear facets were noted in the following manner;

In lateral eccentric occlusion the wear facets are located on premolars, molars and on anterior teeth.

In protrusion, wear facets are located at maxillary and mandibular anterior teeth.

Wear facets at interference contact are located separately.

In this manner all subjects are examined for occlusal wear facets in eccentric occlusion and observations are filled in the proforma, these contributed the basic data for the study.

## Results

**TABLE 1-** Shows distribution of number ,extent and location of wear facets

In age group 18-25, 26-35 and 36-45yrs at various lateral eccentric occlusion. In age group 18-25yrs showed a mean of 4.0 wear facets. All wear facets were located in the anterior region extending onto enamel only ,none in dentine. 58% of subjects having group function had a mean total wear facet of 14.6 and a standard deviation of 2.28, of which 4.0 were on anteriors, 4.3on premolars and 6.3 on molars. All wear facets were located on enamel only. 19% of individuals having group function with interference had wear facets with a mean value of 22.4 with 4.55 standard deviation, of which 4.0 wear facets were located on anteriors, 4.2 on premolars and 6.7 on molars. 1.8 wear facets seen on premolars as interference and 5.7 on molars. All wear facets were located on enamel only.

In age groups 26-35yrs, 26% of subjects having canine protected occlusion showed a mean number of 4.6 wear facets, of which 4.1 were located on enamel and 0.5 on dentine. All facets were located on anterior teeth. 48% of the subjects having group function had number of wear facets with mean value of 18.5 and a standard deviation of 6.74,of which 16.0 were located on enamel and 2.5 were on dentine. Of the 18.5 wear facets 5.6 were on premolars,9.3 on molars and 3.7 on anteriors. 26% of subjects having group function with interference showed a mean value of 27.7 number of wear facets, of which 3.7 were on anteriors 5.5 were on premolars, 8.6 were on molars. Among the interferences present 6.6 wear facets were on molars 3.2 wear facets were on premolars, Of the total wear facets, 24.5were on enamel and 3.2 were on dentine.

In age group 36-45yrs 36% subjects with canine protected occlusion showed a mean number of 5.6 wear facets, all the wear facets were on anteriors of which .1 were on enamel and 5.5 on dentine. 24% individuals having group function had mean total wear facets of 24.1 of which 4.8 wear facets were on anterior, 8.4 were on premolars and 13.7 on molars. All the wear facets were located on dentine and none on enamel. 40% subjects having group function with interference had mean of total wear as 43.0, of which 2.2 wear facets were located on enamel and 40.8 on dentine. Of the total wear facets, 6.1 wear facets were on anteriors, 8.2 on premolars, and 13.3 on molars , 4.3 wear facets seen as interference on premolars and 11.1 seen as interference on molars. On statistical analysis for table No 1 using fisheres test shows very highly significant increase in number of wear facets with canine protected occlusion having least, group function having more and group function with interference having maximum number of wear facet among all three age groups. All wear facets were located in enamel in age group 18-25yrs. In age group 36-45yrs it was observed that a very high significant number of wear facets extended onto dentine.

**TABLE 2** Shows analysis of extent of wear facets in lateral eccentric occlusion in three different age groups. On comparison of extent of wear facet in canine protected occlusion, subjects between age groups 18-25yrs, 26-35 yrs and 36-45yrs showed a mean of 4.0, 4.1 and 0.1 wear facet extending onto enamel. Subjects between age groups 18-25 showed no wear facets in dentine. Subjects between age groups 26-35 and 36-45 showed a mean of 0.5 and 5.5 wear facets extending onto dentine.

On comparison of extent of wear facet in group function occlusion subjects between age groups 18-25 and 26-35 showed mean of 14.6 and 16.0 wear facets extending onto enamel. Subjects between the age groups 18-25 showed no wear facet extending onto dentine, while subjects between the age groups 26-35 and 36-45 showed a mean of 2.5 and 24.1 wear facets on dentine.

On comparison of extent of wear facet in group function with interference, subjects between the age groups 18-25 ,26-35 and 36-45 showed a mean of 22.4, 24.5 and 2.2 wear facets extending onto enamel.

**TABLE 1 : DISTRIBUTION OF NUMBER, EXTENT AND LOCATION OF WEAR FACETS IN THREE AGE GROUPS AT VARIOUS LATERAL ECCENTRIC OCCLUSION**

| 18-25 yrs | NUMBER | EXTENT | | LOCATION | | | INTERFERENCE | |
|---|---|---|---|---|---|---|---|---|
| | T.W. | E | D | PM | M | Ant | PM | M |
| N | 23 | 23 | .0000 | - | - | 23 | - | - |
| C.P | 4.0000 | 4.0000 | .0000 | - | - | 4.0000 | - | - |
| S.D | .0000 | .0000 | - | - | - | .0000 | - | - |
| N | 58 | 58 | 58 | 58 | 58 | 58 | - | - |
| G.F | 14.5862 | 14.5862 | .0000 | 4.3103 | 6.2759 | 4.0000 | - | - |
| S.D | 2.2791 | 2.2791 | .0000 | 1.6245 | 1.8524 | .0000 | - | - |
| N | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| G.F.W.I | 22.421 | 22.421 | .0000 | 4.2105 | 6.7368 | 4.0000 | 1.789 | 5.684 |
| S.D | 4.550 | 4.550 | .0000 | 1.4749 | 1.6614 | .0000 | 1.988 | 1.797 |
| F | 62.79 | 62.79 | - | .03 | .46 | | | |
| P | .001 vhs | .001 vhs | - | .97NS | .634NS | | | |
| **26-35 yrs** | **NUMBER** | **EXTENT** | | **LOCATION** | | | **INTERFERENCE** | |
| | T.W | E | D | PM | M | Ant | PM | M |
| N | 26 | 26 | 26 | - | - | 26 | - | - |
| C.P | 4.6154 | 4.1538 | 0.4615 | - | - | 4.6154 | - | - |
| S.D | 1.7681 | 1.9938 | .9479 | - | - | 1.7681 | - | - |
| N | 48 | 48 | 2.5208 | 4.6458 | 9.3333 | 3.7500 | - | - |
| G.F | 18.5625 | 16.0417 | 3.4824 | 3.2713 | 3.7662 | 1.9186 | | |
| S.D | 6.7380 | 6.6523 | | | | | | |
| N | 26 | 24.462 | 3.2308 | 5.538 | 8.615 | 3.692 | 3.231 | 6.615 |
| G.F.W.I | 27.692 | 10.077 | 7.067 | 3.165 | 3.477 | 1.087 | 3.445 | 4.553 |
| S.D | 10.965 | - | - | - | - | - | - | - |
| F | 54.42 | 37.04 | 8.76 | .01 | .32 | 2.62 | - | - |
| P | .001 | .001 | .001 | .991 | .728 | .078 | - | - |
| Remarks | VHS | VHS | VHS | NS | NS | NS | | |
| **36-45 yrs** | **NUMBER** | **EXTENT** | | **LOCATION** | | | **INTERFERENCE** | |
| | T.W. | E | D | PM | M | Ant | PM | M |
| N | 36 | 36 | 36 | - | - | 36 | - | - |
| C.P | 5.6111 | .1111 | 5.5000 | - | - | 5.6111 | - | - |
| S.D | 1.9607 | .4646 | 2.0494 | - | - | 1.9607 | - | - |
| N | 24 | 24 | 24 | 16 | 24 | 24 | - | - |
| G.F | 24.0833 | .0000 | 24.0833 | 8.3750 | 13.6667 | 4.8333 | - | - |
| S.D | 5.2908 | .0000 | 5.2908 | 2.0936 | 4.5556 | 1.6594 | - | - |
| N | 40 | 40 | 40 | 40 | 40 | 40 | 4.350 | 11.100 |
| G.F.W.I | 43.050 | 2.250 | 40.850 | 8.200 | 13.300 | 6.100 | 4.048 | 4.295 |
| S.D | 7.605 | 4.711 | 8.230 | 5.120 | 5.273 | 2.560 | - | - |
| F | 172.65 | 2.48 | 135.035 | 0.009 | 0.039 | 2.57 | - | - |
| P | .001 | .001 | .001 | 0.992 | 0.961 | .081 | - | - |
| Remarks | VHS | NS | VHS | NS | NS | NS | - | - |

N - Number of subjects, T.W = Total Wear Facets, C.P - Canine Protected, E = Enamel, G.F = Group Function, D = Dentine, G.F.W.I = Group Function with Interference, D.D = Deep Dentine, S.D = Standard Deviation, ANT = Anterior, P.M = Pre Molar, M = Molar

**TABLE 2 : ANALYSIS OF EXTENT OF WEAR FACET IN LATERAL ECCENTRIC OCCLUSION IN THREE DIFFERENT AGE GROUPS**

| | 18 - 25 | | 26 - 35 | 36 - 45 |
|---|---|---|---|---|
| C.P | E | 4.0000 | 4.1538 | 0.1111 |
| | S.D | 0.0000 | 1.9938 | 0.4646 |
| | D | 0.0000 | 0.4615 | 5.5000 |
| | S.D | 0.0000 | 0.9479 | 2.0494 |
| | D.D | 0 | 0 | 0 |
| | S.D | 0 | 0 | 0 |
| G.F | E | 14.5862 | 16.0417 | .0000 |
| | S.D | 2.2791 | 6.6523 | .0000 |
| | D | .0000 | 2.5208 | 24.0833 |
| | S.D | .0000 | 3.4824 | 5.2908 |
| | D.D | 0 | 0 | 0 |
| | S.D | 0 | 0 | 0 |
| GFWI | E | 22.421 | 24.462 | 2.250 |
| | S.D | 4.550 | 10.077 | 4.711 |
| | D | 0.0000 | 3.2308 | 40.850 |
| | S.D | 0.0000 | 7.067 | 8.239 |
| | D.D | 0 | 0 | 0 |
| | S.D | 0 | 0 | 0 |

On comparison of extent of wear facet in group function with interference, subjects between the age groups 26-35 and 36-45 showed a mean of 3.2 and 40.8 wear facets extending onto dentine. On statistical analysis of these results using "f" test showed increase wear facets on dentine with an increase in age which was very highly significant in all three age groups.

**TABLE 3:** Shows distribution of number, extent and location of wear facets in age groups 18-25, 26-35 and 36-45yrs at various protrusions. In age group 18-25yrs, 81% of subjects having anterior guided occlusion showed a mean value of 5.8 wear facets, of which 2.8 wear facets were on maxillary anterior and 2.9 were on mandibular incisors, all the wear facets were located on enamel showing a mean of 5.8 wear facets. 19% of subjects having anterior guided occlusion with interferences showed a mean value of 11.1 wear facets, of which 3.5 wear facets were on anteriors. Among interferences 0.1 wear facets were on premolars and 4.0 on molars. All were in enamel with a mean of 11.1, On stastical analysis using "t" test showed very high significant increase in number of

**TABLE 3 : DISTRIBUTION OF NUMBER, EXTENT AND LOCATION OF WEAR FACETS IN THREE AGE GROUPS AT VARIOUS PROTRUSIVE ECCENTRIC OCCLUSION**

| | 18-25 yrs | NUMBER | EXTENT | | | LOCATION | | INTERFERENCE | |
|---|---|---|---|---|---|---|---|---|---|
| A.G | N | T.W | E | D | DD | MAX | MAN | PM | M |
| | Mean | 81 | 81 | 81 | - | 81 | 81 | - | - |
| | S.D | 5.7778 | 5.7778 | 0.0000 | - | 2.8519 | 2.9259 | - | - |
| | | 2.2583 | 2.2583 | 0.0000 | - | 1.0737 | 1.2122 | - | - |
| A.G.W.I | N | 19 | 19 | 19 | - | 19 | 19 | 19 | 19 |
| | Mean | 11.157 | 11.157 | 0.000 | - | 3.526 | 3.526 | .105 | 4.000 |
| | S.D | 1.80 | 1.80 | 0.000 | - | .841 | .841 | .459 | .667 |
| | T | 9.569 | 9.569 | - | - | 2.557 | 2.043 | - | - |
| | P | .001vhs | .001vhs | - | - | .012 sig | .044 sig | | |
| | **26-35 yrs** | **NUMBER** | **EXTENT** | | | **LOCATION** | | **INTERFERENCE** | |
| A.G | N | T.W | E | D | DD | MAX | MAN | PM | M |
| | Mean | 74 | 74 | 74 | D | 74 | 74 | - | - |
| | S.D | 9.6622 | 7.5676 | 2.0946 | - | 4.794 | 4.865 | - | - |
| | | 2.4843 | 2.4218 | 1.0091 | - | 1.296 | 1.287 | - | - |
| A.G.W.I | N | 26 | 26 | 26 | - | 26 | 26 | 26 | 26 |
| | Mean | 16.923 | 12.115 | 4.808 | - | 4.846 | 5.231 | .308 | 6.538 |
| | S.D | 4.35 | 3.9 | 4.118 | - | 1.287 | 1.608 | 1.569 | 2.502 |
| | T | 10.375 | 6.876 | 5.277 | - | .17 | 1.187 | - | - |
| | P | .001 vhs | .001 vhs | .001 vhs | - | .835 ns | .23 ns | - | - |
| | **36-45 yrs** | **NUMBER** | **EXTENT** | | | **LOCATION** | | **INTERFERENCE** | |
| A.G | N | T.W | E | D | DD | MAX | MAN | PM | M |
| | Mean | 60 | 60 | 60 | - | 60 | 60 | - | - |
| | S.D | 10.6333 | 4.3667 | 6.3000 | - | 5.317 | 5.317 | - | - |
| | | 3.2205 | 1.3400 | 2.9129 | - | 1.6621 | 1.621 | - | - |
| A.G.W.I | N | 40 | 40 | 40 | - | 40 | 40 | 40 | 40 |
| | Mean | 24.17 | 15.37 | 8.75 | - | 6.350 | 6.725 | 1.200 | 9.900 |
| | S.D | 5.01a | 3.58 | 2.77 | - | 1.494 | 1.948 | 2.747 | 4.150 |
| | T | - | - | 4.201 | - | 3.169 | 3.926 | - | - |
| | P | .001 vhs | .001 vhs | .01 hs | - | .002 hs | .001 vhs | | |

wear facets, with anterior guided occlusion showing the least and anterior guided occlusion with posterior interferences having maximum number of wear facets. This results shows very highly significant number of facets extending only on enamel. In age group 26-35yrs shows 74% of subjects having anterior guided occlusion showed a mean value of 9.7 wear facets, of which 4.8 wear facets were located on maxillary anterior and 4.9 were on mandibular incisors, all the wear facets were located on enamel and dentine showing a mean of 2.4 and 1.0 wear facets. 26% of subjects having anterior guided occlusion with interferences showed a mean value of 4.8 wear facet on maxillary anterior and 5.2 wear facets were on mandibular anteriors, Interferences with mean of 0.3 wear facets on premolars and 6.5 on molars. Of these wear facets 12.1 were located on enamel and 4.8 on dentine. On statistical analysis using "t" test shows very highly significant increase in number of wear facets in comparing with anterior guided protrusion. These results showed very highly significant wear facets that is more on enamel in comparison with dentine in anterior guided occlusion and very highly significant increase on dentine in

comparison with enamel in anterior guided with interference.

In age group 36-45yrs, 60% of the subjects having anterior guided occlusion showed a mean of 5.3 wear facets located on maxillary and mandibular anterior. The wear facets were located on enamel having mean of 4.4wear facet on enamel and 6.3 on dentine. 40% of subjects have anterior guided with interferences of which 6.3 wear facet were on maxillary anterior and 6.7 wear facets on mandibular anteriors. Among interferences 1.2 wear facets were on premolars and 9.9 on molars. Of the total wear facets 15.4 wear facets were on enamel and 8.7 were on dentine. On statistically analyzing using "t" test showed very high significant increase in number of wear facets , anterior guided occlusion having least wear facets and anterior guided interference showing maximum number of wear facets. It also shows significant number of wear facets extending onto enamel compared to enamel in anterior guided with interference. In either types of protrusive occlusion significantly more facet were located on mandibular anteriors when compared to maxillary anteriors.

**Discussion**

Tooth wear can be a very destructive process and may lead to functional problems. However, tooth wear is normally asymptomatic and therefore perhaps the most tolerated form of breakdown in the masticatory system [8].

In all age groups subjects with canine protected occlusion showed least and those with group function with interferences showed maximum number of wear facets. This can be explained by the fact that in canine protected occlusion there was total disclusion of posterior teeth while in-group function and group function with interferences contacts between several posterior teeth resulted in increase in number of wear facet.

Stuart [9] concluded that in natural dentition, teeth interdigitate in centric relation but have no cross tooth balance and had the lowest rate of wear.

Results of this study was similar to that of scaife and holt [10] who demonstrated that percentage of patients with wear facets increased in direct proportion to the degree of group function. Considering the distribution of extent of wear facets in three age groups, all wear facets were located in enamel in age group of 18 –25. A very highly significant of wear facets were extended onto dentine in age group of 36 – 45.This might be due to increase parafunctional activity with advance in age.

The above results shows with increase in age there is a shift in extent of wear facets from enamel to dentine in all age groups with various lateral eccentric occlusion.This might be a mere cumulative wearing of teeth with advance in age.

In canine protected occlusion, only tip of the lower canine sliding over the lingual slope of the maxillary canine in laterotrusion resulting in increased wearing of very small localized area that is the tip of canine. There is increase in extent of wear facets in dentin in group function and group function with interference this might be due to increased muscle activity. Results of this study consensus with that of Arturo Manns.[11]

On analyzing the results of location of wear facets in subjects having canine protected occlusion among three different age groups ,facets were located on anterior teeth. This shows with the increase in age there is increased wearing of canines resulting in contact of incisors and their wearing during laterotrusion.

Among the subjects having group function occlusion and group function with interference results showed increased wearing of posterior teeth.

Most of the wear facets were located on molars, followed by premolars, least were in the anteriors. This increase wearing of molars might be due to close proximity of location of these teeth to temporomandibular joint which acts as a fulcrum and exerts more load on posterior teeth, especially during lateral excursions. Subjects showed increase muscular activity of the elevator muscles in group function occlusion this might also have contributed to increased wearing of posterior teeth.

On comparison of number of wear facets in protrusion and laterotrusion occlusion, in protrusion increase in number of wear facets in subjects with interference to those without is less than in laterotrusion. This might be due to disclusion of posterior teeth by the contact of anterior guided occlusion.

On analyzing extent of wear facets in various age groups, These results showed with increase in age there is increased wearing of the tooth with very high number of wear facets extending onto dentin in age group 36-45. This increase in exposure of dentine may also be due to the fact that mandibular incisors have least thick enamel at the incisal edge that is 0.9mm compared to any other tooth in the entire dentition. With increase in age more facets in subjects having anterior guided occlusion with interference were in dentine compared to those having anterior guided occlusion. This might be due to posterior disclusion occlusion achieved by appropriate anterior guidance. This also might be due to reduced elevator activity of masseter and temporalis due to posterior disclusion by appropriate anterior guidance as stated by E.M. William Son and D.O. Lundquist (1983)[12].

On analyzing location of wear facets in subjects with anterior guided occlusion among the age groups , wear facets were located almost equally between maxillary and mandibular teeth. This might be due to uniform contact between the antagonist anteriors which helps in equal distribution of force amongst them.

Subjects having anterior guided with interference occlusion in all age groups equal number of wear facets were located in the maxillary and mandibular anterior teeth, interference contact were in the premolars and molars. Analyzing of these results shows almost equal distribution of facets between maxillary and mandibular anteriors. Facets the distance of molars increased from anterior guidance the influence of anterior guidance upon disocclusion of posterior teeth decreased which resulted in contact of molars during protrusion and there by their attrition.

The clinical implication of this study is to identify the occlusal pattern so that the clinician can ensure any new restoration being fabricated is in harmonious contact relative to the opposing teeth.

## Conclusion

A study was conducted in 300 subjects of both sexes in three different age groups 18-25, 26-35 and 36-45 to find out number, location and extent of wear facets in various eccentric occlusions.

In all the age groups subjects were made to perform lateral excursive movement and categorized as canine protected, group function and group function with interference. After examination of protrusion eccentric occlusion they were grouped as subjects having anterior guided and anterior guided with interference type of occlusion. The wear facets were recorded using blue articulating foil of 8 micron thickness (Fig-1).


**(Fig-1) Occlusal foils in varying thickness**

From the results of the foregoing study following conclusions are drawn

1. On examination of three hundred subjects in lateral excursive movement canine protected occlusion had the least number of wear facets and group function with interference had the maximum number of wear facets. In protrusive movement, anterior guided occlusion had the least number of wear facets and anterior guided with interference had maximum number of wear facets.
2. In all the age groups, wear facets were in the increasing order, canine protected <group function< group function with interference.

3. With increase in age there is increase in number of wear facet in all age groups. Least number of wear facets shown in age group 18-25 having canine protected occlusion. A maximum number of wear facets were seen in the age group of 36-45.
4. All the wear facets in the age group of 18-25 extended onto enamel. In the age 36-45, most of wear facet extended onto dentine none of the wear facets were in deep dentine.
5. With increase in age, there is increase in number of wear facets extending onto dentine.
6. All the wear facets in the subjects with the canine protected occlusion in the age group of 18-25 were located on canines.
7. In the age group of 26-35, 36-45 subjects with canine protected occlusion few wear facets were located on incisors along with canine.
8. Most of the wear facets in subjects with group function and group function with interference in all the age group were located in molars least number of wear facets were located in anteriors followed by premolars.
9. Maximum numbers of interference wear facets were located in molars in the age group of 36-45. A negligible amount of interference wear facet were located in premolars in the age group of 18-25.
10. In protrusion, with increase an age subject showed increase in number of wear facets.
11. Anterior guided occlusion showed less number of wear facets in all the age groups compared to anterior guided with interference
12. All the subjects in the age group of 18-25 had their wear facets extending onto enamel only. With increase in age there is an increase in number of wear facets extending onto dentine in both anterior guided occlusion and anterior guided with interference.
13. In both type of protrusion occlusion almost equal numbers of wear facets were located in both maxillary and mandibular teeth.
14. Most of the interference facets in protrusion were located in molars and very few in premolars.

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CLINICAL REPORT

# Prefabricated Polymethyl Methacrylate Cranial Implant- A Case Report

Dr. Indu Raj, Dr. Sheela Virginia Rodrigous

**Abstract :** Reconstruction of calvarial defects have been accomplished with a variety of autogenous and alloplastic materials. Of the various materials currently available, Polymethyl methacrylate ,has proved to be an effective biomaterial for large cranial defects because of its ease of use, availability, dimensional stability, chemical inertness, nonconductivity, ease of modification and low cost. This article presents a clinical case report of the restoration of a large cranial vault defect with a prefabricated acrylic implant with irreversible hydrocolloid impression and lost wax technique.

**Keywords :** Polymethyl methacrylate (PMMA), prefabricated, implant, cranial defect.

## Introduction

Cranioplasty is one of the oldest neurosurgical procedures dating from 3000 B.C,used to repair cranial defects resulting from trauma, disease and congenital malformation. Many materials such as coconut shell, bones from both human and non human donors, metals including gold, silver, tantalum, titanium more recently biosynthetic materials such as resins and ceramics have been used for covering calvarial defects.

Repairing of cranial defects is carried out to protect underlying brain tissue, to provide pain relief at the site, to improve esthetic appearance and to minimize patient's anxiety. Cranioplasty can be delayed for 6-12 months to allow appropriate vascularisation of scalp flaps. This delay also helps to ensure absence of infection and provides a mature tissue bed to help injury to brain during the procedure.

On comparing,heat cured PMMa is preferred over self cured PMMa as former is 50%stronger than the latter,it ontains less than 0.4% residual monomer following 1-hour terminal boil, decreased surgical time for prefabricated implant placement, polishing can be done in abetter way for prefabricated implant which inturn reduces inflammatory tissue reactions.

This article discusses the procedures involved in the fabrication and placement of a prefabricated heat cured PMMA implant which was used for the repair of a large calvarial defect.

## Case report

A 32 year old male was referred to Department of Prosthodontics, Government Dental College, Kottayam from Department of Neurosurgery, Government Medical College, Kottayam for the fabrication of cranial implant. The patient had met with

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a road traffic accident one year ago. On examining the patient, the defect was so extensive that almost left ½ of the cranial vault was missing.

The most crucial step was finding out the exact margins of the defect. The hair was removed and then careful palpation was performed to locate the margins The boundaries of the defect : anteriorly 1cm above the supra orbital margin, posteriorly extending into the occipital bone upto the occiput, medio laterally it involves most of the left parietal bone (Fig.1).After locating the exact extent, boxing of the defect and

**Fig. 1**

adjacent area with modeling wax was done. The impression was made with irreversible hydrocolloid impression material (Zelgan) which was reinforced with plaster of paris. Impression was removed and poured with type III dental stone.

Then modeling wax was softened and adapted to fill the defect. On hardening, wax try-in performed to compare with the contralateral dome shape. A uniform thickness was maintained for the wax pattern. The extra care was given to the marginal areas.

By considering various factors including financial condition of the patient, we decided to fabricate the implant with heat cured PMMA (DPI ).The pattern invested in a specially designed metal flask. After bench curing, it was processed overnight. The prosthesis was deflasked and polished. Holes were drilled throughout the implant using a No.8 round bur. (Fig.2). These holes enable accumulated fluid to flow

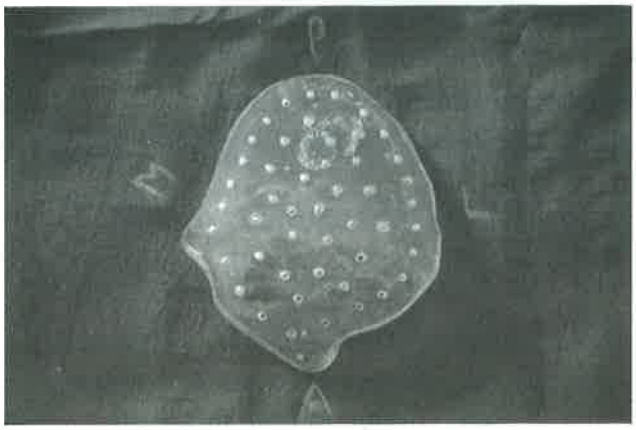

**Fig. 2**

out of subganglial space and subdural haematoma formation is decreased. They permit adhesion and migration of connective tissue which inturn enhances prosthesis stabilization. It also provides vascularisation of scalp and allows suturing. Again the try-in performed with this implant. This was sterilized.

**Fig. 3**

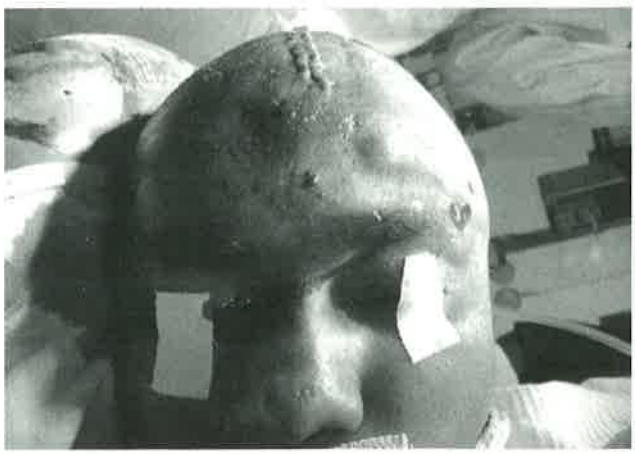

**Fig. 4**

**Fig. 5**

Neurosurgeon performed the surgery, the implant was placed in the exact positon, suturing was done(Fig.3).Iimmediate post operative photo (Fig.4) sitself shows aesthetic improvement.The patient had recall visits.A confident young man was the final achievement of our team effort(Fig.5).

## Discussion

Autogenous bone grafts are the materials of choice for cranial implants, but their acquisition requires another incision and discomfort. Bone implant received from bone bank has got the risk of being resorbed, transmitting diseases etc. Of the various cranial implant materials, Poly methyl methacrylate and titanium are the most viable materials. Titanium is expensive, difficult to fabricate, and hardly affordable by many patients in our society. Cold cure acrylic can be used directly to fabricate a plastic implant at the time of surgery. This material can cause exothermic reaction which can create damage to the surrounding tissues and may lead to infection and inflammation. This can be eliminated by fabricating a custom acrylic implant, using lost wax technique preoperatively.

## Conclusion

The restoration and recovery of a compromised skull continues to be a challenge to craniofacial surgeons and neurosurgeons. Different operative techniques and implant materials are used to reconstruct the rigid framework of the skull. However, no currently available materials satisfy all the requirements. The advantages of prefabricated, heat-cured polymethyl methacrylate implants are long-term biocompatibility, excellent aesthetics, improved compressive, impact and shear strength, impermeability to body fluids etc.

CLINICAL REPORT

# A Simplified Impression Technique to Record The Periimplant Soft Tissues

Dr. M. Narasimman, Dr. C.J. Venkatakrishnan, Dr. Saravanakumar, Dr. N.S. Azhagarasan

**Abstract :** The replacement of a single missing anterior tooth with an implant-supported crown is a highly successful and a challenging procedure. This article describes a simplified impression technique in maxillary anterior zone in which a customized impression coping is fabricated with auto polymerizing acrylic resin and used to register and reproduce the peri-implant soft tissues on the master cast. This procedure is designed to create an accurate reproduction of the gingival contours surrounding the implant, thus contributing to a final restoration with optimal esthetics.

**Key words :** Implant, Impression, Emergence profile, Provisional restoration, Anterior zone.

## Introduction :

Osseointegration is a well-established treatment modality for the restoration of missing teeth. The impressive results reported for the treatment of complete edentulism[1-3] encouraged researchers to establish clinical trials for partially edentulous patients.

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These studies have underscored the merits of either implant-supported restorations[4,5] or combined implant- and tooth-supported restorations[6] in partially edentulous patients. Success has also been reported for single-tooth restorations.[7-10]

In the recent literature, several single tooth replacement treatment techniques using dental implants have been reported.[11-22] In these reports are focused on immediate or early loading protocols are followed in which a provisional restoration is placed soon after implant placement. Clinical studies of immediate or early loading have reported favorable treatment outcomes in terms of implant survival, marginal bone resorption, soft tissue level and the incidence of complications of treatment in which implants were placed in healed sites, [15-18] as well as treatment in which implants were placed in fresh extraction sockets.[19-21]

Immediate or early implant loading provides several advantages for the patient, including a shorter overall treatment time, avoidance of a second-stage surgery, higher rate of patient acceptance and elimination of the need for a removable prosthesis during the healing phase. Loading protocols require careful preoperative planning and patient selection. Furthermore, good primary implant stability is an important prerequisite,[22] for the development of a protected occlusion to create a non occluding provisional crown. However the restoration of missing anterior teeth presents an esthetic challenge in terms of maintaining the smile line, preserving the soft tissues and obtaining an appropriate emergence profile from the gingival tissues.

The purpose of this clinical report was to demonstrate an immediate implant loading protocol for restoration of a missing lateral incisor. After the provisional restoration phase, a customized impression post was made by auto polymerizing resin used reproduce the peri-implant soft tissues with the help of provisional restoration and subsequently, a definitive cement-retained Metal-ceramic crown was placed.

**Case Report :**

A 29-year-old man was reported to the Department of Prosthodontics & crown and bridge, Tagore Dental College & Hospital, Chennai, for the restoration of a maxillary left lateral incisor in which, an implant (NobelReplace Tapered NP, 13 mm; Nobel Biocare AB, Göteborg, Sweden), was placed with implant abutment and also with comfort cap.(Easy abutment, Nobel Biocare AB, Göteborg, Sweden)(Fig.1). The shoulder of the implant was placed at a depth of 3 mm apical to the buccal and cervical aspect of the prospective clinical crown to provide soft tissue to develop an adequate emergence profile. The primary implant stability of >45 Ncm was obtained, during the placement of implant. This was determined with a measurement device for implant site preparation (Osseocare; Nobel Biocare AB, Göteborg, Sweden).

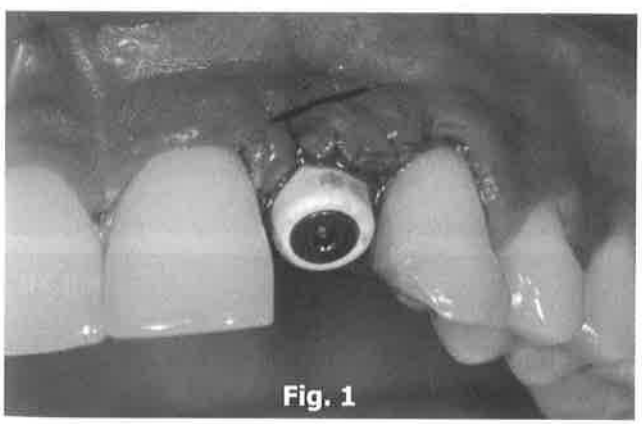
Fig. 1

In the dental laboratory, a screw-retained provisional restoration was fabricated, consisting of an engaging temporary abutment (NobelReplace Temporary Abutment Engaging; Nobel Biocare AB, Göteborg, Sweden) an acrylic denture tooth (Premadent, Cross-linked acrylic denture teeth, Mumbai, India) was bonded against which auto polymerizing resin (DPI-Self cure Tooth moulding powder; Mumbai, India) was modeled to get the desired shape of cervical portion of the maxillary lateral incisor. The abutment was removed and the screw retained provisional abutment was placed within 2 hours of implant placement (Fig.2). The patient was instructed to follow a soft diet, to avoid exerting force on the provisional restoration to avoid excessive contact on the restoration. Antibiotic, analgesic and mouth wash were given.

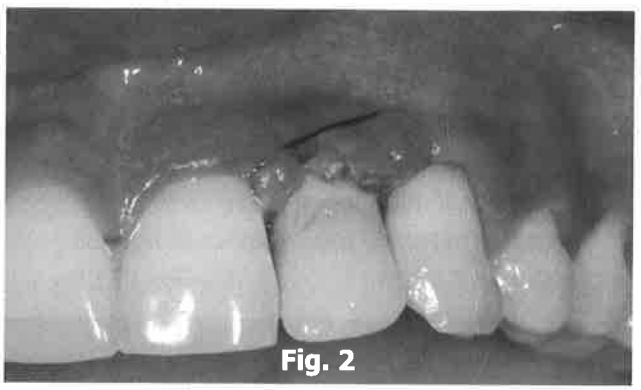
Fig. 2

One week following implant placement, an implant-level impression was made using an impression post (Impression Coping Implant Level Open Tray for NobelReplace; Nobel Biocare AB, Göteborg, Sweden). The impression post was customized in such a way that the existing emergence profile of the maxillary lateral incisor could be transferred to the definitive restoration. To achieve this, the provisional crown was assembled with an implant analogue (Implant Replica, NobelReplace; Nobel Bio-care AB, Göteborg, Sweden) embedded till the cervical portion in addition silicone impression(Aquasil soft putty/Regular Set, Dentsply, USA.) which was present in the Dampen glass(Fig.3).


**Fig.3**

The Screw-retained provisional crown was removed and it was replaced with the impression post (Fig.4). Auto polymerizing resin (Tooth colour moulding powder, Self-cure; DPI, Mumbai, India) was added to the post at the cervical level (Fig.5). After


Fig.4

polishing the individualized post, it was inserted into the implant (Fig.6) and an open tray impression was made with an addition silicone impression material (Aquasil soft putty, Dentsply DeTrey GmbH, Germany) by using the metal stock impression tray (Impression trays; Jabbar&Co, Jalandhar, India.)Before making the impression it was modified in the region of maxillary lateral incisor to access the impression post screw.

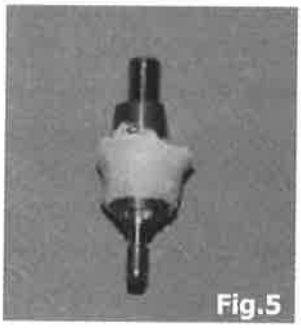
Fig.5


Fig.6

In the dental laboratory soft tissue cast was prepared (Fig.7). An abutment (Easy abutment, Nobel Biocare AB, Göteborg, Sweden) was used to make the cement retained metal-ceramic restoration (Fig.8).

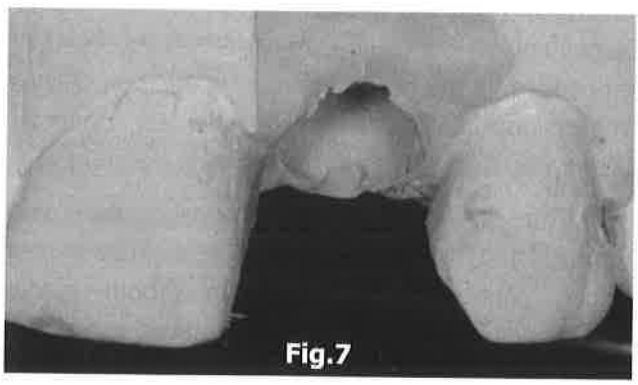
Fig.7

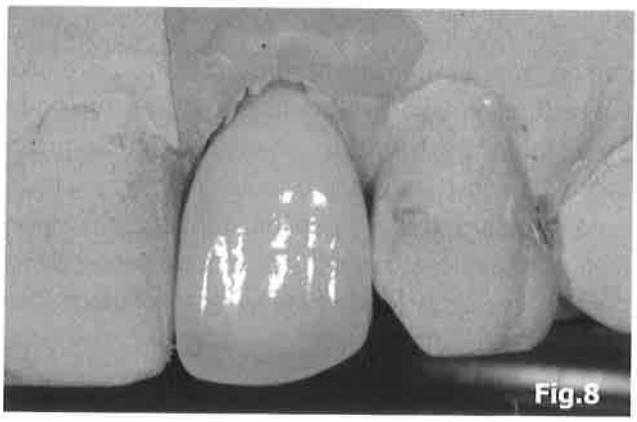
Fig.8

The abutment screw was torqued to 32 Ncm to the implant. The metal-ceramic crown was luted with the Glass Ionomer cement (GC Gold Label Luting & Lining cement; GC Corporation, Tokyo, Japan) after one week of implant placement. Occlusion was verified in centric and eccentric contacts (Fig.9). In 12 month follow-up period there was no complication noted. Patient was pleased with esthetics (Fig.10)

**Discussion :**

Restoration of maxillary anterior region is challenging procedure due to its esthetic situation.

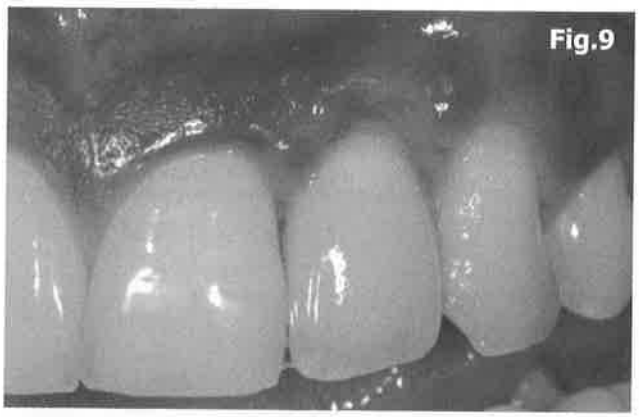
Fig.9

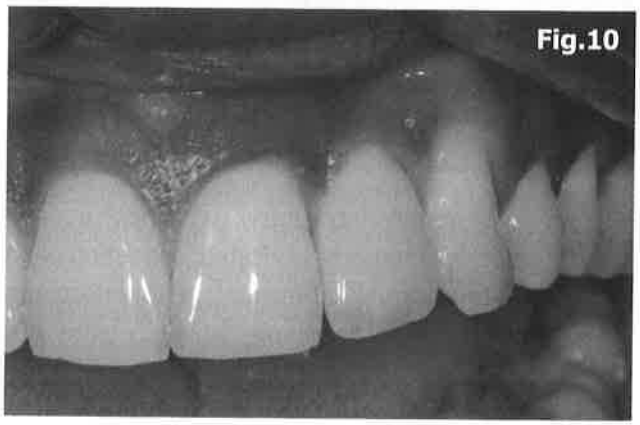
Fig.10

Even though alternative treatment options like Removable partial dentures and fixed partial dentures are available implant supported fixed prosthesis gives advantage of fixed option over removable prosthesis and avoiding preparation of the abutment tooth for tooth supported fixed partial denture. Implant supported fixed prosthesis provides the emergence profile compare to tooth supported fixed partial denture. This clinical report describes the restoration of maxillary left lateral incisor under immediate loading protocol using modified impression technique[23,27]. A good primary stability was achieved in this case which is above 45Ncm is the important prerequisite for the Immediate loading[21]. The provisional restoration was used to predict and evaluate the form and shape of the final restoration and to get approval from the patient thus increases the patient acceptance. The screw retained provisional crown was given for easy retrievability and modification of cervical portion of provisional prosthesis when it is required. The definitive metal-ceramic crown was fabricated after a week of implant placement due to patient demand. Because of this an incomplete wound healing can be noted at the gingival portion of the crown. The cement retained metal ceramic crown was given due to the access screw entry in the incisal edge of the crown which compromise the esthetic and function of the Metal ceramic crown. This procedure did not affect either the esthetic outcome or successful Osseointegration of the treatment.

Finally the cement retained metal-ceramic crown was fabricated. The advantage of the cement retained restoration over the Screw-retained restoration demands the proper implant position for the access screw whole to be in palatal side to increase which in demand of esthetics. However the screw retained restoration provides the advantage of retrievability and eliminates the possibility of periimplant tissue irritation by the cement remnants.

**Conclusion :**

This clinical report has described an impression technique that accurately duplicates the peri-implant tissue profile. The final prosthesis is shaped exactly like the provisional prosthesis for ideal shape, contour and soft-tissue position. The described technique prevents distortion of the gingival form when the final impression is made and permits accurate reproduction, allowing for predictable esthetics in the final restoration.

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CLINICAL REPORT

# A Simple and Cost Effective Technique for Reconstruction of Traumatic Cranial Defect

Dr. Rajendra Prasad Bitragunta

**Abstract :** Cranial vault deformities as sequelae to trauma may be as high as 70%. The successful management of a case of trauma in an emergency situation requires quick evacuation of the haematoma, repair of the dura and the scalp but not necessarily the integrity of the cranial segment as an immediate measure. So the reconstruction of the cranial defect in these cases is mostly carried out as a secondary procedure with "polymethyl acrylic resin" prosthesis. This article presents reconstruction of cranial defect with heat cured polymethyl methacrylate resin prosthesis, because of easy availability, low cost, quick application, excellent results and no post operative complications.

**Key words :** Cranial reconstruction, Cranial prosthesis, Temporal bone, Polymethyl methacrylate resin.

## Introduction

Cranial defects as a result of trauma including vehicle accidents, gunshot wounds and occupational accidents can be cosmetically disfiguring. Defects can also occur as a result of inflammatory, neoplastic and congenital insults.[1] Reconstructing these defects in a natural, aesthetic fashion can pose a challenge to the clinician. With the advent of newer implant material, primary reconstruction of traumatic cranial vault defect is possible provided the general condition of the patient permits the surgeons to do so. This is not possible most of the times, but if done, it would avoid a second anaesthesia and surgery. Majority of the cases underwent second reconstruction because of the initial surgical emergency requiring quick debulking and closure.

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## Case Report

A 37-years-old male patient reported to the Department of Prosthodontics, with a chief complaint of facial disfigurement due to traumatic injury of left temporal bone. He gave a history of trauma 20 months back and underwent surgery for open reduction and fixation of skeletal fractures. After 9 months of surgery again a second surgery was performed for the removal of left temporal bone due to infection at the same site. As a result of altered facial esthetics, the patient suffered severe emotional trauma in terms of social acceptance [figure 1]. Before undertaking any

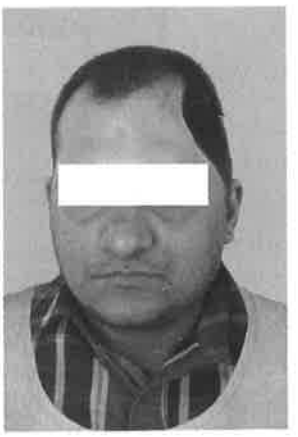

**Figure 1: pre-operative view of the traumatic cranial defect.**

reconstructive procedures of the cranial defects, the patient was evaluated both clinically and radiologically by the neurosurgeon. The radiological investigations included X-ray skull- AP and lateral view supplemented with CT scan for defining the site and size of the defect.

Patch test was carried out to the patient planned for reconstruction with poly methacrylate resin plate to rule out any hypersensitivity reaction.

**Procedure**

1. Prior to the secondary reconstruction, the defect was marked on the scalp [figure 2].

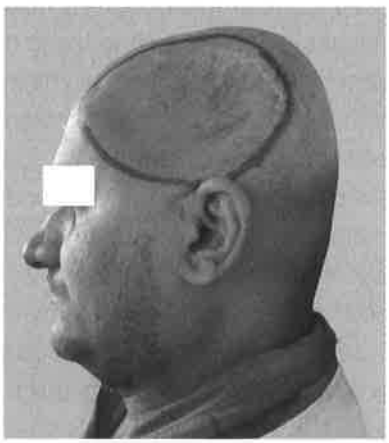

**Figure 2: The cranial defect marked.**

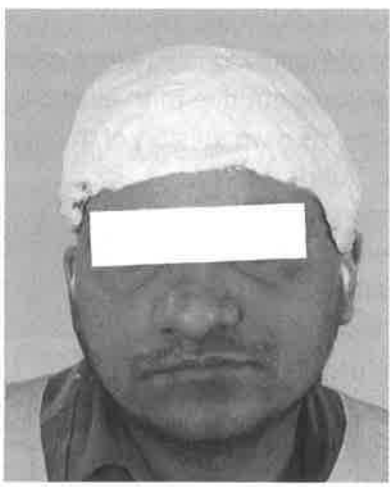

**Figure 3: Alginate impression of skull including defect was reinforced with dental plaster**

2. Irreversible hydrocolloid (Alginate) impression material was used to make the impression of the skull including the defect and dental plaster was used to reinforce the impression [figure 3].
3. A cast was made with dental stone.
4. Acrylic cranial plate was fabricated and processing was carried out in a water bath at $1680^{0}$ F for 12 hours and boiled for 30 minutes to ensure a complete cure and maximum reduction of free monomer.
5. At the edge of the prosthesis, multiple holes of 1.5mm diameter were made at a distance of 1.5mm to 2mm from each other for proper fixation. The prosthesis was given a final finish and high polish [figure 4].

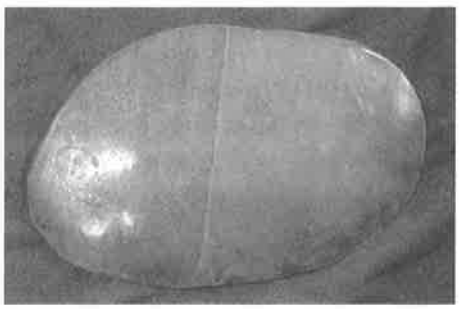

**Figure 4: Prosthesis after finish and polish.**

6. The prosthesis is then sterilized by soaking for 48 hours in 2% glutaraldehyde solution.
7. The patient was taken to the operating room, where incision from the previous surgery was used to gain access under general anaesthesia.
8. Despite careful dissection, the dura mater was inadvertently opened and repaired. During surgery, prior to the placement of prosthesis, a step cut of depth 2mm is made at the periphery of the defect. It facilitates the proper seating of the prosthesis and smooth marginal adaptation [figure 5].

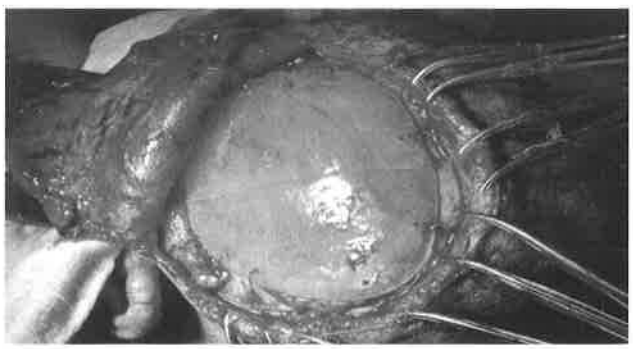

**Figure 5: Prosthesis in-situ.**

9. Before fixation of the prosthesis, the dural hitch sutures are placed through any suitable perforation already made in the plate. It prevents the subsequent formation of the subdural haematoma.
10. The prosthesis is fixed with 22-guage stainless steel wire and the knot is kept under the prosthesis.
11. It is important to fabricate the plate slightly larger than the actual defect. So that the prosthesis does not dip into the defect and lead to an unacceptable aesthetic contour.

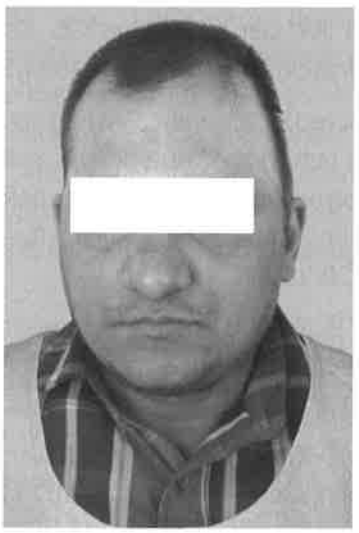

**Figure 6: Post-operative view-after 2 years.**

12. The scalp was then closed in a layered fashion and a compressive head wrap applied to prevent subgaleal fluid collection. The patient's follow-up appointments consisted of neurologic examinations and cosmetic inspections.
13. The 2- year post surgery follow-up has demonstrated that the patient had an uneventful postoperative course and excellent cosmetic results [figure 6].

## Discussion

Cranial defects have been reconstructed using both alloplastic materials and autografts.

The alloplastic materials that have been used for these defects are hydroxyapatite[1] silicone rubber,[2] acrylic,[3] metal plates, [4]and proplast.[5] Advantages of alloplastic materials are their availability, non-resorbability, the ease of the surgical procedure incorporating the materials and the excellent postoperative cosmetic results. Disadvantages include foreign body reaction to the material and the potential of infection which may produce fistulae, slippage, extrusion, granulomas and erosion.[6] Autogenous materials include bone taken from the ilium, rib, calvaria, dermis-fat or cartilage.[7-10] Their advantages include tissue tolerance and a viable reconstructive matrix. Disadvantages include unpredictable resorption, potential for early infection, donor site morbidity and inability to obtain adequate bone for large defect.[11,12]

Cranial defects caused by trauma can be satisfactorily treated using polymethyl methacrylate resin prosthesis. Many authors have outlined the merits of acrylic resin for cranioplasty procedures as compared with other materials.[13,14] „Polymethyl methacrylate' an acrylic polymer produced from esters of methacrylic acid was first used for reconstruction of cranial defects by Zendar in 1940. It can be used either as a heat cured preformed prosthesis or cold curing form. A preformed polymethyl methacrylate prosthesis is preferred as there is no heat on polymerization and no excess liquid monomer which might irritate and damage the underlying structures.[15] This prosthesis is radiolucent and non-carcinogenic. It possesses low thermal and electrical conductivity. It is strong, biocompatible and tissue response is minimal.

However acrylic prosthesis has a tendency to shatter on impact, particularly in large defects.

Some authors suggest incorporation of titanium miniplate [16] or stainless steel wire mesh [17] in the acrylic prosthesis which offer better strength to the prosthesis. To overcome the demerits of being radiolucent some authors recommend impregnation of these plates with small amount of barium, so that it becomes detectable by radiographic means in case of accidental fracture of the plate.[16] The perforation in the plate is a definite advantage since they allow accumulated fluid to seep out into the sub-galeal space, permit adhesions between the prosthesis and

the soft tissue which helps to secure the former and allows adequate blood supply to the overlying flap i.e. scalp. The highly polished surface makes it well acceptable and is well tolerated. Its wide availability and low cost makes it the most acceptable prosthesis used today.

## Conclusion

With the advent of digitally programmed 3-D models of skull, the exact dimensions of the defect can be generated on which an accurately contoured prosthesis can be designed.[18]

Although heat cure methyl methacrylate prosthesis has been giving gratifying results, the search for better and biodegradable material for reconstruction of cranial defects is under trial. These include biodegradable plates, screws and non-ceramic hydroxyapatite cements which stimulate osteoid tissue formation. In the near future these materials will open a new-era in cranial reconstruction due to their inherent Osseo-conduction, Osseo-conversion and Osseo-integration properties.

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CLINICAL REPORT

# Prosthetic Rehabilitation of Patients with Dentinogenesis Imperfecta: Clinical Considerations and Case Reports

Dr. Shri Krishna Kabra, Dr. Veena Jain, Dr. Pooja Kabra

**Abstract :** Dentinogenesis imperfecta (DI) is a hereditary disorder resulting in defective dentin in both primary and secondary dentition. The complications of DI are difficult to manage and provide a challenge to the dentist. Early and correct diagnosis of DI is imperative to enable appropriate preventive intervention and optimal dental treatment. An integrated approach to the problems of conserving teeth in patients with DI is described through two case reports.

**Keywords** : Dentinogenesis Imperfecti, fixed-removable prosthesis, full mouth rehabilitation

## Introduction

Dentinogenesis imperfecta (DI) is a hereditary mesodermal defect of dental origin transmitted as an autosomal dominant trait. It is one of the most common disturbances of dentin formation affecting both deciduous and permanent dentition with incidence of 1:8000. Shield et al. have suggested the following classification: Type I: DI that occurs with ostogenesis imperfecta. Type II: DI not associated with osteogenasis imperfecta also referred to as herediatary opalescent dentin (most common type). Type III: DI of "Brandywine type" (a triracial isolate in Maryland)[1,2]

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## Clinical Aspect

Clinically the color of teeth may range from a gray to brownish violet or yellowish brown and exhibit a characteristic unusual translucent or opalescent hue, which is actually a manifestation of dentinal discoloration seen through translucent enamel. The enamel may be lost early because of an abnormal dentino-enamel junction. With the early loss of enamel, the dentin undergoes rapid attrition up to gum level if left untreated.[3,4,8]

## Radiographic aspect

The distinctive radiographic appearance of DI dentition is critical in establishing correct diagnosis. The striking feature of the disease reveals partial or complete obliteration of pulp chamber and root canals by continuous formation of dentine. Root appears short and conical and crown appears bulbous with constriction at cemento-enamel junction. The cementum, periodontal membrane, and supporting bone appear normal. [5,6,7,8]

## Histologic aspect

The histologic structure of the dentin in DI appears relatively normal, except that the number of dentinal tubules is decreased with immature collagen fibrils. The characteristic scalloping at the dentino-enamel junction is diminished or absent. This scalloping is supposed to provide mechanical

interlocking between dental hard tissues. When this scalloping is missing, the enamel prisms can be easily detached. As a result teeth exhibit severe attrition or fracture. [8,14]

**Assessment and treatment plan**[9,10,12]

Treatment of patients with DI is directed primarily towards preventing the loss of enamel and subsequent loss of dentin through attrition.

**Treatment of DI has different objectives:**

1. To provide the patient with esthetic appearance to prevent psychological problems
2. To recover the lost vertical dimension
3. To avoid interfering with the eruption of remaining permanent teeth

**Deciduous dentition**

Attrition of deciduous teeth often results in their being worn down to gum level. Treatment is usually limited to regular recall and oral hygiene instruction.

**Mixed dentition**

When the permanent incisors and first permanent molars erupt, they are the ones, which are not worn out. Clearly, attempts at conservation with the aim of preventing attrition must be started as soon as possible by placing stainless steel crowns on first permanent molar. Alternatively, an upper removable biteplane in occlusion with all except the molar teeth on one side can be fitted. As these erupt to meet one another, their clinical crowns become sufficiently long for future metal ceramic crowns to be cemented.

**Permanent dentition**

When the dentine has been effectively preserved as result of early treatment or because of mild condition, treatment by conventional crowns is relatively straightforward. If the dentin has not been preserved, rapid attrition results in complete loss of the crowns of teeth. A decision has to be made on the need to increase the occlusal vertical dimension to compensate for attrition. The patient's tolerance of an increase vertical dimension should be assessed by either biteplane, overdentures or by composite restorations, which should be worn and assessed for a period of 6 weeks to 3 months. In some cases all that can be done for the patient is to leave them with overdentures. In some cases, however, it is possible to make crowns, pin retained cast thimbles under crown once freeway space is gained through full mouth gingivectomy and alveolar bone trimming. Post crowns should be avoided due to risk of pulp exposure, but not being able to treat adequately a fine residual pulp canal, and the risk of lateral perforation of the roots in post preparation without a pulp canal to guide the preparation.

**Case Report 1**

A 14-year-old girl patient reported to the department of Prosthodontics at C.D.E.R, All India Institute of Medical Sciences, New Delhi, India, complaining of unsightly appearance of teeth in lower jaw.

Clinical examination showed extensive attrition of teeth in lower jaw, which had characteristic opalescent hue and were attrited due to the loss of enamel and dentin [Figure 1]. Amount of tooth loss in upper jaw was minimal and had yellowish brown hue. On clinical examination, 15 and 16 were found to be tender on percussion. 16 was fractured at the level of gingiva. Radiographic examination revels complete obliteration of pulp chambers and root canals of most of the teeth in lower jaw. 15 and 16 had periapical radiolucency and furcation involvement suggestive of periapical pathology. All maxillary molar showed complete obliteration of pulp chamber while the remaining teeth in upper jaw have normal size pulp chamber and root canals [Figure 2]. Roots were short and conical. Clinical, radiological, and family history was suggestive of type II DI.

**Treatment plan**

The treatment was planned in three phases:

**1st phase** : Mouth preparation

All the teeth with guarded prognosis were extracted (i.e., 15 and 16). Oral prophylaxis was performed and patient was educated how to maintain the oral hygiene and periodontal health to save the remaining teeth.

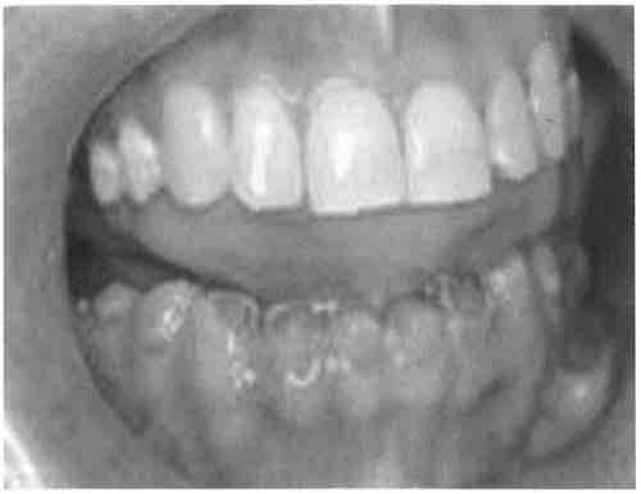


**Fig. 1Intraoral Pre-operative View**

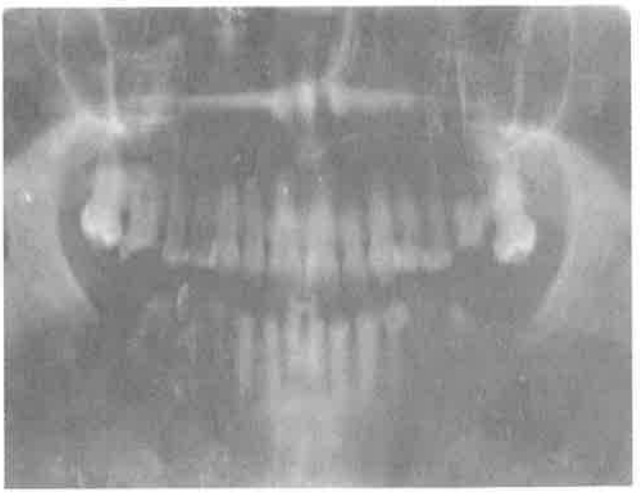


**Fig. 2 Pre-operative Panorex View**

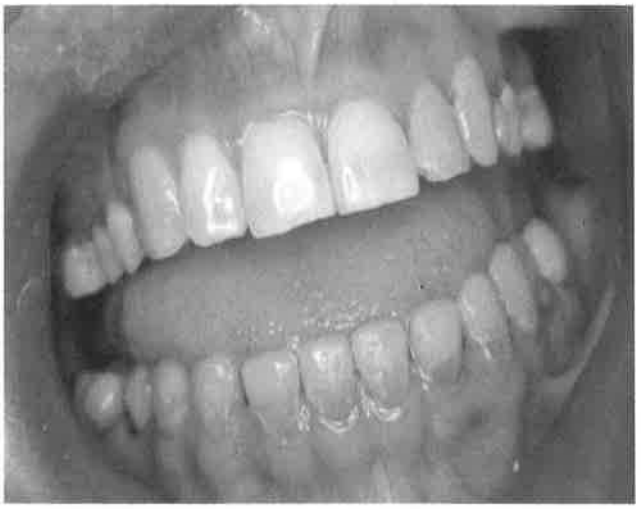


**Fig. 3 Restoration Of Lost Vertical-diagnostic Composite Build Up Of Lower Arch Alone**

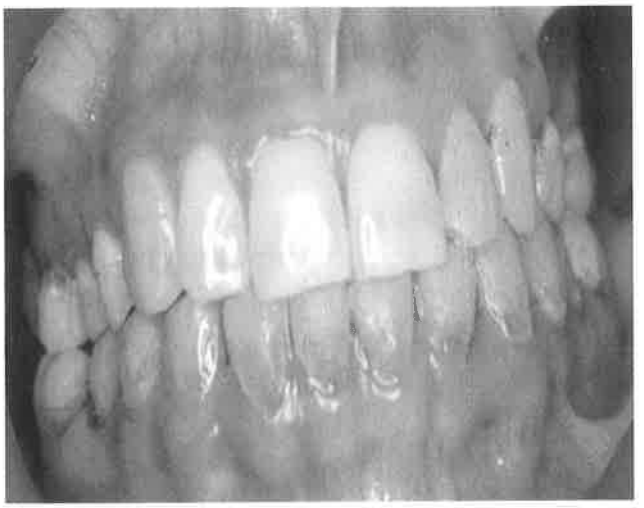


**Fig. 4 Composite Build Up In Occlusion**

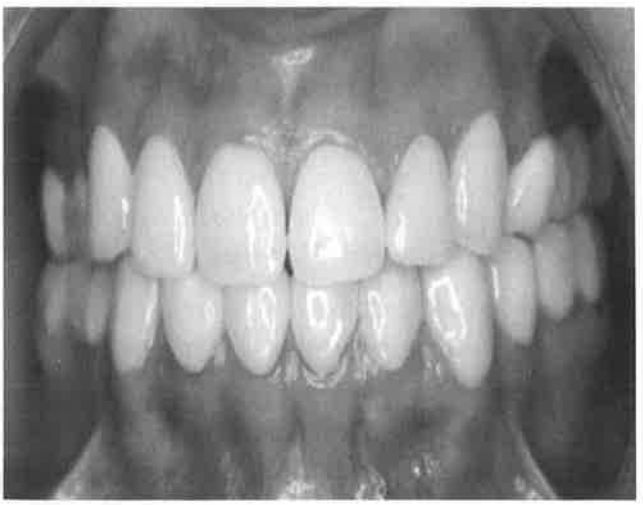


**Fig. 5 Final Metal Ceramic Restoration In Occlusion**

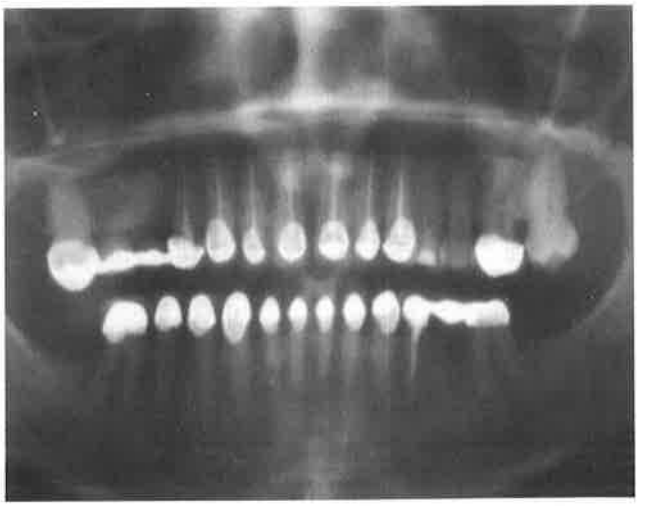


**Fig. 6 Post Operative Panorex View**

**2nd phase** (Intermediate phase): Restoration of lost vertical dimensions

Vertical dimension was established according to physiologic rest position, esthetics, and phonetics. Acrylic splint was fabricated to ascertain whether increase in vertical of occlusion would be accepted by the patient's stomatognathic system. Examination after 3 weeks showed that raising the bite had no apparent harmful effect on the physiology of masticatory apparatus. Maxillary and mandibular cast was mounted on whipmix articulator with the help of facebow and acrylic splint. Diagnostic wax-up was done at the established vertical dimension. Composite buildup was done on all the mandibular teeth using vaccuform template obtained from diagnostic wax-up and canine-guided occlusion was established [Figures 3 and 4]. Composite buildup of crown required use of dentine pins or channels for the retention of composite. Patient was kept under observation for three month. Patient had not complained of muscle or joint pain during this period except few build up was repeated due to fracture.

**3rd phase** (final phase): Fabrication of porcelain fused to metal crown and bridge.

A silicon putty index was fabricated before starting the tooth preparation to facilitate in fabrication of chair side provisional restorations. All teeth were prepared with a circumferential heavy chamfer finish margin. The preparation depth was 2.00 mm for the occlusal surface and 1.5 mm for the labial and lingual surface. The teeth were immediately restored with acrylic provisional crowns. Impressions were made in addition silicone material; following the dual mix impression technique. Facebow and centric relation record was taken to mount the maxillary and mandibular cast. Metal copings were fabricated, seated on die and metal coping trial was taken. Porcelain was applied and occlusion was adjusted on articulator and a trial was taken at bisque stage, to make the necessary adjustments. These restorations were glazed and cemented with Glass Ionomer cement [Figure 5]. During cementation, alternate crowns were cemented initially to ease in removal of extra cement from gingival crevice. Patient was kept on follow up schedule of six month after initial follow up period. Even after 2 years of follow up, there was absolutely no evidence of clinical failure except slight marginal inflammation on the gingiva.

**Case Report 2**

A 28-year-old male patient reported to the department of Prosthodontics at C.D.E.R, All India Institute of Medical Sciences, New Delhi, India, for improvement in esthetics. On clinical examination, it was observed that all his teeth had characteristic opalescent hue. Enamel was lost in most of the teeth and they were attrited to gum label except the molars in lower jaw and one molar in upper jaw [Figure 1a]. Panorex revealed poor periodontal status in few teeth and complete obliteration of pulp chambers and root canal in all the teeth [Figure 2a]. On the basis of clinical and radiological finding, a diagnosis of DI was made.

**Treatment plan**

All the teeth with guarded prognosis were extracted and definitive treatment was differed till the tissue was healed completely. Maxillary cast overdenture and fixed removable type of prosthesis in lower jaw was planned. For the fabrication of fixed removable type of prosthesis, telescopic crown on 18 and 26 with semi precision attachment on 28 was decided. Initially to start with the treatment, bite plane was fabricated at raised vertical to ensure that raising the bite had no apparent harmful effect on the physiology of masticatory apparatus [Figure 3a].

**Fabrication of prosthesis**

To prosecute the treatment plan, sharp margin on any tooth in upper and lower jaw was rounded. Metal coping for telescopic crowns and metal crown with provision for semi precision attachment on 28 was fabricated and cemented [Figure 4a].

Trial denture base was made ready for both the jaws following the conventional steps of complete denture fabrication. Mandibular refractory cast was mounted against maxillary trial denture, so that occlusal surface of telescopic crowns can be developed according to maxillary occlusion plane. Metal framework was fabricated and tried in oral cavity [Figure 5a].

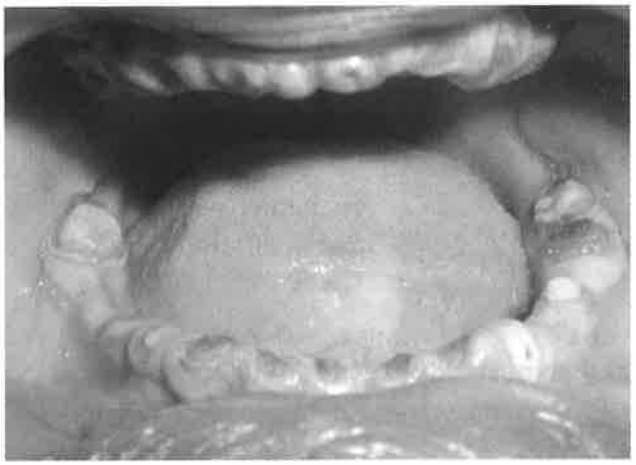


Fig. 1a

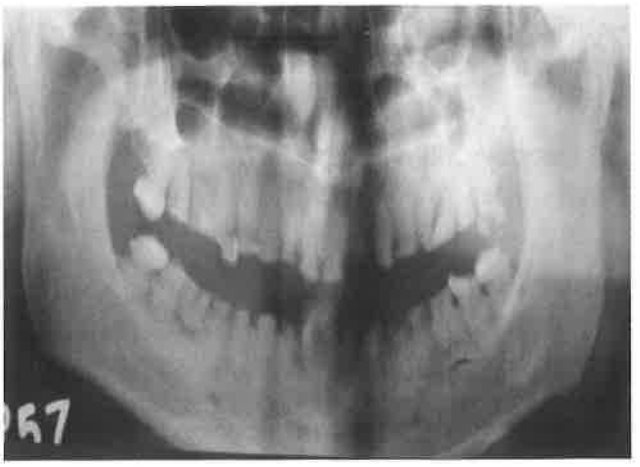


Fig. 2a

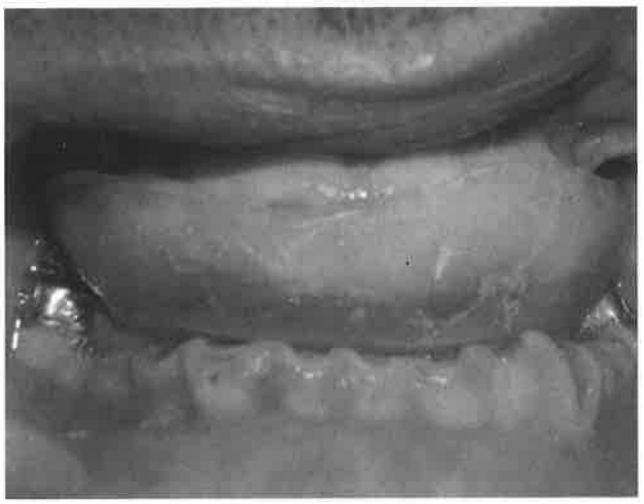


Fig. 3a Restoration Of Lost Vertical-bite Plane

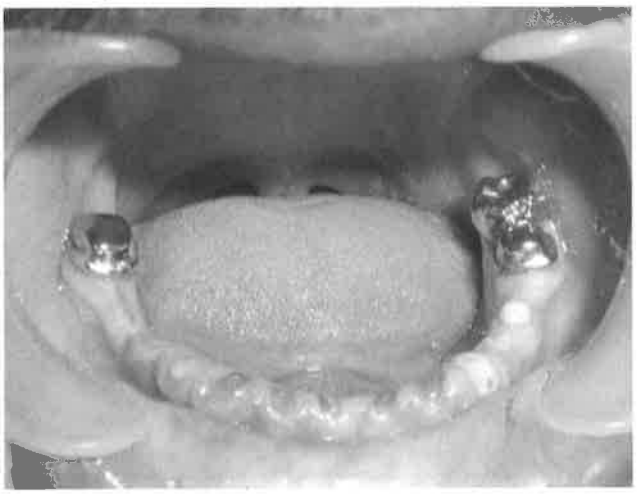


Fig. 4a Metal Coping For Telescopic Crowns & Metal Crown With Provision For Semi Precision Attachment On 28

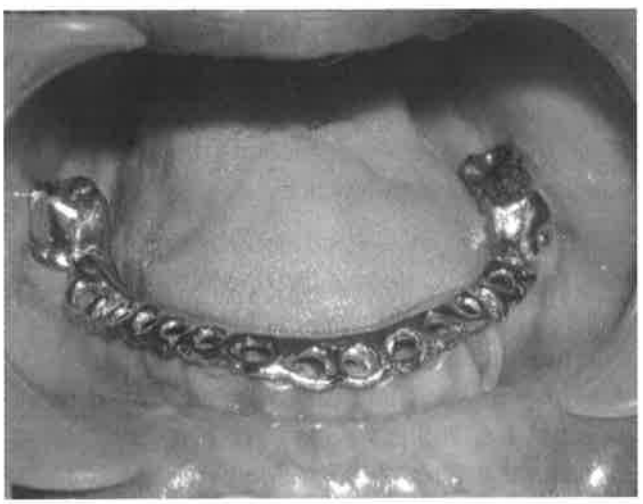


Fig. 5a Metal Framework Trial

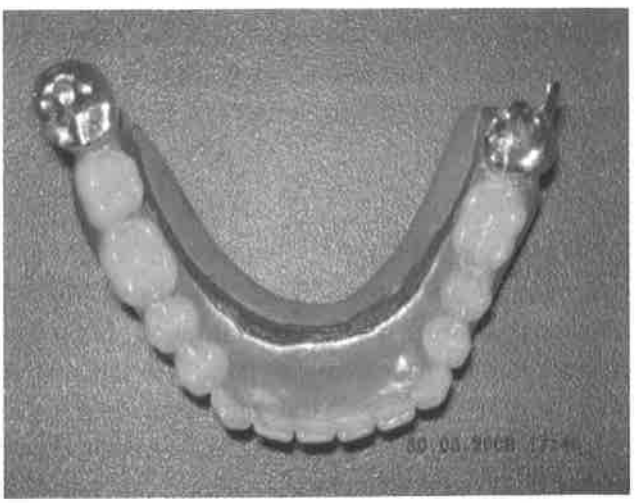


Fig. 6a Cast Partial Fixed-removable Lower Denture

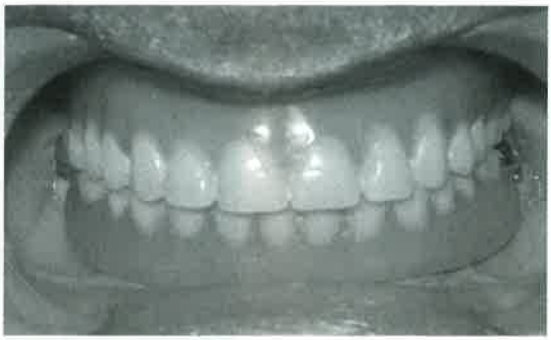
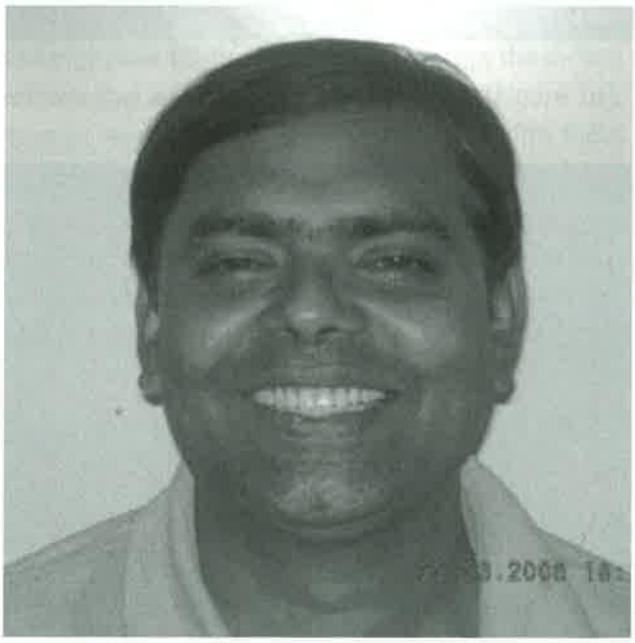


**Fig. 7a Upper Overdenture And Lower Cast Fixed-removable Prosthesis In Occlusion**

**Pre-operative**



**Post-operative**

Wax bite rim to fabricate mandibular trial denture was fabricated on metal framework against the previously formed maxillary trial denture. Try-in was taken and both the denture was acrylized, finished, polished, and delivered to the patient [Figure 6a and 7a].

## Discussion

Most patients suffering from DI who seek treatment are motivated by psychological esthetic and functional concerns. The rehabilitation of these patients is difficult and challenging. The goal of the treatment is to protect the remaining teeth and restoration of esthetics and functions. The complete or partial obliteration of pulp chambers complicate the situation, as support from root canals can not be taken. The objective that must be taken into account when the prosthodontic treatment is chosen is to save as much as possible of the remaining structures of teeth and protect them by providing a relaxed mandibular position and increased vertical dimension of occlusion, which will facilitate the recovery of adequate masticatory function.

In the first case report, jacket crown fabrication was the most preferred treatment of choice as it prevents further tooth loss. Whereas in the second case report, jacket crown fabrication was not possible due to non-existent clinical crowns except in mandibular molars. Also crown-lengthening procedures were avoided due to short roots. Therefore, an intermediate treatment option of maxillary cast overdenture and fixed-removable cast

mandibular overdenture (telescopic prosthesis) was planned and executed.[5,10,13]

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CLINICAL TIP

# A Predictable Procedure For Packing Denture Base Resin After Fracture Of Investment Material

Dr. Vidya Kamalaksh Shenoy, Dr. Sharon J.R Saldanha, Dr. Rodrigues J Shobha, Dr. Prashanti .E

**Abstract :** Fracture of the investment material and cast can be an aggravating experience while processing the removable dentures. This article describes a laboratory procedure for packing denture base resin into the denture flask when the cast is intact and investment material is fractured.

**Keywords :** Denture base, Processing, Fracture, Investment Inadvertent fracture of the investment material and cast can be an aggravating experience while processing the dentures (Fig.1). Fracture occurs during separation of two halves (drag and the cope) of the denture flask after the wax has been eliminated, either because of failure to apply separating media between the two pours of the dental stone or failure to blockout unfavourable undercuts in the cast.[1] As a result packing denture base resin into the mold becomes difficult and may necessitate the repetition of the clinical procedures. A procedure is described for packing denture base resin into the denture flask when the cast is intact and investment material is fractured.

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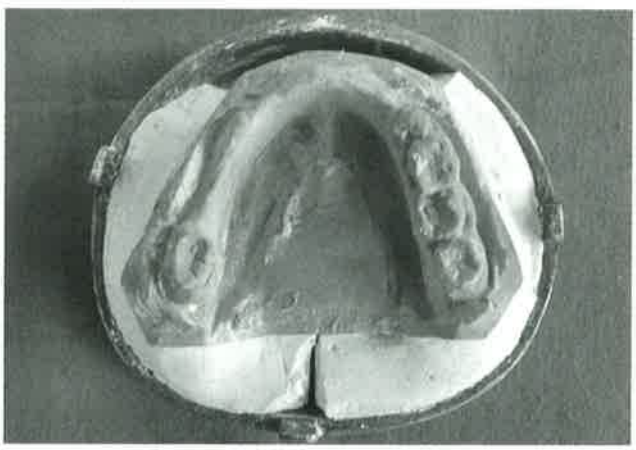

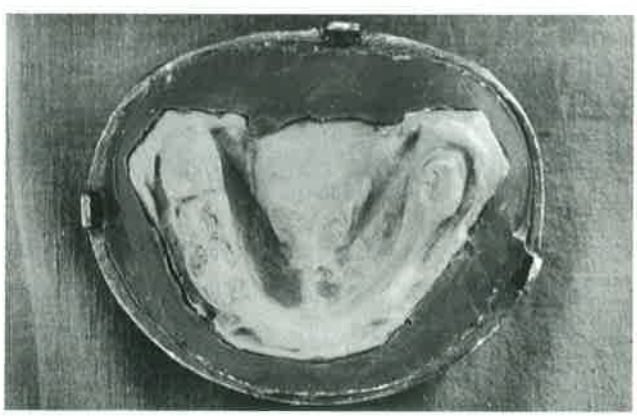

## Procedure

1. Remove all traces of investment material from the drag of the denture flask and clean the surface.
2. Position the intact cast corresponding to its indentation in the cope of the flask.
3. Apply adhesive(Caulk tray adhesive; Dentsply,Konstanz,Germany) onto the surface of the drag of the denture flask and base of the cast.

4. Mix heavy-body vinyl polysiloxane impression material (Reprosil Putty; Dentsply, Konstanz, Germany) and place on the base of the cast.
5. Close the drag of the denture flask onto the cope in a press until they are in a close approximation.
6. Allow excess impression material to come out and wait till complete polymerization.
7. Cast gets attached to the impression material (Fig.2).
8. Open the flask and pack with denture base resin.

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CLINICAL REPORT

# Rehabilitation of a Residual Facial Defect with Silicone Prosthesis

Dr T. Soorya Poduval, Dr Deepa Jayashankar

**Abstract :** This clinical report describes the use of room temperature vulcanizing Silicone elastomer to restore a large residual facial defect. The prosthesis was designed to overcome the disadvantages associated with traditionally fabricated prosthesis namely, delamination of silicone of the acrylic base and poor marginal adaptation. Intrinsic staining of the prosthesis using powder pigments was done to match the color for Indian population and minimize the extrinsic staining. Emphasis was given for the patient's concern for a normal appearance..

## Introduction

Head and Neck Squamous Cell Carcinoma (HNSCC) is the most distressing of all cancers because of the visibility of the mutilation associated with this type of malignancy. Head and neck is the site of the most complex functional anatomy in the human body. Any malignancy in this region will have an impact on important human functions namely, CNS, breathing, vision, cosmesis, voice, swallowing, etc.

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HNSCC is the sixth most prevalent neoplasm in the world (~ 900,000 cases diagnosed worldwide[1]) in those who have survived, pain; disfigurement and physical disability from treatment have had an enormous psychosocial impact on their lives - McGregor et al. [2]

## Objectives of maxillofacial prosthetics

- Restoration of esthetics and function
- Protection of tissues
- Therapeutic or healing effect
- Psychological therapy

Substantial team effort is needed to restore a normal appearance and function.

## Case Report

A 65-year old female patient was referred from Kidwai Institute of Oncology, Bangalore to the Department of Prosthodontics, Bangalore Institute of Dental Sciences, Bangalore with a residual facial defect.

Patient was diagnosed with squamous cell carcinoma of the right buccal mucosa two years ago; she underwent wide excision of the lesion along with hemimandibulectomy. Radical neck dissection on the right side was done leading to both intraoral and extra oral deformity.

Patient presented with extensive scarring on the right cheek and neck. (Fig 1) Hemimandibulectomy was done on the right side, there was limited mouth opening. (Fig 2) Rehabilitation of this large residual facial defect was utmost priority considering

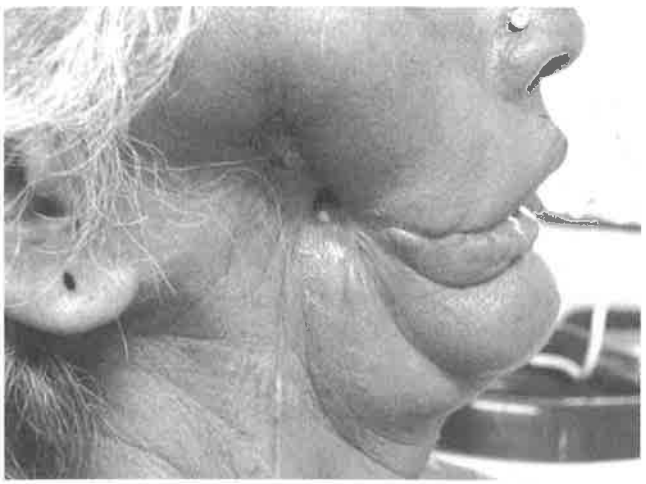

**Figure 1 : Residual defect after surgery**

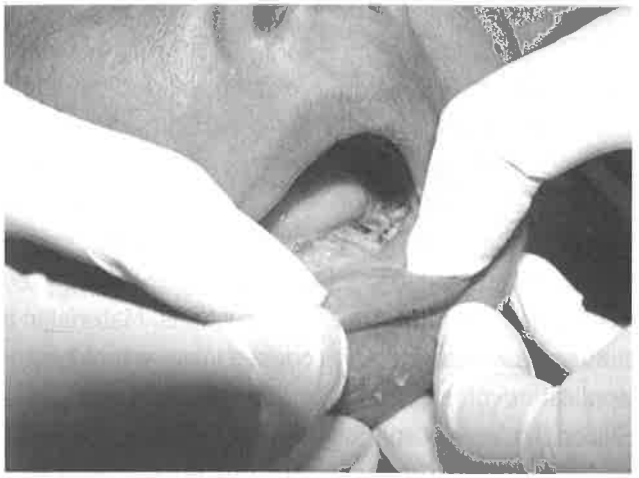

**Figure 2 : Limited mouth opening**

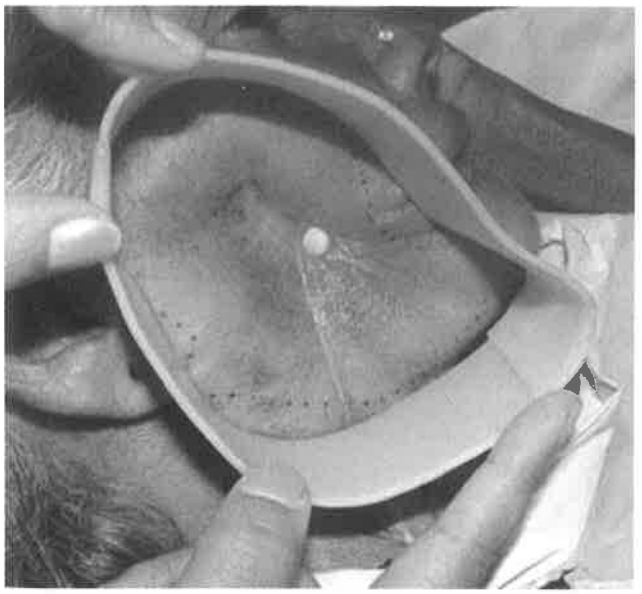

**Figure 3: Marking the defect**

**Figure 4: Impression made using alginate**

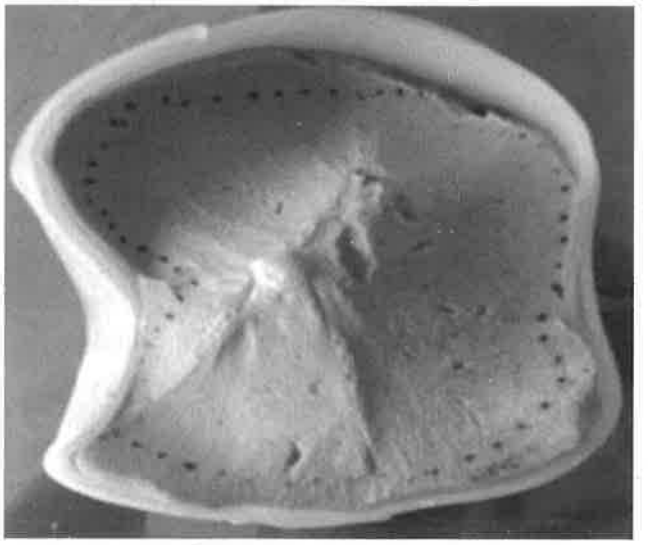

**Figure 5: Final Impression**

**Figure 6 : Wax Pattern on the cast**

**Figure 7 : Preparation of the Mold**

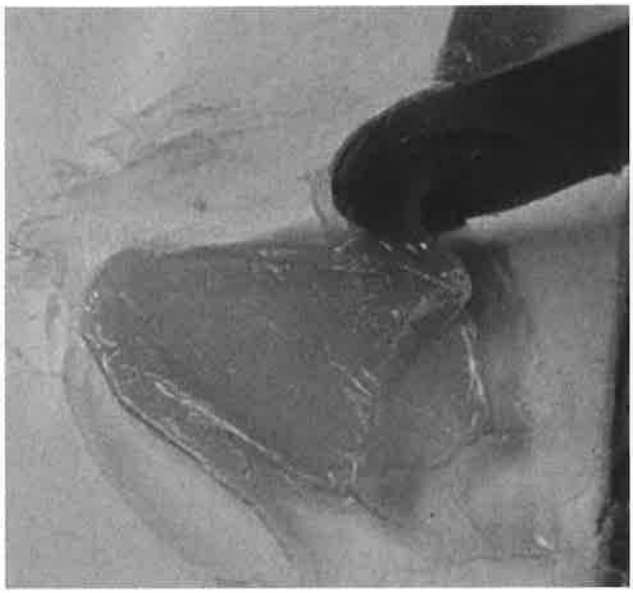

**Figure 8: Manipulation of RTV Silicone**

significant facial disfigurement. Patient's concern demanded a normal appearance.

**Procedure**

Patient was reclined on the dental chair with head slightly elevated. This position achieves a relaxed muscle tone and facilitates easier material application. Gravity helps to stabilize the material. External borders of the defect to be reproduced was marked and boxed with boxing wax held in place. (Fig 3) Irreversible hydrocolloid* (Algitex, Dental Products of India, Mumbai) was poured into the defect area to the desired thickness. Paper clips bent in 'L' shape were embedded in hydrocolloid before the material sets for reinforcement. (Fig 4)

Dental plaster was poured to the depth of ¼ to ½ inch at the borders, when plaster was set, the patient was asked to wrinkle the face to loosen the impression. With a quick tug the boxed out area containing the impression was removed. (Fig5) Accuracy was checked, and the impression was poured using type III dental stone*( Denstone, Pankaj Manufacturers, MP). The defect was built up with base plate wax*(Golden Dental Products, Hyderabad) and sculptured to match the symmetry to the patient's left side of face (Fig 6). Wax try in was done, necessary adjustments made and stippling and characterization done. Area of scar tissue was relieved as it would interfere in retention of prosthesis. A mold was prepared using this wax pattern using type III dental stone. RTV (room temperature vulcanizing) silicone*(MP Sai Enterprises, Mumbai) was used for the fabrication of this facial prosthesis[3]. (Fig 7)

A technique utilizing RTV as suggested by Lepley was used[4]. RTV silicone was blended with suitable pigments* (Camlin India Pvt. Ltd) to produce the patient's skin color. The pigments used were white, burnt umber, yellow ochre and ultra marine blue. (Fig 8) Color matching was done to suit the basic skin shade of the patient[5]. Catalyst was added and mixed according to manufacturer's instructions. Material in a fluid state was carefully introduced into the mold, after application of separating media (Cold Mould seal). Silicone rubber was allowed to polymerize overnight under pressure. Glossy surface of the prosthesis was

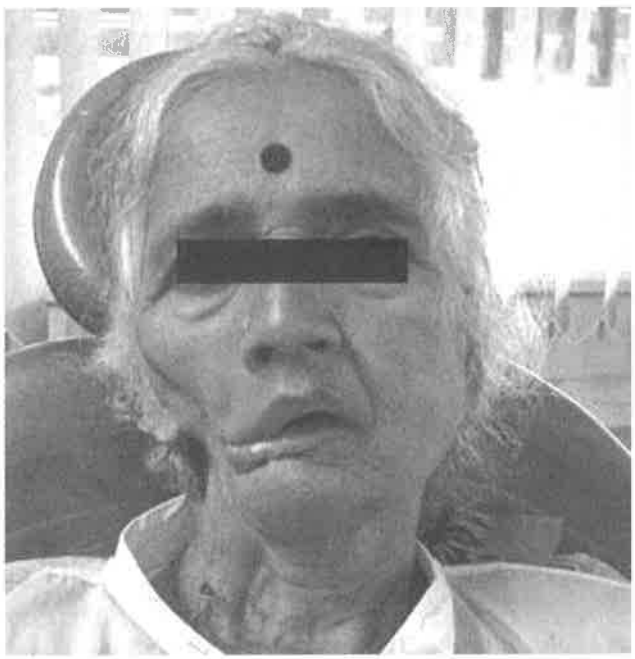

**Figure 9:Residual Facial Defect**

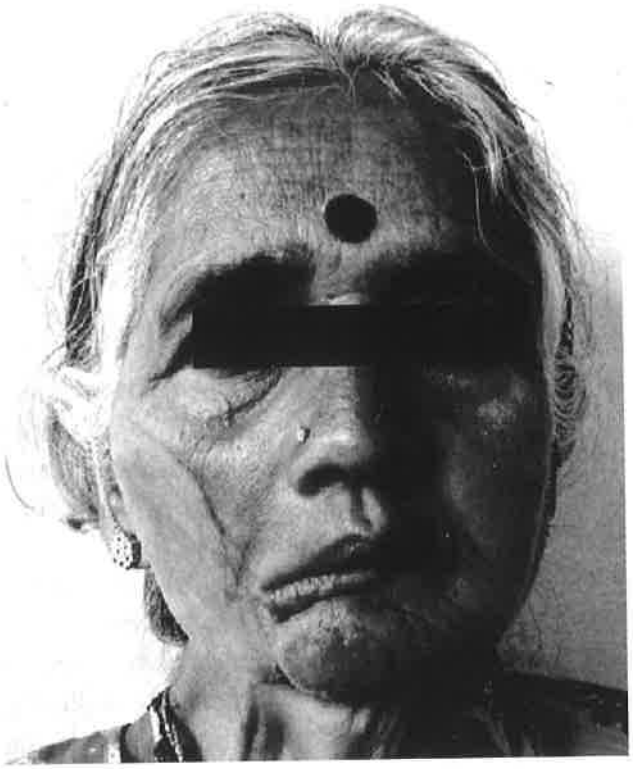

**Figure 10: Defect restored with prosthesis**

dulled to the desired degree by abrading the surface with wet pumice using finger pressure. Prosthesis was fitted to the patient using medical grade adhesive[6]. (Fig 10)

**Summary and Conclusion**

This clinical report describes the use of medical grade room temperature vulcanizing silicone in rehabilitation of a large residual facial defect caused due to wide excision of squamous cell carcinoma of right buccal mucosa. The treatment plan was emphasized on prompt aesthetics and psychological concerns of the patient.

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CLINICAL REPORT

# Functional and Esthetic Rehabilitation of a Severely Worn Dentition

Dr. Geetha K. Patil, Dr. Preeti Satheesh Kumar, Dr. Satheesh Kumar K.S.

**Abstract** : Planning and executing the restorative rehabilitation of a decimated occlusion is probably one of the most intellectually and technically demanding tasks facing a restorative dentist. The patient described in this clinical report has been diagnosed of having a mutilated dentition with reduced vertical dimension of occlusion. The rehabilitation was to be performed by successfully integrating various treatment concepts to regain the lost function, comfort and esthetics of the patient.. Maxillary and mandibular fixed restorations and cast partial denture were constructed for the therapy.

**Keywords** : fixed prosthodontics,mouth rehabilitation, mutilated dentition, removable prosthodontics, interocclusal splint, rehabilitation, worn dentition.

## Introduction :

Planning and executing the restorative rehabilitation of a decimated occlusion is probably one of the most intellectually and technically demanding tasks facing a restorative dentist. Full mouth rehabilitation seeks to convert all unfavorable forces on teeth into favorable forces which permit normal function and therefore induce healthy condition. Thus it entails the performance of all the procedures necessary to produce a healthy, esthetic, well functioning, self maintaining masticatory function[1]. It implies the restoration of impaired occlusion, enhancement of esthetics, preservation of the remaining teeth and maintenance of a healthy periodontium.

A definite correlation between the malfunction and the clinical findings is should be made, in order to attack the problem from every conceivable angle. The reasons for undertaking occlusal rehabilitation may include the restoration of multiple teeth, which are missing, worn, broken-down or decayed. And Esthetics, as in case of multiple anterior worn down teeth and missing teeth. Increasingly occlusal rehabilitation is also required to replace improperly designed and executed crown and bridge work. In certain circumstances treatment of temporomandibular disorders may also be considered as an indication for rehabilitation. Frequently they involve not only replacement of the lost tooth structure but also restoration of lost vertical dimension.[1].The ultimate goal of this study is to provide an ordered pattern of occlusal contact and articulation which will optimize oral function ,occlusal stability and esthetics.[2,3]

## Etiology of extremely worn dentition

Occlusal wear is most often attributed to attrition. The causes for worn dentition are a) Congenital

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abnormalities-Amelogenesis imperfecta and [c]Dentinogenesis imperfect b)Para functional oral habits Chronic bruxism leads to excessive wear. This habit is usually associated with emotional stress and may be triggered by occlusal interferences.c)Abrasion- Excessive wearing away of tooth tissue by external agents can mutilate the dentition d)Erosion- Chemical action leads to worn cupped-out appearance of incisal edges and lingual surfaces. Citrus juices, cola dinks, carbonic acid beverages,vinegar,pickles,hydrochloric acid for achlorhydra,regurgitation of stomach foods and chronic vomiting in anorexia nervosa cause erosion.e)Loss of posterior support- is probably the most common cause of decreased occlusal vertical dimension. Posterior collapse that results from missing, tipped, rotated , broken down teeth, malposition and occlusal interference exerts undue force on anterior teeth resulting in teeth mobility and excessive wear of clinical crown.[4]

**Case Report :**

A 55-year-old partially edentulous patient with satisfactory general health reported with the chief complaint of several missing teeth, severe attrition of teeth present, reduced chewing efficiency, temporomandibular joint (TMJ) pain and discomfort due to overclosure.

A detailed history and examination revealed that the patient had lost his teeth gradually over a period of time and had a habit of clenching in the day and bruxing while sleeping. The attrition was marginally less in the posteriors as compared to the anterior teeth. Enamel was chipped off on the lingual surface of anteriors and occlusal surface of posterior teeth. There was a total collapse of the vertical dimension

**On examination :** It was found that the second molars were the only teeth in any form of intercuspating occlusion.The patient was unable to reproduce any stable centric occlusion.

Lateral and protrusive excursions were not guided by any group of teeth. The periodontal condition was satisfactory. There were no signs of inflammation or disease process. There was pathological tooth mobility in mandibular anteriors.There were very few incipient or advanced carious lesions seen in the existing teeth. The loss of tooth structure was clearly attributed to the patient's habit of bruxing. A total of five teeth showed pulp exposures due to the excessive loss of tooth structure (11,16,21,22,33)(Fig 1)The edentulous ridges were of

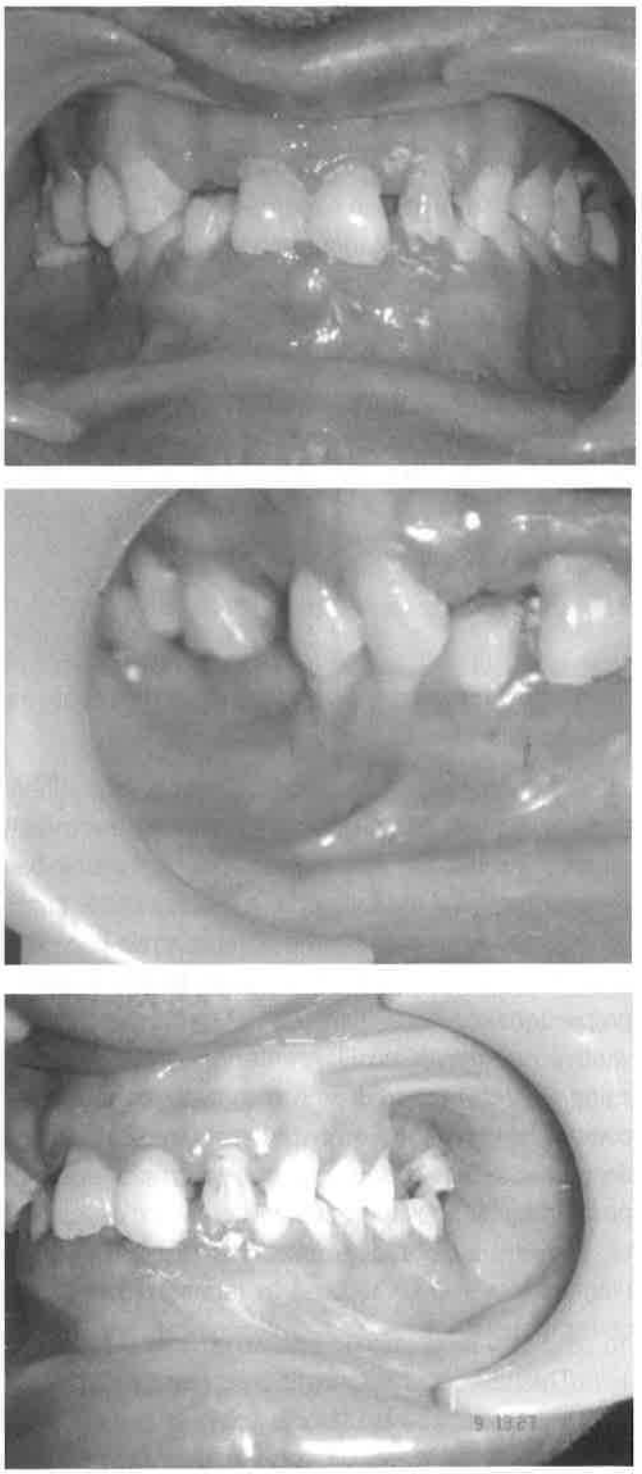

**Fig-1 Pre operative**

medium size and with firm and resilient mucosal covering. The radiographic examination included full mouth intraoral periapical radiographs and orthopantogram.

**Diagnosis :** The patient described in this clinical report has been diagnosed of having a mutilated dentition with reduced vertical dimension of occlusion. The rehabilitation was to be performed by successfully integrating various treatment concepts of fixed and removable prosthodontics.

The treatment plan was presented to the patient. The type of restorations, restorative materials, esthetic expectations, complications, limitations and oral hygiene requirements were discussed. The patient appeared to understand and provided his consent This option met the stated objectives with regard to the patient; it was financially affordable and provided the patient the opportunity to later select other options when he was more financially and emotionally ready.

**Proposed Treatment Plan with Rationale**

Two sets of diagnostic casts were made ,one was used for diagnostic wax up and the other to prepare an occlusal splint.

At rest, the patient did not display any of his maxillary anterior teeth. When he smiled, the incisal edges of his maxillary central incisors were visible but anterior teeth did not follow the curvature of the lower lip leading to the display of a reverse smile line. The patient displayed a lack of adequate length-to-width proportions of his maxillary teeth. The ideal length-to-width proportion of maxillary anteriors were calculated using Golden proportions. A diagnostic wax up was completed on a set of mounted casts to establish the desired esthetics, occlusal plane, tooth contour and positioning for final restoration. These were developed to provide a mutually protected occlusion. This diagnostic wax-up was used to fabricate provisional restorations [5].

The next set of diagnostic casts were mounted on a semi-adjustable articulator using face bow transfer followed by anterior deprogramming using Lucia Jig,centric interocclusal records.

Anterior jig prevents posterior teeth from occluding and thus disrupts the proprioceptive memory. As the anterior stop is rigid on contact with lower incisor teeth, anterior resistance is created and a mandibular leverage is created with naturally braced tripod effect along with two condyles. The Jig breaks the patient's habitual closure pattern and acts as the third leg of the tripod by creating resistance while stopping the closure.Mandibular deprogramming was done by asking the patient to bite on these with anterior teeth for 5 -10 minutes. The memory position of teeth intercuspation is lost. After the jig is made posterior bite record was taken. [6]

The only reliable method to confirm the loss of vertical dimension is with temporary restorations. A removable occlusal overlay splint is given for 6-8 weeks and patient is evaluated for comfort and function at that dimension. When the patient is comfortable, teeth are prepared and provisional fixed restorations are placed. This is evaluated for another 2-3 months before final restorations are fabricated.[7]

The vertical dimension was increased gradually over a period of 3 months with a mandibular removable occlusal Overlay Splint, made of heat cure acrylic resin which also allowed for establishment of centric relation and provided a mutually protected occlusion. [8]According to Dawson ,even if there is a slight increase in Vertical Dimension, it should be as gradual as possible. This is to reduce requirements for adaptation to minimum. The patient was asked to wear the overlay splint for a period of three months to evaluate his tolerance to the 4mm increase in vertical dimension of occlusion.[6,9] (Fig.2) The patient was recalled periodically, to review his progress.(Fig 2)

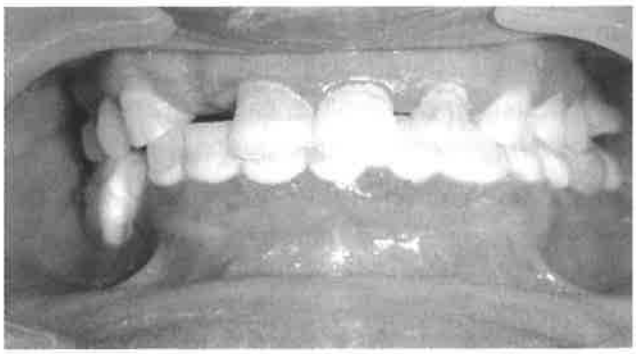

**Fig-2 Removable Occlusal Overlay Splint**

**Endodontic therapy** : Each tooth was examined for caries, decalcification, erosion, attrition, abrasion, exposed root surface or fractures and restored where required. After a detailed clinical examination it was decided to treat the root canals of all the teeth which had pulp exposures. The involved teeth were maxillary anteriors, and left mandibular canine. (11,21,22,33). Elective endodontic treatment was necessary for supraerupted teeth i.e. right maxillary 1st molar (16). Extremely worn down maxillary anterior teeth with inadequate support for restoration required post and core after endodontic treatment. Mandibular anteriors and grossly decayed mandibular 3rd molars were extracted.

**Prosthodontic therapy** : After a period of 3 months, when the patient was functioning comfortably definitive prosthodontic treatment was undertaken. The teeth were prepared to receive metal /metal ceramic restorations in phases followed by temporization.

Tooth preparations were completed on maxillary anteriors followed by tooth preparations on maxillary posterior teeth.(Fig3) Occlusal reduction was done only on supra erupted teeth which did not follow the plane of occlusion. Provisionals were made and cemented and the occlusal plane was analyzed.(Fig4) The curvatures of the anterior teeth were determined by establishment of the esthetically correct "smile line" and its relationship to phonetics and the functional aspects of the anterior guidance. Next the Mandibular teeth were prepared to receive crowns. Provisional's were made and cemented.(Fig5)Treatment partial denture was fabricated in relation to 31,32,41,42 and 46, 47. The patients function with the full mouth provisional restorations was evaluated for 3 months. This was to check his adaptation to the proposed vertical dimension, to the new occlusal scheme, esthetics, phonetics and function.

In the mandibular arch, a cast partial denture was planned and the appropriate components were planned on the crowns. After three months of comfortable function final restorations were fabricated .At the time of impression making, all soft tissues were healthy .Mandibular and maxillary impressions were

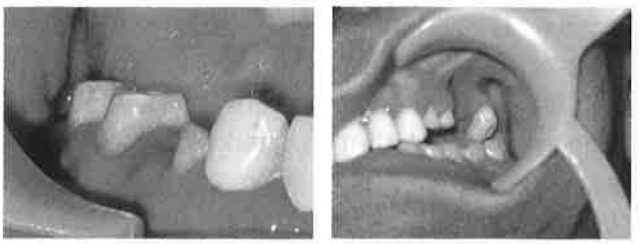

**Fig 3:Tooth preparation completed in maxillary arch**

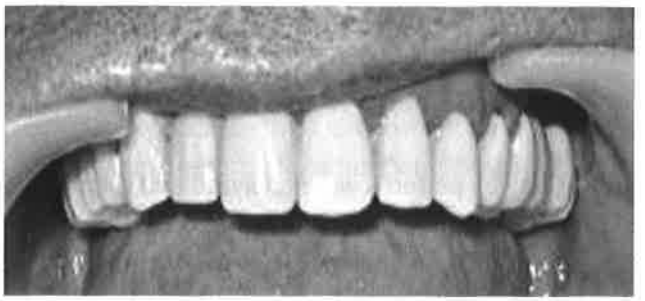

**Fig4- Provisonal crowns in the Maxillary arch**

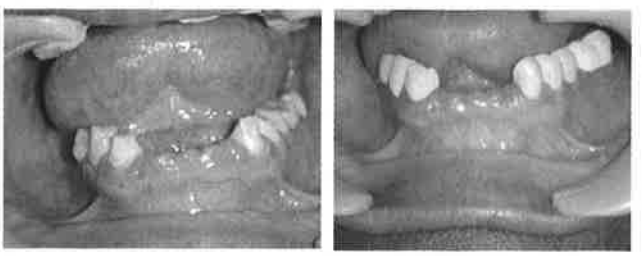

**Fig5- Tooth preparation followed by placement of provisional crowns**

made using vinyl polysiloxane impression material (Express, 3MESPE; St. Paul, MN).The casts were poured in type IV dental stone (Prima-Rock; Whip Mix Corp). The wax patterns were fabricated on the dies. The occlusal and cingulum rest seats were carved out in wax patterns of the crowns to accommodate the cast partial denture.As a rule ,ceramic materials are relatively strong in compression, but weak in tension. Forces on ceramic surfaces that cause elongation often led to fracture. Metal ceramic restorations allows to place potentially damaging tensile forces on metal surfaces.[10] Therefore fixed restorations which provide support for cast partial denture, will be constructed in metal.

**Occlusal considerations**: There is no one type of occlusion that is optimum for all patients. Ideal occlusion is that which is compatible with the stomatognathic system, providing efficient mastication and good esthetics without creating

physiologic abnormalities. Mutually protected occlusion has been explained in a number of ways, but the usual connotation refers to an occlusal arrangement in which the posterior teeth contact in centric relation only, the incisors are the only teeth contacting in protrusion, and the cuspids are the only teeth contacting in lateral excursion.Canine-protected occlusion was developed in the definitive restorations to decrease lateral forces on the posterior dentition. Protrusive guidance was developed to distribute the protrusive forces to the maxillary and mandibular incisors.

The wax patterns were analyzed and then it was decided that one posterior set of teeth would be fabricated first to maintain the vertical dimension subsequently the other side would be created using the existing rehabilitated teeth as a frame of reference. Crowns in the left quadrant were fabricated and cemented with Fuji Type-I glass ionomer cement. Followed by cementation of crowns in the right quadrant. Maxillary anteriors were restored with metal ceramic restorations last.(Fig 6) Mandibular Cast Partial framework replacing the mandibular anteriors and the mandibular right posterior was fabricated. (31, 32, 41, 42, 46, 47) and inserted in the patients mouth.(Fig 7,8)

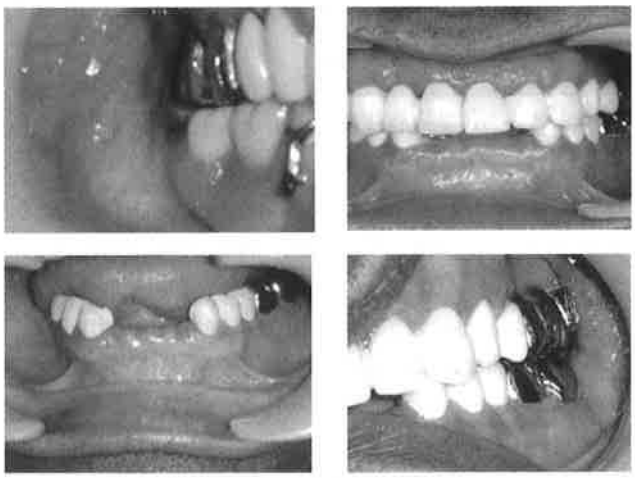

**Fig 6 Final Restoartions Cemented in Maxillary and Mandibular Arch**

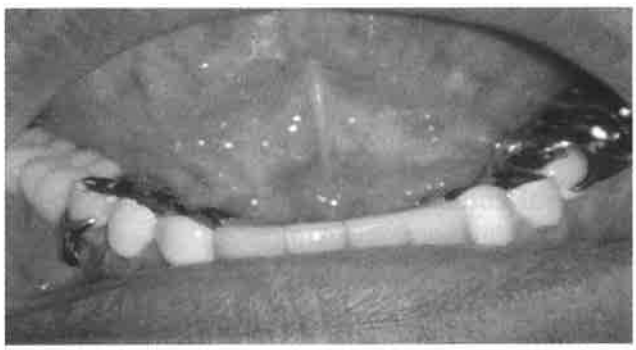

**Fig 7 Cast Partial Denture in Mandibular Arch**

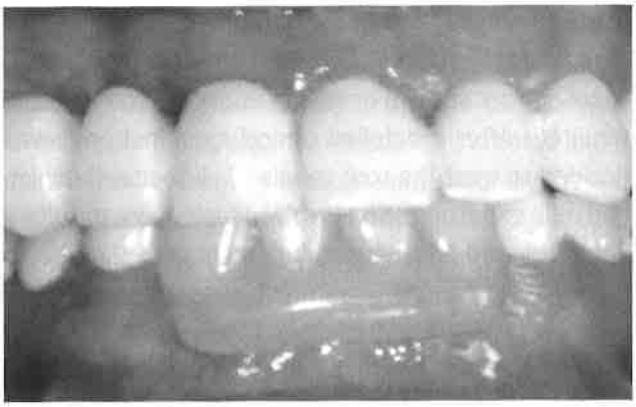

**Fig 8 Post Operative**

**Post-Treatment Therapy** : Oral hygiene instructions included a review of brushing, flossing and the use of fluoride toothpaste. The patient returned 24 hrs after insertion for the final evaluation. Irreversible hydrocolloid impressions were prepared.A heat-processed, clear acrylic resin maxillary occlusal splint providing a mutually protected occlusion was given to the patient to wear while sleeping and during the daytime as required. Instructions on the care of and when to wear the occlusal splint were given to the patient.

The prognosis was favorable. It was explained to the patient that the long-term prognosis of the restorations would depend on the maintenance of oral hygiene and the wearing of the occlusal splint for the protection of the restorations against parafunctional wear. The importance of maintaining a high standard of oral hygiene was stressed to the patient.

## Conclusion

Every patient has unique treatment requirements. Full-mouth fixed rehabilitation is one of the greatest challenges. Apprehensions involved in the reconstruction of debilitated dentitions are heightened by widely divergent views concerning the appropriate procedures for a successful treatment. The procedure explained in this clinical report is an organized way to

rehabilitate a mutilated dentition. The successful integration of fixed and removable prosthodontics has resulted in accurately fitting, esthetic and functionally efficient prostheses. The economical constraints of the patient have restrained us from rehabilitating the patient with implants. Provided the recall schedules and oral hygiene maintenance is properly done and restorations are meticulously fabricated considering mechanical and biological factors, full mouth rehabilitation can provide a long term success.

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CLINICAL REPORT

# Management of Hemifacial Microsomia

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**Abstract :** Hemifacial microsomia is a hereditary anomaly affecting orofacial structures with varying clinical features. Physical deformities affecting face, ears, eyes and oral cavity can pose esthetic and functional problems. Rehabilitation of patients should be multidisciplinary including Prosthodontist as patient presents with complex clinical features. Treatment approach depends on patient's age, extent of physical and psychological deformity. This paper presents a case report of a successful rehabilitation of hemifacial microsomia patient with ear prosthesis.

## Introduction :

Hemi facial microsomia is a hereditary condition involving face, where in skull may be underdeveloped on the affected side. It may also show abnormalities of eye including dermoids or notches in the eyelid. The orbit can be small or may be entirely absent on the affected side. The face looks vertically shorter because the mandible on the affected side will be underdeveloped. The ear may be underdeveloped or even absent resulting in the defective hearing.

There are different degrees of this condition namely craniofacial microsomia and Goldenhar syndrome. People with Goldenhar syndrome may also have neck problems; most commonly fusion of or bony ridges between bones of neck. Goldenhar syndrome is also called occuloauricular dysplasia or OAV.[1]

Although, 'Hemifacial' refers to one half of the face, the condition is bilateral in 31% of the cases, with one side being more affected than the other.[2,3,4] In 48% of the cases, the condition is a part of Goldenhar Syndrome.[5] The clinical picture of HM varies from a little asymmetry in the face to severe under-development of one facial half with orbital implications, a partially-formed ear or even a total absence of the ear. The chin and the facial midline are offcentred, and deviated to the affected side. Often, one corner of the mouth is situated higher than the other, giving rise to an oblique lip line. Other asymmetric symptoms are the unilateral hypoplastic maxillary and temporal bones, a unilateral shorter zygomatic arch and malformations of the external and internal parts of the ear. Auditory problems (conduction deafness) as a result of malformations in the middle ear and facial nerve dysfunction (temporal and zygomatic branch)[6] are very common in these patients, 30–50% of the patients have auditory problems.[7] Intra-oral structures can also be affected in this condition: agenesis of third molar and second premolar may be present on the affected side, as well

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as supernumerary teeth, enamel malformations, delay in tooth development and hypoplastic teeth.[8] The masseter, temporal and pterygoid muscles, and the muscles of facial expression are hypoplastic on the affected side. The degree of under-development of the bone is directly related to the hypoplasia of the muscle to which they are attached.[9] In most cases, there is an under-developed condyle, but Aplasia of the Mandibular Ramus and/or Condyle, with the absence of one glenoid fossa also sometimes occurs. In these cases, the maxilla is hypoplastic at the affected side.

**Case report**

A female Patient aged 13 yrs reported to department of Prosthodontics, Rajarajeshwari Dental college, Bangalore, with the chief complaint of small ear on the left side. She gave a history of congenitally missing left ear and also her hearing was mildly impaired on the affected side.

Medically history revealed that she had a hole in heart, difficulty in breathing on little physical exertion with no family history.

**Extraoral Examination :** A small ear tag on left side. Mandible was deviated on affected side.(fig 1)

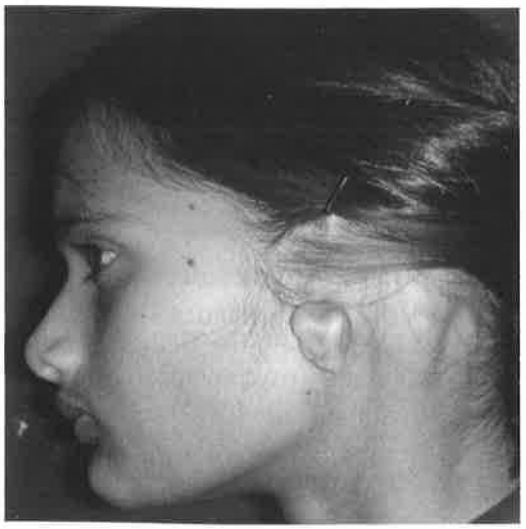


**Fig. 1**

**Intraoral Examination :** Teeth present in Maxilla – 1-7 on both sides, Mandible – 2-7 on both sides and Mandibular centrals were missing. There was increase in overjet and overbite, with a high arched palate and the mandible was deviated to left side and was also

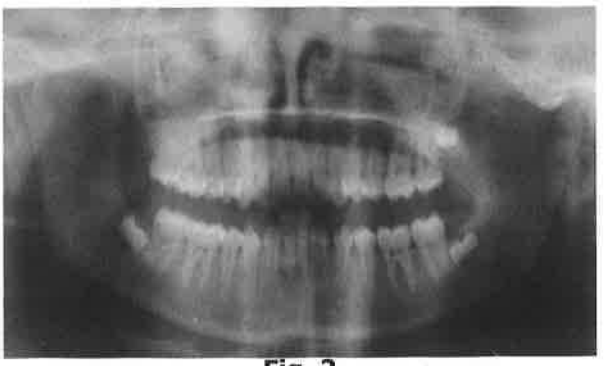


**Fig. 2**

hypoplastic on same side. Radiographic investigations confirmed the condition as hemifacial microsomia. (Fig: 2)

**Treatment Plan :**

Patient was convinced for rehabilitation of ear defect with ear prosthesis. Treatment was initiated with psychological counselling and reassured treatment outcome regularly during treatment.

**Ear impession :** Diagnostic impressions of Ear remnants were made using irreversible hydrocolloid material (Alginate) and custom trays were fabricated with spacer with objective not to distort flabby remnant ear during final impression procedure. Final impressions were made using elastomeric impression material (Fig 3).

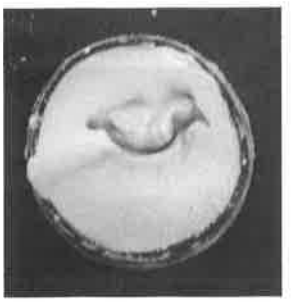


**Fig. 3**

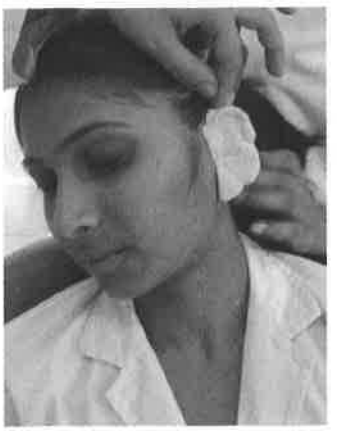


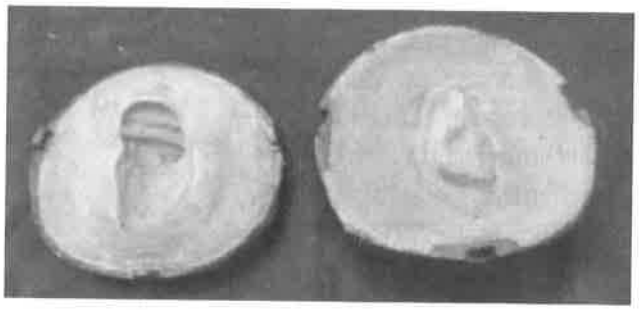
**Fig. 4**

**Donor selection :** We selected a donor with same size of unaffected ear and impression is made with putty elastomeric impression materials for preparation of wax patterns. (Fig: 4)

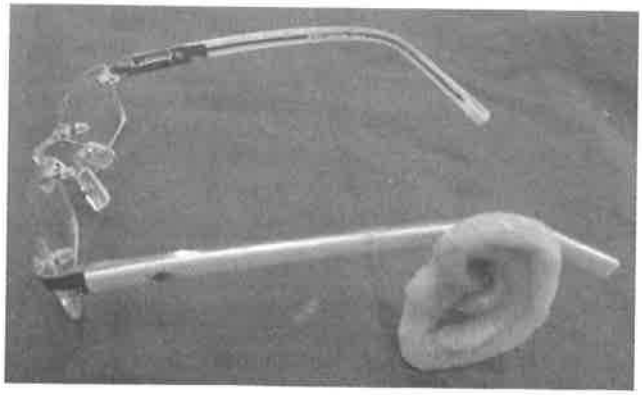
**Wax pattern :** Molten wax was poured in mould and retrieved after cooling. Wax patterns were adjusted according to remaining ears. Wax patterns were fastened to ear band and tried on facial cast and then on the patient.

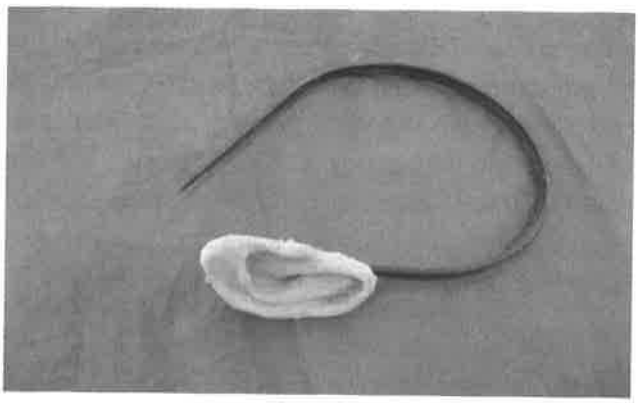
(Fig: 5) Wax patterns were finalized according to location, size, symmetry, and characterization. RTV silicone was used for the fabrication of prosthesis.

**Investment :** Wax patterns were invested in flask using stone as investing medium. (Fig: 6)



**Colour shading :** Intrinsic stains were incorporated incrementally till we achieved basic patient's skin tone. Cotton fibres and rare earth pigments were added to first layer of silicone material to mimic rough surface and capillaries of a natural ear. (Fig: 7) Colour distribution was done according to natural ears.





Prosthesis was luted to spectacle and ear band using cynoacrylate, prosthesis was tried on patient's face, extrinsic staining and final modifications were made. (Fig: 7 and 8) Patient was instructed about limitations, use and maintenance of prosthesis. (Fig 9 & 10) Patient was happy with prosthesis, at post insertion appointments patient had trimmed her long hairs which she used to keep to hide her ear deformity.

**Discussion :**

Since Hemifacial microsomia syndrome can cause physical and psychological deformity of individuals, treatment at early age can provide profounding results in overall growth and development[9,10,11] Syndrome's complex deformities correction requires multidisciplinary approach including Prosthodontist, Plastic Surgeon, Oral surgeon and Speech Therapist.[12,13]

Patient may need a hearing aid at an early age depending on severity of hearing loss. The sounds children recognize in first year of development are

important for speech development. Previously it was believed that children with Hemifacial microsomia have lesser intelligence, but later it was found to be associated with hearing problem. Children who were treated at early age with hearing aids were as intelligent as other children.[14]

Cleft palate, reconstruction of ears, inner ear surgery to build ear drum, hearing aid implants and reconstruction, tracheotomy to correct airway are surgical options for the patient.

Treatment for adult patients depends on age; extent of deformity, functional and patient's need.

Rehabilitation of presented case with ear prosthesis showed significant improvement in patient's social life. Patient had overcome problems of interaction, social life and had begun going to school and her self confidence was increased. The results of presented case show role of maxillofacial rehabilitation in achieving and improving affected individual's psychology.

**Conclusion :**

Prosthetic rehabilitation of Hemifacial microsomia syndrome depends on patient's age, extent of deformity and attitude of patient towards treatment. With latest technologies like rapid prototyping, implant retained prosthesis we can enhance quality of rehabilitation. But rehabilitation at earlier age with removable prosthesis can be of psychological benefit improving affected quality of life.

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CLINICAL REPORT

# A Modified Impression Procedure For Severely Resorbed Mandible

Dr. Nidhi Kathuria, Dr. Anshul Arora

**Abstract :** Severely resorbed mandibular ridges are common clinical findings which adversely affect the support, retention and stability of complete denture. This paper presents the non surgical alternative to such cases focusing on a modified impression technique in which primary impression is made by viscous admix of impression compound and tracing compound and final impression is developed by use of open and closed mouth procedures utilizing tissue conditioning material.

## Introduction

Loss of alveolar bone from edentulous jaws is a serious and common clinical problem, especially among elderly. One of the principle functional problem in the resorbed mandible other than instability is inability of the residual ridge and its overlying tissues to withstand masticatory forces [1,2]. The nature of mucosa overlying the resorbed mandibular ridge influences a patient's ability to withstand loading. These ridges may be complicated folds of non-keratinised tissues lying on them [3]. Alveolar ridge resorption may be corrected by surgical implantation and vestibuloplasty techniques [4]. When these techniques are not feasible, it becomes imperative to record existing supportive structures that support the prosthesis and preserve the remaining tissues. The impression may be made in either the open or closed mouth position [5]. The closed mouth procedure permits the development of physiologic muscular border molding and records the soft tissues under pressure but it requires a lot of patient co-ordination. The open mouth procedure permits the dentist to control the amount of pressure over the tissues [6]. Many impression procedures have been described for severely resorbed mandible. The purpose of this article is to describe an impression technique which gain maximum support from underlying denture bearing area by two approaches, functional and anatomic. Peripheral borders are recorded functionally with mouth closed and finally the impression is made with mouth open and satisfies anatomic approach. The objective is to develop a physiologic impression which attains maximum support from both hard and soft tissues.

## Case Report

A 70 year old edentulous male was referred to the Department of prosthodontics, for prosthodontic rehabilitation. The patient reported that he had been wearing a complete denture for 10 years and complained that they were loose fitting. The intra oral examination revealed the presence of severely resorbed mandibular ridge and also the existing set of complete denture were instable. Since the patient

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Title Page

wished to avoid surgical procedures, it was decided that a complete denture would be given to the patient, paying special attention to the impression technique.

**Technique**

The step by step technique is described as follows:

1. The maxillary preliminary impression was made in stock metal tray using impression compound (Impression composition,Y-Dents, Delhi, India) (Figure 1) and mandibular preliminary impression was made using an admix of 3 parts by weight of impression compound to 7 parts by weight of tracing compound (Pinnacle tracing sticks, DPI, India), the admix is created by placing the constituents in hot water and kneading with gloved fingers (Figure 2). The primary casts were obtained.

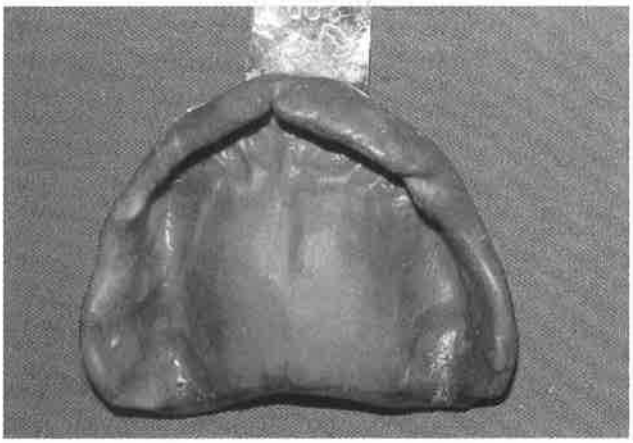

**Fig 1 Maxillary Primary impression**

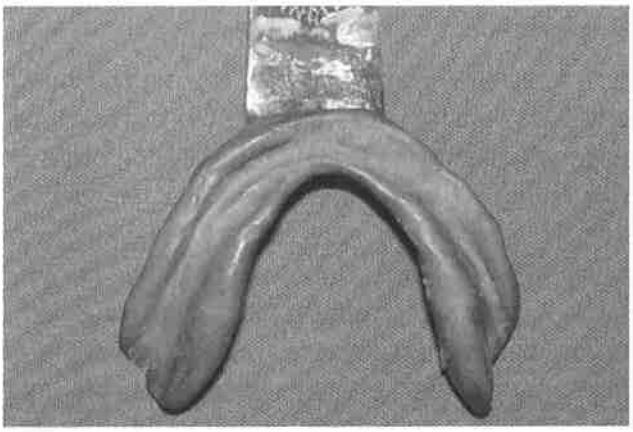

**Fig 2 : Mandibular Primary Impression Made Using Admix Of Impression Compound and Tracing Compound**

2. A wax spacer (0.6mm thick) was adapted on the basal seat area of the maxillary primary cast. This was followed by making of maxillary custom tray, using chemically activated acrylic resin tray material (MP Sai, Mumbai).
3. Maxillary border molding was undertaken with tracing compound and final impression was made using light body elastomeric impression material (Speedex light body by coltene/whaledentag, Switzerland) and cast was poured (Figure 3).

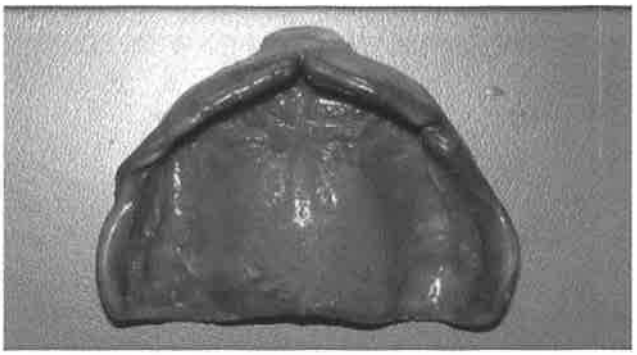

**Fig 3 : Maxillary final impression**

4. A record base for maxillary cast was fabricated using chemically activated acrylic resin material (RR Cold cure, DPI, India) and a flat wax occlusal rim was made, using modelling wax (Hindustan, India).
5. A mandibular custom tray to be used initially as a record base with a flat wax occlusal rim was fabricated.
6. Maxillomandibular relationship at a selected vertical dimension of occlusion was recorded (Figure 4).

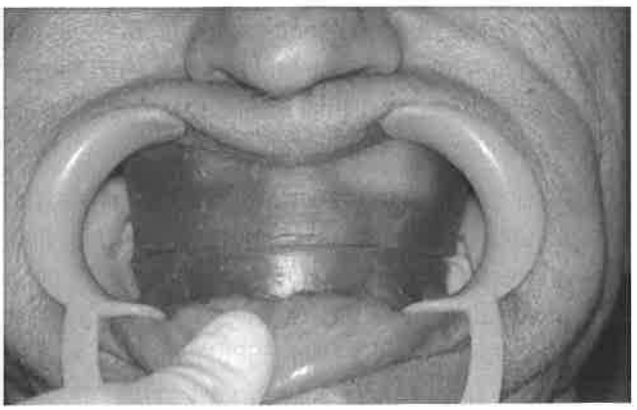

**Fig 4 : Maxillary Record Base with Occlusal Rim and Mandibular Custom Tray in Centric Relation at Acceptable Vertical Dimension of Occlusion. Flat Rims In Contact Without Inclines**

7. The border extensions were developed with tissue-conditioning material (Soft liner, GC Corporation, Tokyo, Japan). The lingual borders were developed with the mouth open and the patient was asked to perform tongue movements. The patient was instructed to produce "OOO" and "EEE" sounds while biting on occlusal rim [7,8] (Figure 5). This resulted in physiologic molding of the material. The first application of conditioning material was of thicker consistency to gain maximum extension.

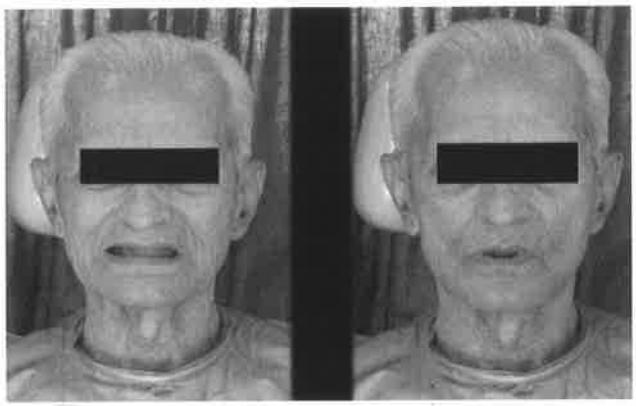

**Fig 5 : Molding the material physiologically by producing "OOO" and "EEE" sounds while biting on theocclusal rims[7],[8]**

8. This step was repeated as often as necessary to develop proper extension. For further applications material was mixed in thinner consistencies **by modifying liquid powder ratio**. Overextension of the conditioning material was removed with hot knife blade.

9. Each application of conditioning material was left in mouth for approximately 10 minutes to allow it to stabilize and the final addition may be left in for 20 minute for further stabilization.

10. After the desired extensions were obtained with conditioning material (Figure 6) , the final impression was made using polyether light body impression material (Impregum soft polyether impression material,3M ESPE) with the mouth open (Figure 7). The cast was poured immediately to avoid distortion of tissue conditioning material. **In order to prevent distortion during pouring, box the impression using a mix of plaster and pumice [9].**

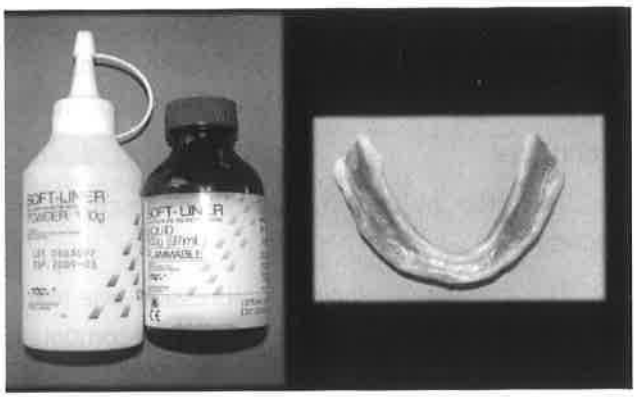

**Fig 6 : Completely Developed Borders with Tissue Conditioning Material**

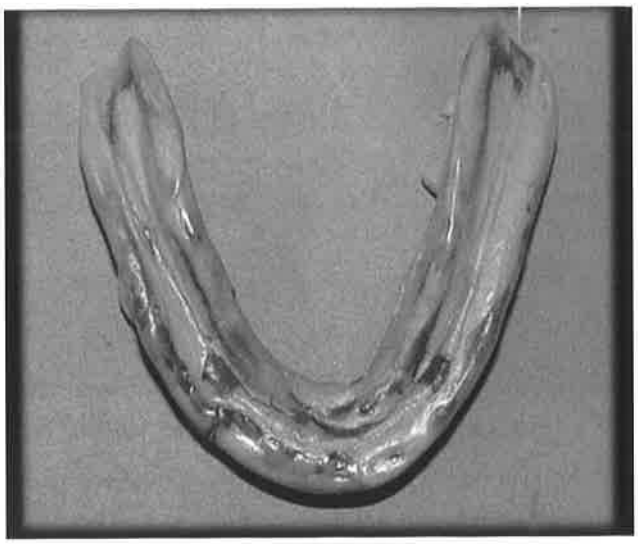

**Fig 7 : Mandibular Final Impression made with Mouth Open. Excellent Reproduction of Tissue Details is Seen**

## Discussion

A relatively common finding in most edentulous cases is presence of severely resorbed mandibular ridge. In patients with severely resorbed ridges, lack of supporting structures decreases the amount of available support and reduced denture bearing area which in turn will affect both retention and stability. Implant supported prosthesis may be the most viable option, however accompanying medical condition or medical treatment of such elderly patients may contraindicate any surgical procedure. This makes impression procedure of such cases imperative and technique sensitive.

Keeping the above fact in mind a modified impression technique which records the denture bearing area in both functional and anatomic form has been described. Moreover primary impression is made using an admix of 3 parts by weight of impression compound to 7 parts by weight of tracing compound. According to McCord and Tyson the philosophy is that a viscous admix of impression compound and tracing compound removes any soft tissue folds and smoothes them over the mandibular bone. This reduces any discomfort arising from creased mucosa lying between the denture base and mandibular bone [1].

The functional type of impression will provide the patient with a denture that will function with maximum support and stability. Borders extensions developed can be considered physiologic overextension. The impression technique also uses the materials with which dental practitioners are familiar with. However, this technique does require lot of time to develop final impression. Moreover, final impression should be poured immediately to avoid distortion of tissue conditioning material.

## Conclusion

This paper describes an impression technique for management of severely resorbed mandibular ridge. The impression technique records the underlying denture bearing area in both functional and anatomic form. The material used are readily available and used in contemporary general practice.

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CLINICAL REPORT

# Esthetic Rehabilitation of Cleft Lip and Palate with Fixed Partial Denture and Gingival Veneer

Dr. Amit Kumar Ray, Dr. Sanjana .J. Rao, Dr. Archana Shetty, Dr. Karthik .J

**Abstract** : This clinical report describes the esthetic rehabilitation of a cleft lip and palate patient with fixed partial denture and gingival veneer. Patients with cleft lip and palate are unique in that the psychological as well as the oral problems must be evaluated individually to the most ideal treatment. The changes in appearance, function, and psychological wellbeing have an enormous impact on patients' lives.

**Keywords :** Cleft Lip; Cleft Palate; gingival veneer.

## Introduction

The prevalence of cleft lip and palate among the general population has been estimated to range from 1:500 to 1:2500 live births [1,2] .Cleft lip occurs in 20-30% of cases, cleft lip and palate in 35-50% and cleft palate alone in 30-45% [3]. In India, a survey conducted by Christian Medical College, Vellore reported incidence of cleft lip and palate in the regional population as 1:639.

Sex prediction shows male to female ratio as 3:2. Incidence of cleft lip is common in males and cleft palate in females.[4]This report describes a case of prosthetic rehabilitation in a patient with cleft lip and palate with all ceramic fixed partial denture prostheses and gingival veneer. The etiology is complex and depends on genetic and environmental factors [1]. Many patients with clefts also present with defects in the alveolar ridge and with either congenital absence of the permanent maxillary incisors, or with teeth that are in a rudimentary form, e.g., peg-shaped or small crowns and short roots. The maxillary central incisors are often severely malposed. This malpositioning, in addition to the tooth-lip relationship and the extent of hard and soft tissue deficiency, influences the esthetic appearance and phonetics[5] .In the cleft lip and palate patient who require treatment for functional and/or aesthetic reasons, it is necessary to consider the periodontal state of the teeth present in the mouth. The teeth next to the cleft often show an alveolar ridge defect and it can be difficult to correct the periodontal defect .The poor plaque control is determined by badly positioned teeth, a defect in arch length and a crossed bite, all of which are characteristic features of these patients [6]. There are various methods of definitive prosthetic treatment in cleft palate patients. A combination of bone grafting and implant-supported fixed or removable prostheses is an invasive treatment approach. A conservative alternative treatment could be conventional fixed or removable prostheses for patients who refuse surgical intervention[7].

## Case Report

A 23 year old female patient reported to the dental clinic with the chief complaint of unaesthetic bridge in the upper right anterior teeth region and unacceptable odor in the mouth. Intraoral

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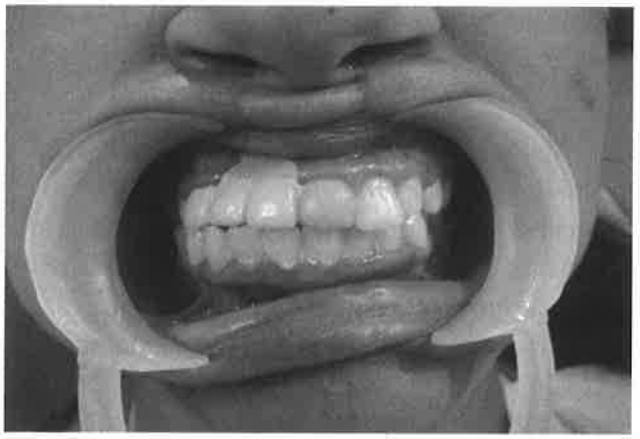

**Fig I – Pre – Operative**

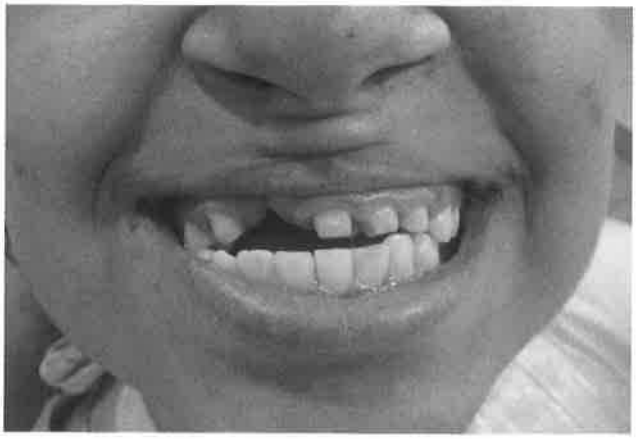

**Fig II – Teeth Preparation**

examination revealed that the patient having congenital cleft lip and palate with missing maxillary right lateral incisor and a 4 unit fixed partial denture from 11 to 13 using 2 pontics in the region of maxillary right lateral incisor (12), (FIG I). It was also revealed that her left maxillary lateral incisor (22) was congenitally missing and no space found in between 21 & 23. Past history revealed that she had undergone cheiloplasty at 7th month and palatoplasty when she was 2 years old. There was a midline deviation of about 4mm and a large space in the cleft area of 12.

The treatment was carried out as follows. The previous fixed partial denture was removed. Maxillary and mandibular complete-arch impressions were made using irreversible hydrocolloid impression material (Jeltrate, Alginate, Fast Set; Dentsply Intl, York, PA, U.S.A.). Diagnostic casts were fabricated using Type IV dental stone (Gyprock , India.) and mounted on a semi-adjustable articulator (Whip Mix Corp) using a face-bow transfer with a centric relation record. The articulator was programmed using protrusive and lateral records .

The occlusal scheme was developed through a diagnostic wax up. On examination of the diagnostic wax up, it was observed that there was a gross deviation of the dental midline. Hence an intentional endodontic treatment of maxillary right and left central incisors was planned and carried out to give the left central incisor to look as lateral incisor and the right central incisor to look like the left central incisor. A diagnostic wax up was presented to the patient for her approval. The teeth were then prepared and modified to receive the fixed partial denture prosthesis by the support of 13, 11, 21 & 23 as the abutment teeth (FIG II). Definitive impressions of the prepared teeth were obtained using hydrophilic addition silicone impression material (Affinis Coltetene Whaledent). Working casts were obtained from Type IV die stone (Kalrock, Kalabhai , Mumbai) and mounted onto the articulator using interocclusal records. Laboratory-processed provisional restorations (Protemp IV , 3M ESPE) were fabricated and cemented with temporary cement (TempBond; Kerr Corp), (FIG III a and FIG III b). An option of 6 unit metal free ceramic prosthesis using 4 retainers and 2 pontics (shaped as 11 & 12) was presented to the patient for improved esthetics. A bisque trial was done, prior to glazing of the ceramic material was done. The crowns (Cercon CAD CAM, Degudent ,Germany) were cemented with resin luting cement (Rely X U 100, 3M ESPE), (FIG IV).

Maxillary impression was then made with irreversible hydrocolloid for the gingival veneer. Shade matching was done with the gingival shade guide (Ivoclar Vivadent, Liechenstien). The gingival veneer (Sunflex flexible denture, USA) was then processed and delivered to the patient (FIG V ). Post operative instructions were given to the patient regarding the insertion and removal of the veneer. The patient was instructed to remove the gingival veneer at night. Periodic recall was done to check any associated problems of the prosthesis. At the follow up sessions, patient expressed her satisfaction regarding the esthetic and hygienic expectations with the fixed partial denture and the gingival veneer.

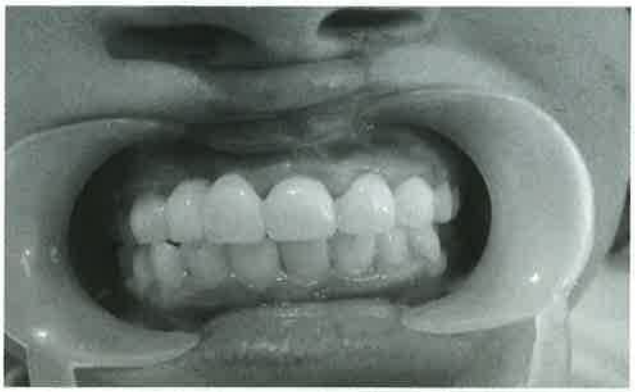

**Fig III A & B – Provisionalisation**

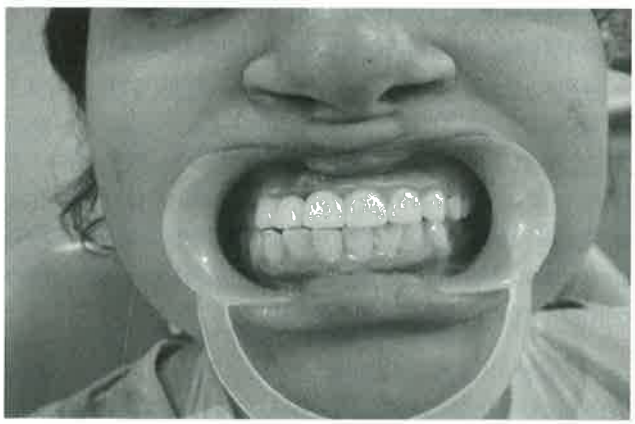

**Fig IV – Metal Free Ceramic Fixed Partial Denture**

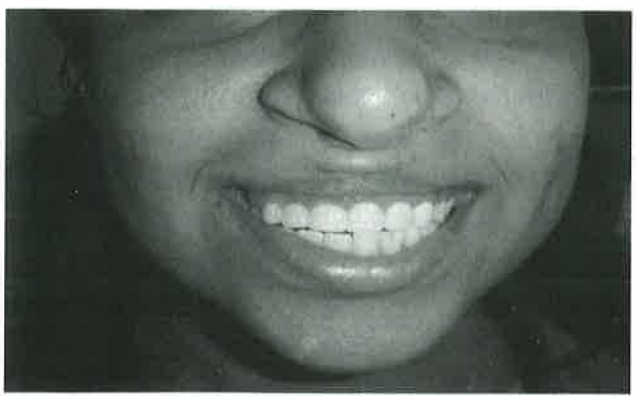

**Fig V – Fixed Partial Denture with Gingival Veneer**

## Discussion

The primary challenge faced by the clinician treating the adult cleft lip and palate patient is satisfying the esthetic concerns while maintaining a healthy and functional dentition. The patients' growing awareness about cosmetic treatment compels the clinician to look towards newer materials as well as newer techniques for the rehabilitation process. A multi disciplinary approach for the restoration of function and esthetics was decided in the rehabilitation of the patient. The patient's main concern was the esthetic factor with respect to the fixed partial denture. She was conscious of the very visible pink porcelain in the defect area and expressed that she was embarrassed whenever she smiled. The second main concern of the patient was with regard to the bad odor emanating from the defect area and explained that food often got stuck in the defect portion and her inability to clean the area. The surgical treatment in such situations is costly, requires prolonged healing time, and the results are often unpredictable; this makes it an unpopular choice. The reconstruction of these areas with prosthesis like gingival veneer can be useful to correct the deformities especially in the maxillary anterior region. Dental practitioners can provide comfortable and accurately fitting gingival veneers that are very stable and esthetically restore the interdental papilla and gingival recession defects. This method is an innovative treatment option for dealing with esthetic challenges and long-term dental health[8]. Gingival veneers are a predictable, inexpensive, non-invasive, effective and aesthetically pleasing way of replacing lost tissue.[9]The removable gingival veneer in the anterior region helped in maintaining the lip support as well as the oral hygiene.

A thorough evaluation regarding the need for periodontal care and endodontic treatment was done prior to the oral rehabilitative procedure. The patient desired only prosthesis to improve the esthetic and hygiene with regards to her treatment.

## Conclusion

A combination of fixed and removable prostheses was hence necessary to obtain the maximum and ideal

outcome for the patient. The diagnostic wax up provided the dentist with the ideal dental midline, pontic design, occlusal scheme and the gingival veneer extension. This combination succeeded in the restoration of the patients smile as well as the oral hygiene.

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CLINICAL REPORT

# Mandibular Guidance Prosthesis : An Easy And Novel Approach

Dr. Gunjan Pruthi, Dr. Veena Jain, Dr. Hari Prakash

**Abstract :** Mandibular guide flange prosthesis is designed to restrict the patient to vertical opening and closing movements into maximum occlusal contacts. Over a period of time, this guided function should promote scar relaxation, allowing the patient to make unassisted masticatory contact. This article describes an easy and effective approach for fabrication of such prosthesis. Design includes maxillary denture base with buccal shield and mandibular guidance prosthesis with cribs made up of stainless steel orthodontic wire. Technique is easy, cost effective and requires fewer number of patient's visits.

## Introduction

Loss of the continuity of the mandible destroys the balance and the symmetry of mandibular function, leading to altered mandibular movements and deviation of the residual fragment towards the surgical side[1-3]. Clinically, it results in facial asymmetry and malocclusion[4]. Prosthodontic rehabilitation of such cases can be done with the help of "mandibular guidance appliance". The main purpose of this appliance is to re-educate the mandibular muscles to re-establish an acceptable occlusal relationship for the residual hemimandible, so that the patient can control adequately and repeatedly the opening and closing mandibular movements [5,6].

There are numerous methods reported in literature for reducing and minimizing mandibular deviation resulting from discontinuity defects, including mandibular guidance therapy, intermaxillary fixation, resection guidance restorations, splinting, and fabrication of prostheses similar to "swing lock" removable partial dentures or maxillary prostheses with a palatal ramp and implant supported fixed prosthesis. Such appliances are complex; technique sensitive, costly and they require relatively more number of patient visits [1,4,7-11].

This article describes a procedure for the fabrication of mandibular guidance prosthesis using 20 gauge stainless steel orthodontic wire. It helped the patient to close teeth in intercuspal position. Improved facial symmetry was also accomplished. Appliance is simple, cost effective and is especially indicated in long standing mandibular defects.

**Brief History :** The patient reported with a chief complaint of difficulty in chewing food and inability to close mouth properly. He had a unilateral discontinuity mandibular defect (Cantor and Curtis Class II)[12] on the left side since one year due to surgery for well differentiated squamous cell carcinoma of left retromolar trigone ($T_3N_1M_0$). The patient was not financially sound.

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Clinical examination revealed facial asymmetry with deviation of the mandible towards the resected side, with lack of intercuspation between the maxillary and the mandibular teeth (Fig. 1). Patient's mandible could be manually placed into the centric occlusion with mild force application. Mandibular based acrylic resection prosthesis with a buccal guiding flange was planned.

**Fig. 1 : Extraoral View of Patient Showing Deviated Mandible**

**Procedure :**

1. Maxillary and mandibular preliminary impressions were made by using irreversible hydrocolloid (Zelgan, Dentsply pvt. India ltd.).
2. Maxillary cast was poured in type III dental stone ((Kalstone, Kalabhai Karson pvt. ltd., Mumbai, India).
3. The mandibular primary cast was poured with Type II dental plaster (Kaldent, Kalabhai Karson pvt. ltd., Mumbai, India). Custom tray was fabricated on primary cast in cold cure (DPI cold cure, Dental products of India, Mumbai) and mandibular final impression was made with medium body addition silicone material (Aquasil, Dentsply pvt. India ltd.), to record complete depth of buccal and lingual vestibules.
4. Mandibular secondary cast was poured in type III dental stone (Kalstone, Kalabhai Karson pvt. ltd., Mumbai, India).
5. A maxillo-mandibular record was made with occlusal registration wax by manually assisting the mandible into the centric occlusion and the maxillary and mandibular casts were mounted on a mean value articulator.
6. Wax up for the prosthesis was done on the articulator.
7. The design for maxillary prosthesis included a buccal shield placed in right posterior maxillary buccal vestibule and the supporting denture base covering the palate. Interproximal clasps engaging the premolars and the molars were made with 21 gauge stainless steel orthodontic wire to provide retention to the prosthesis. The guide flange was sufficiently blocked out, so that it would not traumatize the maxillary teeth and the gingival of the patient (Fig. 2).

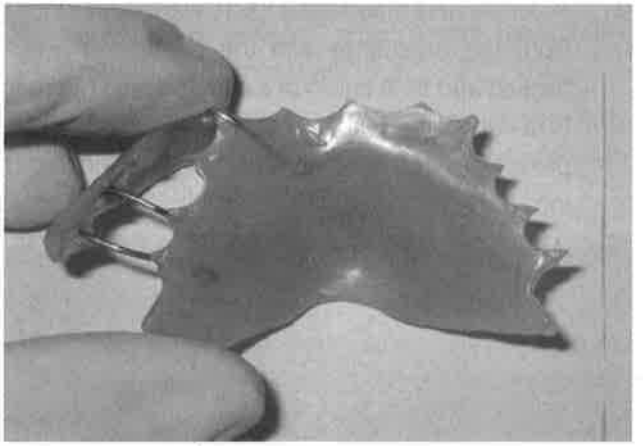

**Fig. 2 : Maxillary Prosthesis with Buccal Shield**

8. The design of the mandibular guidance prosthesis included a buccal flange on the non defect (right) side in which cribs made up of 20 gauge stainless steel orthodontic wire were incorporated in such a way that they should rest on the buccal surface of the buccal shield of maxillary prosthesis. This provided a mechanical system which prevented the mandible from turning towards the resected side and helped the patient to close teeth in maximum intercuspation. This buccal flange was attached to the lingual side of the denture base with the help of interconnecting wires which crossed over

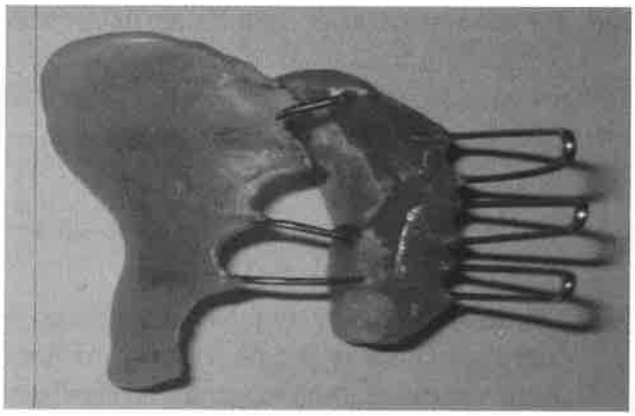

**Fig. 3 : Mandibular guidance prosthesis**

the occlusal surface of teeth in interproximal region from the buccal to the lingual side of the prosthesis. This along with interproximal clasps helped in better retention and strengthening of the prosthesis (Fig. 3).

9. Maxillary and mandibular casts were demounted from the articulator and the prostheses were flasked and heat cured in a conventional manner (Travelon, Dentsply India pvt. ltd.). The prosthesis was finished, evaluated and inserted intraorally (Fig. 4).

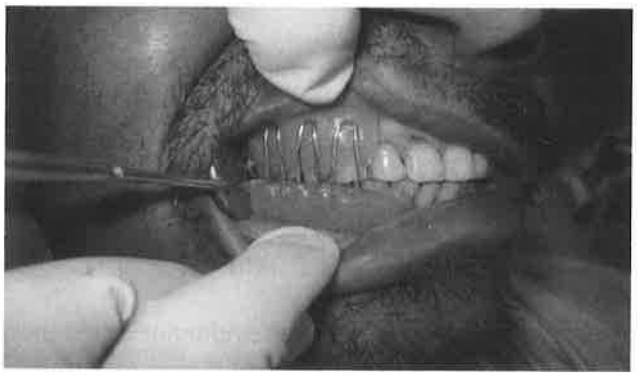

**Fig. 4 : Intraoral View of Patient with Appliance**

10. Patient was taught to guide the mandible manually during insertion of mandibular prosthesis. He was advised to wear the prosthesis intermittently with gradually increasing the duration of wear as it is uncomfortable for the patient to wear the prosthesis in the beginning. Patient was instructed to remove the prosthesis during night and during meals.

11. Physiotherapy was suggested to assist the patient in improving the symmetrical arc of closure and in finding the centric occlusion position without guiding the mandible manually. The exercise consisted of simple opening and closing of the mandible with and without the appliance. These movements tend to loosen scar contracture, reduce trismus and reprogram the remaining musculature to close the mandible into the centric occlusion. Patient was followed up after 24 hours, 1week post insertion of appliance, then at 1 month interval. Patient was able to patient to make unassisted masticatory contacts after wearing the appliance for approximately six month (Fig. 5).

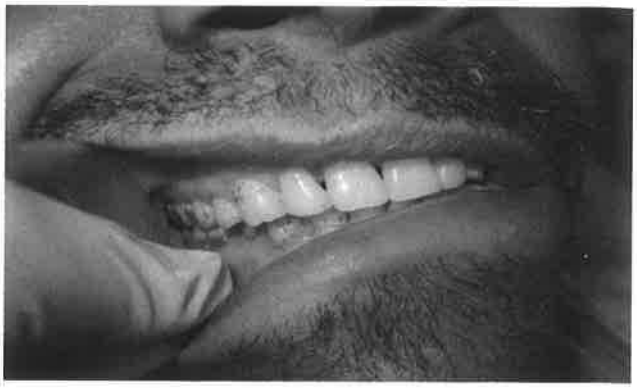

**Fig. 5 : Patient Closing in Maximum Intercuspation After Prosthodontic Treatment**

## Discussion

Mandibular guide flange prosthesis functions as an interim training device designed to restrict the patient to vertical opening and closing movements into maximum occlusal contacts [13]. If the mandible can be manipulated comfortably into an acceptable occlusal position, then a cast metal guidance is appropriate. But a cast metal guidance flange allows for only minimal adjustment. So, if some resistance is encountered in positioning the mandible, then a guidance ramp of acrylic resin is suggested as an improved relationship is obtained [1]. Definitive partial denture restorations are deferred until an acceptable maxillo-mandibular relationship is obtained or an end point in mandibular guidance therapy is reached [15].

The acrylic guide flange prosthesis which is presented here is a simple and cost effective method for managing the mandibular deviation. The other

advantages include lesser laboratory procedures, fewer number of patient visits for delivery of prostheses as compared to the cast metal guidance prostheses and its ease of adjustability.

This appliance finds its special indication in patients where the mandibular defect is long standing and patients report after considerable time has elapsed after resection of the mandible, though it is equally useful in patients who report early for treatment. Periodic modification of the appliance is possible by the addition of autopolymerizing resin to the buccal shield attached to maxillary denture base and by adjustment of cribs attached to mandibular denture base. Initially, patients complain of pain in muscles, difficulty in wearing appliance for long duration. This is because of scar contracture or fibrosis of muscles. Patients are advised to increase the duration of wear of the appliance gradually. Modifications are done till the patient is able to close in maximum intercuspation with minimum effort. This may be followed by palatal ramp prosthesis to help the patient in mastication.

This appliance has limited use in patients with decreased mouth opening and/or in patients where depth of buccal vestibule is insufficient to place buccal shield. Appliance can not be given in edentulous patients or in patients with multiple missing teeth on the non defect side, as adequate retention cannot be obtained.

## Summary

This clinical report describes the fabrication of mandibular guidance prosthesis with acrylic flanges and cribs made up 0f 20 gauge stainless steel wire to guide the mandible. Organized mandibular exercises were suggested for eliminating mandibular deviation and uncoordinated muscle movements. The patient was able to close in intercuspal position after insertion of the prostheses.

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CLINICAL REPORT

# "Re-establishment of the Sublingual Crescent Extension in Patient with Retracted Tongue ; A Review and Case Report"

Dr. Mukesh Kumar Singhal, Dr. Aditi Agarwal, Dr. Prabhakar Angadi, Miss Sakshi Chhabra

**Abstract :** Extension of sublingual crescent flange is an important factor of retention and stability of mandibular denture. Retracted tongue position complicates the situation. The anatomy of sublingual crescent and clinical procedure for recording the anterior lingual seal area are described. The steps are performed with minimum pressure technique when the tongue is in resting position. The present article deals a review and case report of retracted tongue patient in the view of the re-establishment of sublingual flange. Patient has class II floor of mouth with a clearly defined space for sublingual fold and gland. Reported patient was referred by a private practitioner. The article enumerates the education and training to hold the tongue in rest stage. Chair side registration and transferring of sublingual crescent area are also discussed. Extension is replaced with autopolymerizing resin in dental clinic. Integration of the sublingual crescent increases the significant retention and stability in aforesaid patient.

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**Keywords :** Retracted tongue, Extension of sublingual area, Minimum pressure technique, Anterior lingual seal, Rest position of tongue

## Introduction :

The sub lingual crescent extension may be defined as the portion of lingual flange of a mandibular denture that occupies the anterior lingual sulcus. It starts from the anterior alveolar ridge and goes into the soft tissue of the tongue base that is not directly surrounded by bone. The glossary of prosthodontic [1] terms differentiates among the sublingual crescent, sublingual fold and sublingual fossa and define them as follows:

**Sublingual crescent :** the crescent shaped area on the anterior floor of the mouth formed by the lingual wall of the mandible and the adjacent sublingual fold. It is the area of the anterior alveolingual sulcus. Sublingual fold: the crescent-shaped area on the floor of the mouth following the inner wall of the mandible and tapering toward the molar region. The sublingual gland and sub maxillary duct form it. Sublingual fossa: a smooth depression on the lingual surface of the body of the mandible near the midline, above the mylohyoid line and below the alveolus. This fossa accommodates part of the sublingual gland.

Retracted tongue position changes the dimensions of sublingual space and disturbs the peripheral seal that is needed for the optimum retention. This article highlights the review and presents a case report of the re-establishment of sub lingual crescent extension in the patient of a retracted tongue.

## Review

Many terms have been given to the sub lingual crescent flange as lingual vestibule [2], other authors described it as anterior lingual region [3], sublingual region [4] and sublingual space [5, 6]. The term sub lingual crescent seems to be more appropriate because it describe it on anatomic aspect. The term anterior lingual seal may be considered because it describes a specific portion of lingual flange showing its precise location and function. If one accepts the terms posterior palatal seal at posterior border of maxillary denture, then the anterior lingual seal area may be described soft tissue lingual to the bearing mucosa on which an extension to the mandibular denture may rest to aid the tongue in creating an uninterrupted border seal [7]. The anatomical periphery of sublingual crescent region is bounded medially by the base of the tongue and laterally by mandible. Mylohyoid muscle is located inferiorly and forms floor of the mouth. Mylohyoid muscle deepens anteriorly, forming a sublingual cell composed of genioglossus muscle arising from upper genial tubercle.

**Outline of sublingual crescent flange:** Lawson [3] suggested that thickening in the sublingual denture flange could result in more retention, especially when the tongue is relaxed and seal is not broken. Some authors suggested that where marked residual ridge resorption occurs, it may be desirable to use the tongue and the buccinators muscle to fix the denture in place by the appropriate designing of the width and form of the flanges [8] and they have preferred dynamic impression method with the use of tissue conditioning material. Brill et al [9] reported that thinning the denture flanges would increase the retentive forces by the muscle fixation if the patient has an adequate ridge. On the other hand, Lott and Levinz [10] demonstrated the clinical advantages of thicker borders. Accurate border molding within physiologic boundaries accomplishes the most desirable border sea1 [11].

**Anterior border seal and extension of sub lingual crescent flange:** Tongue position plays an important role in mandibular denture stability. Wright et al [12] suggested that the ideal resting position of the tongue is the apex of the tongue to lightly touch the lingual surfaces of the mandibular anterior denture teeth, and the lateral surface to contact the posterior teeth of the mandibular denture. This increases the retention and stability. On other hand, when the tongue is being retracted, it becomes square or triangular, exposes the anterior floor of the mouth, alters the dimension of the lingual sulcus and disrupts the retentive seal of the mandibular denture [13].

Extension of the denture over the resting tissue of the sublingual area completes the border seal. A minimum pressure is exerted on the floor of the mouth. This will allow the movement of genioglossus muscle without dislodging the denture. Minimum pressure can be described as weight of softened modeling compound. Excess pressure will occlude the opening of glands with the swelling of the tissue. This article has highlighted the review and presents a case report of the re-establishment of sub lingual crescent extension in the patient of a retracted tongue.

## Case report :

About a few months back, a fifty-year-old female patient was referred to the deptt. of Prosthodontics, by a private practitioner. Patient had a complaint of retention and stability with mandibular complete denture. The Patient suffered edentulism from the last six months. On intraoral examination, she had a class II mandibular ridge with moderate resorption [14] and Class II floor of mouth, a clearly defined space for sublingual fold and gland [15]. She also has a habit of retraction of tongue (Fig. 1). On examination, it is noticed that mandibular complete denture has deficient anterior lingual flange (Fig. 2). Authors suggested a short clinical trial as a chair side procedure

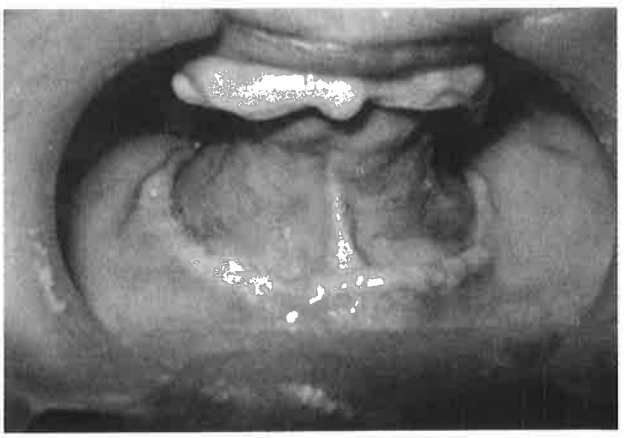

**Fig. 1**

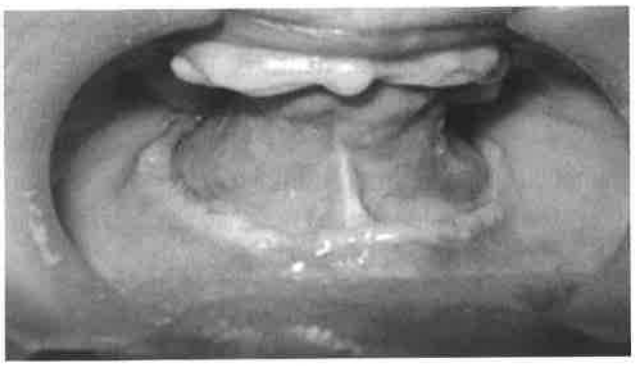

**Fig. 2**

to enhance the seal area. This was accomplished by a re-establishment of extension of sublingual crescent flange.

**Procedure**

1. Firstly, authors gave the instructions to patient to hold the tongue in resting position for increase the retention and stability. They instructed the patients to pronounce the long "e" sound [16].
2. Initial steps for extension of sublingual crescent is done through the border molding with green tracing stick compound (DPI Pinnacle Tracing Sticks, The Bombay Burmah Trading Corporation, Mumbai, India) under minimum pressure technique as described above. Tongue in this situation will be in resting position with tip lightly touches the lingual surface of mandibular anterior teeth. Instruct the patient to close and relax.
3. For checking the completion of sublingual crescent border seal, a resistance to dislodgment achieved. Denture is more stable on swallowing and speaking. The retrieved impression of lingual flange (Fig. 3) is visually inspected for surface irregularities and it is disinfected and poured for a cast with class III green dental stone of kalabhai (Fig. 4).
4. After removing the green stick compound, the border of the denture was roughened and prepares a 45-degree bevel joint [17] along with retentive keys. Replaced the retrieved crescent area with autopolymerizing resin ((Rapid Repair, Dentsply, Gurgaon, India) in a pressure pot (Fig. 5). Polished trial mandibular denture prosthesis had an extension of sublingual crescent. The patient was examined and reviewed. The result was much satisfactory.

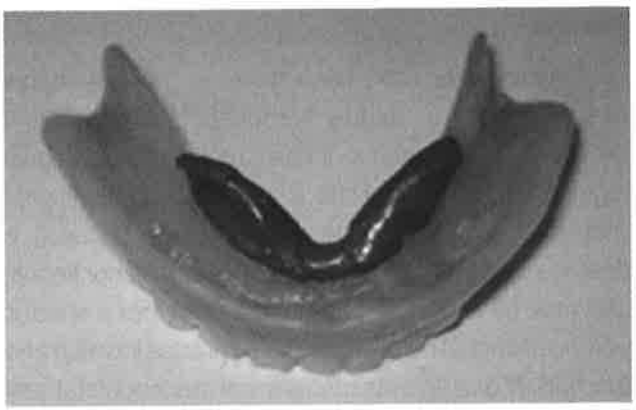

**Fig. 3**

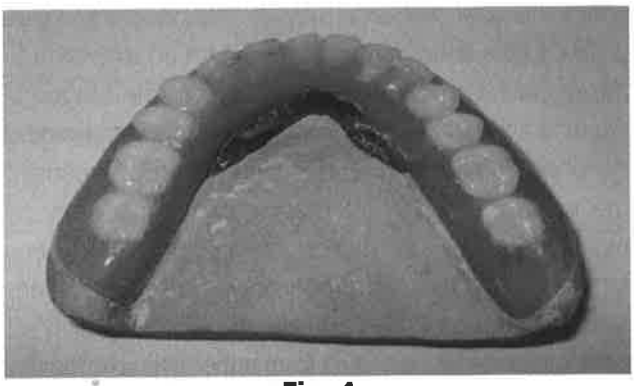

**Fig. 4**

**Fig. 5**

**Discussion**

Retention and stability in mandibular denture may depend on two factors. One factor is thickness and wideness of the sublingual border which helps to achieve a better seal. It gives continuity to the prosthesis with the floor of mouth [3, 18]. Second factor, patient has the tendency to retract their tongue on

mouth opening. When the tongue is being retracted, the muscles in the floor of the mouth contract, causing the fornix of the anterior vestibule to become wider, tauter and more elevated than when the tongue is in the normal resting stage. This tongue movement alters the shape of the lingual sulcus and often compromises the peripheral seal of the denture [19, 20]. As the mandibular anterior lingual vestibule elevates the denture and the posterior lateral borders of the tongue press against the posterior lingual flanges of the denture, the intaglio surface of the denture will have less mucosal surface contact. This disruption in tissue contact can allow air to enter under the denture, with a subsequent reduction of retention [21, 22]. To pronounce the long "e" sound helps the patient to train and coordinate the positions of the tongue and buccinators muscles [16]. The use of dough staged autopolymerizing resin in comparison to light cure denture resin is more economical for the prosthesis.

## Conclusion

Variations in outline and anatomy of sublingual crescent area dictate to use of different impression techniques and modification in flange design. In current case report, re-establishment of extension of sublingual crescent area makes a clinically winning mandibular denture. In spite of that, in retracted tongue patient, education and training offers a high quality of prosthesis. Extension of sublingual flange gives an anterior lingual seal which provides stability and retention. Authors validate their finding and recommend further studies involving significant number of the patients.

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CLINICAL REPORT

# Lithium Disilicate Ceramics - The Science and the Art

Dr. M. Shiva Shankar, Dr. Purushotham Manvi, Dr. Nithesh Rai

**Abstract :** All ceramic restorations are increasingly being used in our day to day to practice. As more and more choices of materials are available for the fabrication of these restorations as dentists, it is important for us to be better informed about the capabilities of these materials. In this paper we have discussed the advantages of one such popular material the lithium disilicate with clinical examples.

**Keywords :** Lithium disilicate - CAD CAM Crown – All ceramic crown.

## Introduction

The rise of all ceramic restorations as a replacement for the porcelain fused to metal restorations has been guided by the increase in the demand for aesthetic restorations from both the patients as well as dentists. The demand for metal free restorations has led to researchers introducing a plethora of dental ceramics with improved strength and aesthetics. Lithium Disilicate is one such ceramic which is widely used today for the fabrication of all ceramic restorations. Lithium disilcate ceramic is commercially available under the brand of IPS E MAX manufactured by Ivoclar Vivadent, Lithium disilicate ceramic is a highly aesthetic material which is indicated to be used for both anterior as well as posterior situations. They can be luted either by adhesive or conventional luting agents. It can either be pressed or milled.

Micro structurallylithium disilicates are true glass ceramics composed of quartz, lithium oxide, alumina, potassium oxide and other components. They have a crystal content of approximately 70% and refining this crystal size leads to its improved flexural strength to 360 Mpa. They are also translucent even with the high crystalline content due to the low refractive index of lithium disilicate crystals. This property of lithium disilcates allows them to be used as a core material or fully contoured restorations [1].

The lithium disilicate used for pressing technique is produced according to a unique bulk casting process to create the ingots which are subsequently used for pressing. This involves a continuous manufacturing process based on glass technology (i.e., melting, cooling, simultaneous nucleation of two different crystals and growth of crystals) which is constantly optimized in order to prevent the formation of defects. The microstructure of the pressable lithium disilicate material consists of 70% needle-like lithium disilcate crystals that are embedded in a glassy matrix. These crystals measure approx 3 – 6 µm in length (Fig.1). The pressed copings can be veneered to create the final morphology and the shade of the restoration easily as the veneer porcelain consists of fluorapitite

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crystals in an aluminosilicate glass1. Fluorapitite is a fluoride-containing calcium phosphate, Ca5(PO4)3F. The fluorapitite crystals contribute to the veneering porcelain's optical properties and coefficient of thermal expansion (CTE), so that it matches the lithium-disilicate[2].

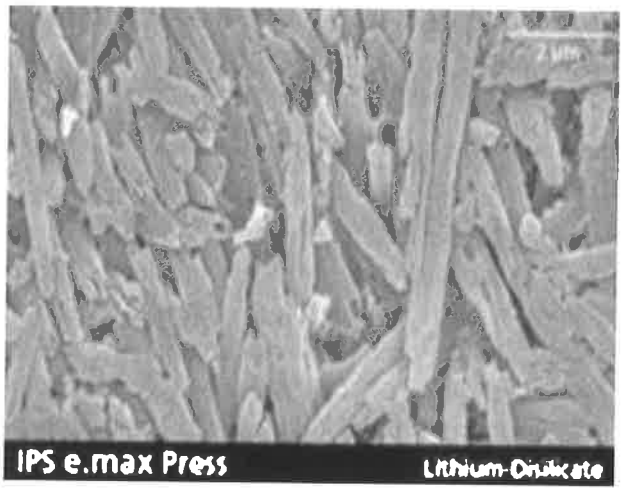


**Fig1. SEM of E max Press**

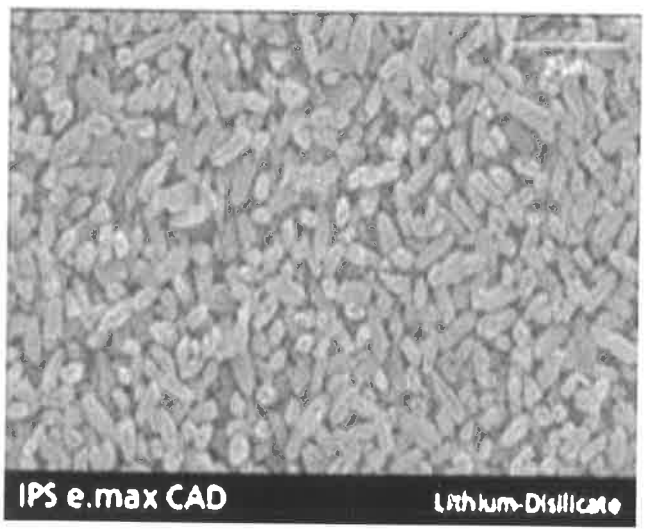


**Fig 2. SEM of E max CAD**

The lithium disilicate used for milling are produced in the same way as the pressing ingot, but an intermediate crystallization is achieved in order to ensure that the blocks can be milled efficiently (blue, translucent phase). This intermediate crystallization process leads to the formation of lithium metasilicate crystals which are responsible for the processing properties and machinability. After the milling process the restorations are fired in a ceramic furnace in order that they reach their final crystallized state and strength. This firing is referred to as crystallization firing. The microstructure of the intermediate crystallized phase consists of 40% platelet – shaped lithium metasilicate crystals embedded in a glassy phase and the crystals range from 0.2 to 1.0 µm. Post crystallisation 70% fine grain lithium disilicate crystals embedded in the glassy matrix is obtained (Fig. 2). As with pressable lithium disilicate the millable blocks are also coloured using colouring ions, however the colouring elements are in a different state of oxidation during the intermediate phase hence they appear in blue colour and the desired colour is obtained post crystallisation1.

## Clinical Reports

### Case 1

Female patient aged 26 years reported to the Department of Prosthodontics, Krishnadevaraya college of Dental Sciences for a replacement of a fractured anterior bridge . On examination it was found that a chipped acrylic bonded to metal bridge in relation to 12 – 14 and a carious and rotated 15 (Fig.3 & 4). After radiographic examination it was decided to fabricate a new bridge in relation to 12 – 14 and a crown in relation to 15. The patient was informed of the choice of restorations possible and the patient opted for an all ceramic bridge and a crown. It was decided to do an e max press bridge in relation to 12 – 14 and a crown in relation to 15. The existing bridge was removed carefully without damaging the tooth structure and modifications were done in relation to 12 and 14 for receiving an all ceramic bridge and tooth preparation for 15 was carried out (Fig.5&6). Poly Vinyl siloxane impressions were recorded after gingival retraction. Model was poured with type IV die stone and frame work was pressed in the laboratory and fit of the framework was checked in the patient's mouth for the fit and subsequently it was layered in the laboratory to the corresponding shade and finished.

The finished bridge and the crown were checked for the fit and highpoints if any and then adhesively cemented (Multilink)(Fig.7&8).

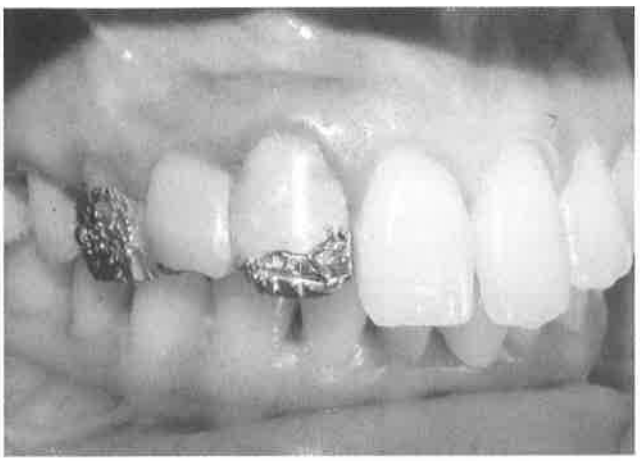

**Fig.3 Pre-op Labial View**

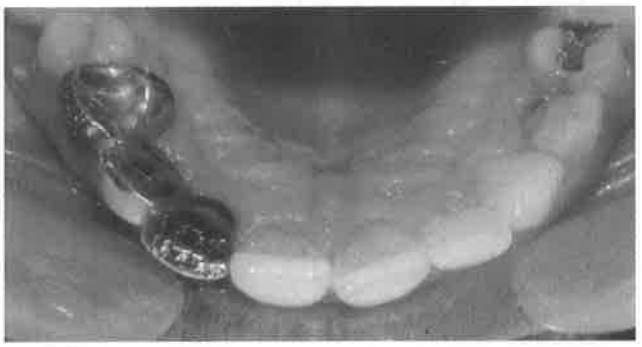

**Fig.4 Pre-op Occlusal View**

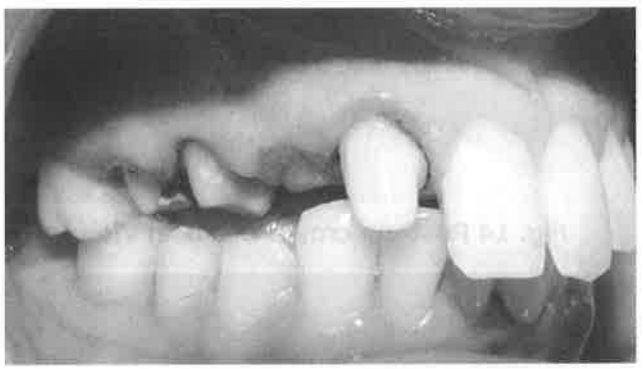

**Fig.5 Tooth Prep Labial View**

**Fig.6 Tooth Prep Occlusal View**

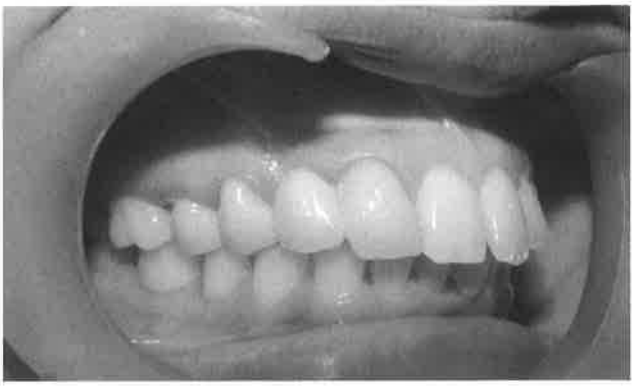

**Fig.7 Post-op Labial View**

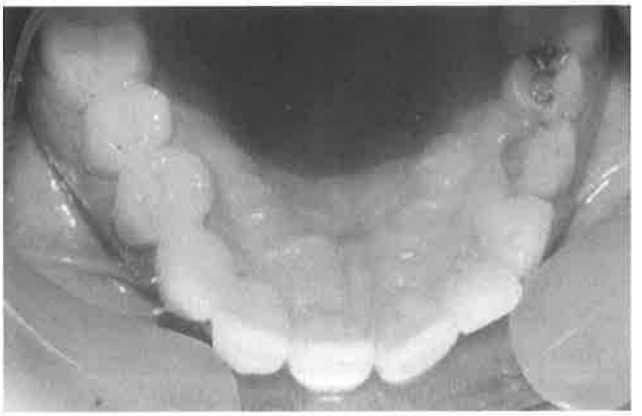

**Fig.8 Post-op Occlusal view**

**Case 2**

A 32 yr male patient reported to the Department of Prosthodontics, Krishnadevaraya college of Dental Sciences for a crown for a maxillary premolar. On examination it was found that tooth 15 was root canal treated and required a crown (Fig.9). The patient was informed of the treatment options and the patient opted for metal free ceramic crown. It was decided to fabricate a e max CAD crown. Tooth preparation was done to receive an all ceramic crown(Fig.10) and impressions were recorded using poly vinyl siloxane impression material and the model was poured using CAM stone (Scannable Die stone). The model was scanned using 'In Eos' scanner (Sirona) and the crown was designed in the 'Cerec InLab' software (Fig.11 & 12). The crown was milled using E max CAD block in the 'Inlab MCXL' milling machine. After milling the crown was tried in the mouth for the fit(Fig.13) and high points were removed using an airotor handpiece and diamond bur. After the fit was checked crystallization and glazing firing was carried out in the

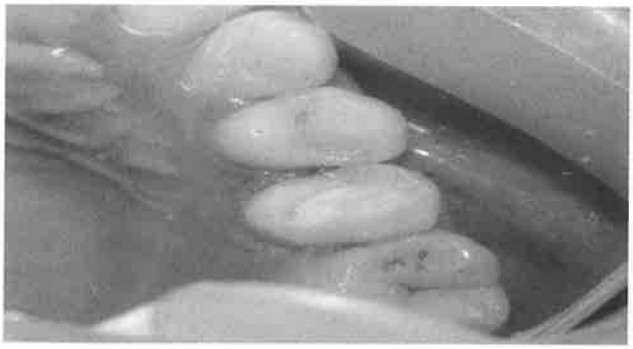

Fig.9 Pre-op

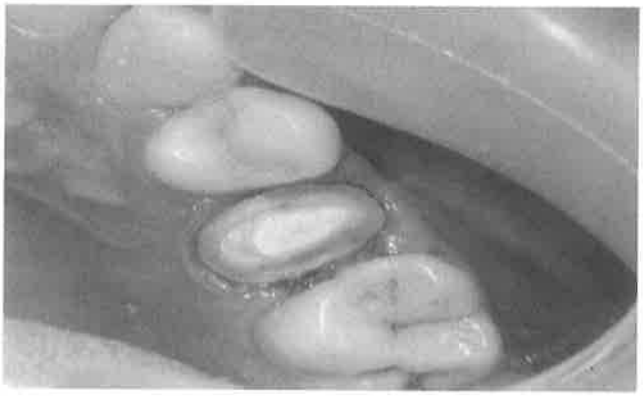

Fig.10 Tooth Preparation

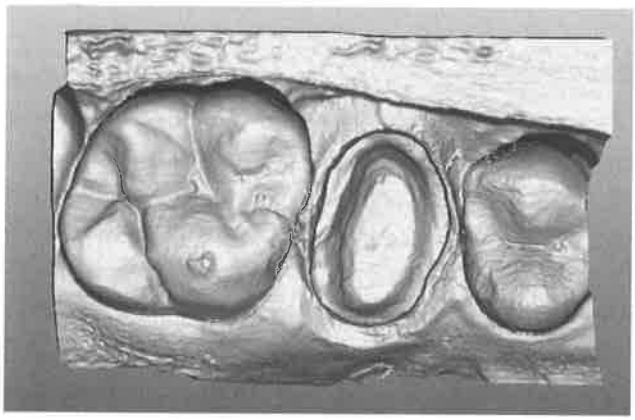

Fig.11 Digital Model

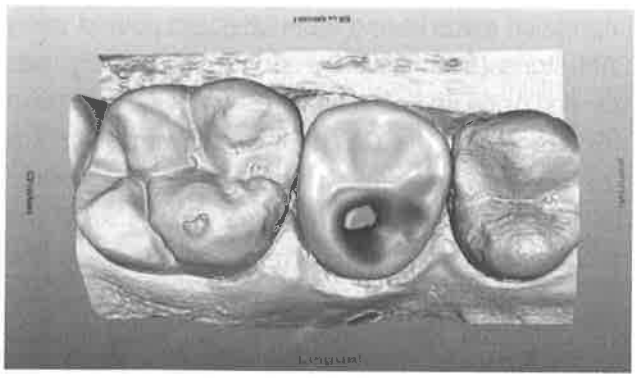

Fig.12 CAD Crown

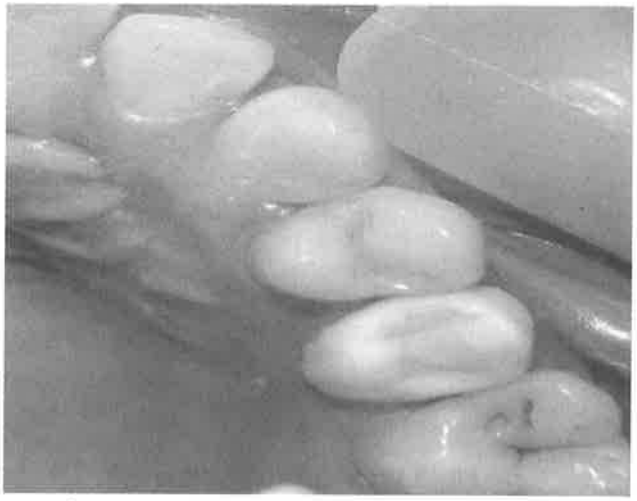

Fig.13 CAD crown before crystallization

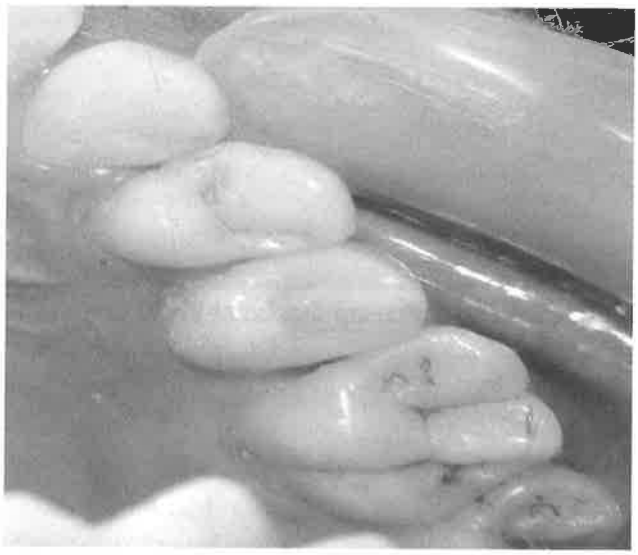

Fig. 14 Post–op crown Occlusal View

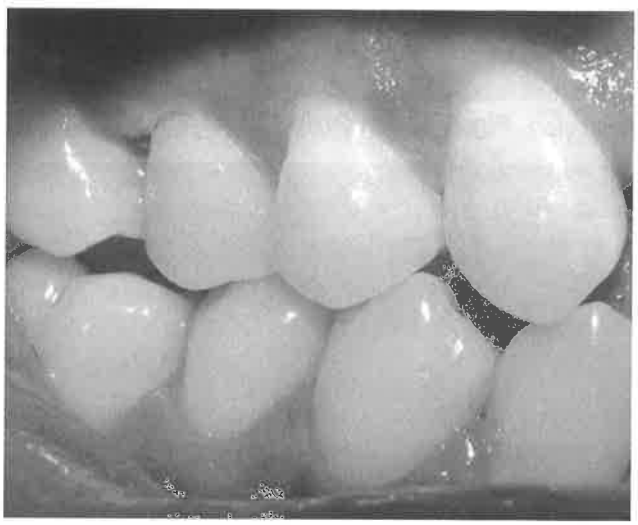

Fig. 15 Post–op crown Buccal view

laboratory and then the crown was adhesively cemented (Multilink)(Fig.14 &15).

## Conclusions

Lithium Disilicate material is one of the versatile materials available to us in the present day which fulfils the demands of the dentists as well as the dental technicians for aesthetics, strength and functionality[3,4].

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CLINICAL REPORT

# An altered cast technique to improve the tissue support for removable partial denture opposing a complete denture

Dr. Joshi Shubha, Dr. Dhaded Sunil, Dr. Joshi. Shalini, Dr Ganesh Ramesh,
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**Abstract :** The altered-cast technique also known as the corrected-cast technique for distal extension removable partial dentures. Here is a case report of a patient which has been treated with the altered-cast technique, when compared to a conventional removable partial denture the altered-cast technique is simple technique that requires an additional step but offers several advantages like stability, minimal stress on abutment teeth and more predictable occlusion.

The altered cast technique has other advantages of load distribution that have shown a well-fitting denture base that distributes stresses favourably to the supporting bone and abutment teeth and increased residual ridge coverage coupled with a well-fitting denture base that reduces stress per unit area, potentially preserving the remaining supporting structures.

**Key words :** Altered cast technique, Corrective cast technique, Distal extension base, Free end saddle.

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## Introduction

An altered cast impression technique is to improve support of distal extention base removable partial denture is widely taught, but not often used in dental practice. The supporting structures of the edentulous ridge and the remaining teeth are utilized to best advantage by altering the edentulous part of the cast upon which a distal extension removable partial denture is fabricated. This technique should be used for most distal extension removable partial dentures as it produces extremely stable dentures, Furthermore, when all phases of the procedure are performed faithfully, post insertion adjustments are markedly reduced. Basically, the altered-cast procedure applies some of the principles of impressions for complete dentures to the fabrication of the tissue surfaces of extension removable partial dentures. The refined impression of the edentulous tissue surfaces is made after the metal casting has been completed and is used to alter the edentulous areas of the master cast. [1]. The advantages of an altered cast impression technique are that it evenly distributes stresses between hard and soft tissues and to the abutment teeth. The supporting structures of the edentulous ridge and the remaining teeth are utilized to best advantage by altering the edentulous part of the cast upon which a distal extension removable partial denture is fabricated [2]. Here is a case report, with a situation of maxillary complete edentulous arch and mandibular bilateral edentulous arches. The treatment planned was maxillary single complete denture with metallic denture base and mandibular cast partial denture.

**Case report**

A male patient aged 50 yrs who is a known diabetic from 4yrs reported to our department with a complaint of missing maxillary and mandibular teeth (Fig 1). He had a history of wearing conventional single complete denture for maxillary arch since 2 yrs and conventional removable partial denture for mandibular arch. His chief concern was that the mandibular

**Fig 1 : Pre Operative Profile**

prosthesis fractured often and required repair. Examination revealed that 43, 42, 41, 31, 32, 33 were the only remaining natural teeth (Fig 2), the vertical dimension of the previous denture was acceptable. Detailed examination was carried out followed by preliminary impression using impression compound (modelling compound DPI ltd) for maxillary arch and irreversible hydrocolloid (Zelgan, DENTSPLY) for mandibular arch and Diagnostic casts were obtained.

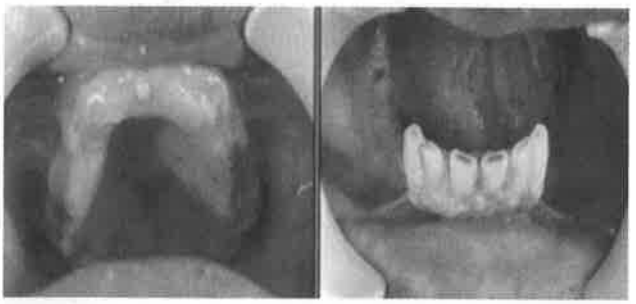

**Fig 2 : Pre Operative Profile Intra Oral View**

Treatment plan included single complete denture with metal denture base for maxillary arch and cast partial denture for mandibular denture Diagnostic cast was surveyed and the infrabulge survey line was obtained. Mouth was prepared for the canine rests on both the mandibular canines and guiding planes were created and framework designing was completed. Final impression was made using single stage addition silicone material (Aquasil ultra heavy and Reprosil, DENTSPLY caulk) light body for mandibular arch. For maxillary arch custom tray with full spacer was fabricated and border molding was carried out using low fusing compound by sectional method and secondary impression was made using zinc oxide eugenol paste ( DPI ltd)

The master casts were duplicated and refractory cast was obtained. The design was transferred to the refractory cast. An RPI for both canines and lingual plate major connector including step backs and supported by canine rests was planned, this major connector has an advantage of rigidity and is very much comfortable. The casting procedure was completed and the finished framework was examined for accuracy of fit on the master cast (Fig 3) and also in the mouth.

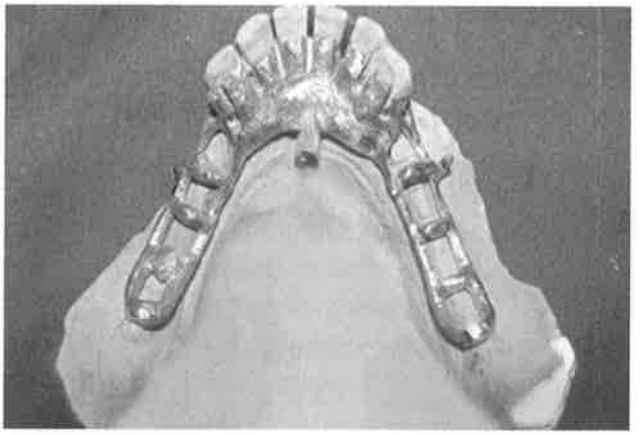

**Fig 3 : Metal Framework**

For the maxillary arch, the fabricated metal denture base covering the palatal vault was used and acrylic resin was added up for the fabrication of trial denture base.

For mandibular arch, the acrylic resin custom tray was fabricated on the edentulous area and the tray was used to do the border molding steps followed by secondary impression (Fig 4).

The mandibular master cast was altered by splitting/ removing of the edentulous area. For this 2 perpendicular cuts were made using die cutting

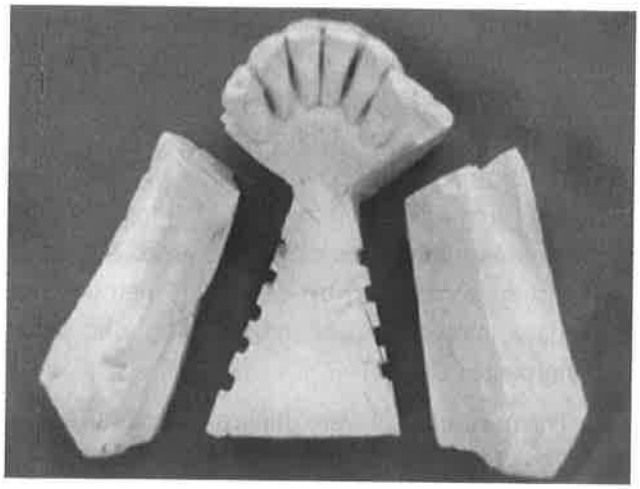

**Fig 4: Secondary Impression**

circular saw, 0.5 mm distal to the remaining natural teeth. This cut was carried from the outer edge of the cast to 6-7 mm medial to the lingual vestibule. The second cut was made parallel and medial to the edentulous ridge extending from the posterior most aspect of the cast to the most medial aspect of the first cut. Groves were then placed at 2 mm regular interval on the lateral aspect of the cut surface of the remaining part of the master cast, to aid in retention of the newly poured stone (Fig 5).

**Fig 5: Mastered Cast Altered at The Edentulous Region**

The framework along with the secondary impression was seated back on the remaining part of the master cast accurately and was fixed with sticky wax (Fig 6).

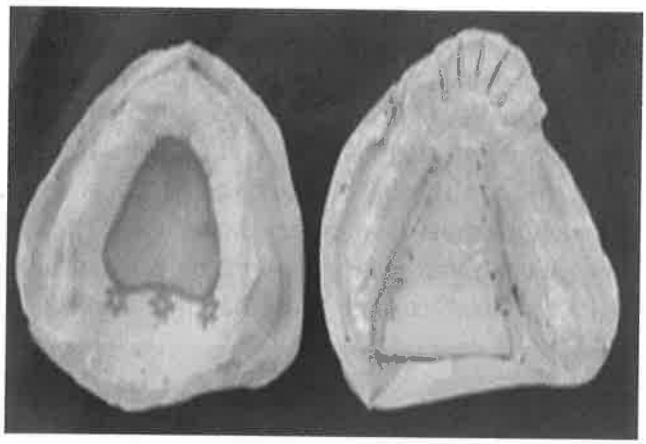

**Fig 6: Secondary Impression Placed On The Split Diagnostic Cast**

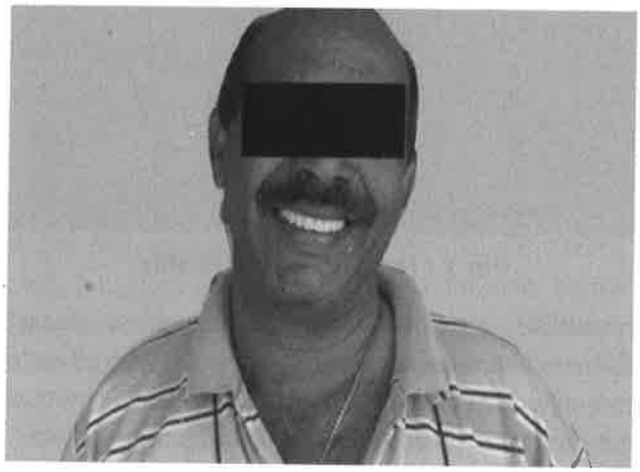

**Fig 7: Altered Cast**

The impression was beaded and boxed and cast was poured with die stone (Fig 7).

After obtaining an altered cast, the trial denture base was fabricated at the edentulous area of the framework and maxillomandibular relations were recorded. Teeth was selected to match his previous

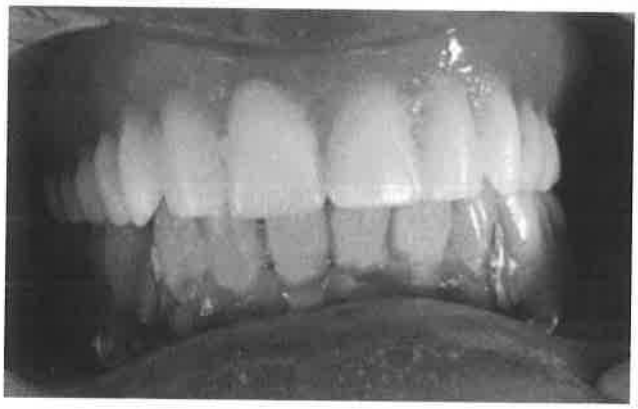

**Fig 8: Post Insertion View**

dentures and arrangement in class I relation was made.

The arrangement was tried in the mouth and the relations were reconfirmed and further procedures of fabrications were continued and completed (Fig 8) [3]. Regular follow ups were done and minor adjustments were carried out in the initial stages of denture wearing. He maintained good hygiene and followed the instructions. He was checked at 3 months and at 6 months; he was happy with the dentures and could masticate efficiently. The dentures did not require any relining at that stage.

## Discussion

Requirements for successful RPD service include cross-arch stability of the framework, maximal coverage of the edentulous residual ridge and stress control. The basic principles include a rigid major connector, multiple positive rest seats, mesial rests, parallel guide planes, the I-bar clasp design and the altered cast impression technique. The prosthesis can be stabilized in response to vertical stresses by means of favourable load distribution between supporting bone and abutment teeth. All components, when used effectively, will aid in reducing stresses to the underlying supporting tissue. A rigid major connector, strategically placed indirect retainers and well-adapted and –maintained bases also will aid in the stability and retention of the RPD and, thus, the maintenance of oral health. It was reported by Frank and Nicholls [4] that indirect retainers aid in force distribution, whereas guide planes and clasp assemblies provide the retention desired of a distal extension RPD. These components are beneficial in RPD design. Support for resistance of vertical forces is achieved via rigid teeth, mucosa and bone. If a distal extension RPD is to be successful, harmony needs to exist among these three biological systems. If the support required by any one component is excessive, it can result in mobility of abutment teeth, ulceration of mucosa, accelerated resorption of the remaining residual ridge or all of these, thus increasing the possibility of premature failure of the prosthesis. It is stated by Hindels that "stability of the appliance is a most important requirement for its proper function and for the patient's comfort."[5] A denture's stability is related to adequate support from the teeth and residual ridge. Holmes and Leupold [6] have demonstrated that the altered cast impression technique demonstrated the least amount of movement of the base at the time of placement and the most favourable ridge-to-denture-base relationship. The distal extension RPD fabricated with the altered cast impression technique attempts make accommodations between the differences in resiliency of soft tissue of the edentulous ridges and the hard tissue of the remaining teeth.[7]

The refined impression of the edentulous tissue surfaces is made after the metal casting has been completed and is used to alter the edentulous areas of the master cast.

The resultant cast accurately reproduces the supporting tissues in a form that provides the correct denture base extension and Favourable physiologic support when the denture is in its fully seated position. The altered-cast procedure is a definite step toward the preservation of the remaining oral structures. It will provide better removable partial denture service to patients [3].

Some advantages of the altered cast impression procedure include improved stress distribution, decreased food impaction, and decreased torque of the abutment teeth and preservation of the oral structures, it derives support simultaneously from the teeth and the denture base, improves the residual-ridge-to-dentition relationship of the prosthesis, all of which lead to patient satisfaction.

Distal extension edentulism can affect a patient's ability to function as a dentate person. A well-made removable partial denture that has appropriate extensions, borders and ridge-to-dentition relationship will benefit the partially edentulous patient by providing increased comfort and improved dental function [4].

## Conclusion

The altered-cast procedure is a definite step toward the preservation of the remaining oral structures [8]. It will provide better stability to

removable partial denture and helps in the perception of hot and cold and thus maintaining the health of the mucosa. It is also so stable that fractures are minimized.

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REVIEW ARTICLE

# GINGIVAL RETRACTION: An Essentiality in Fixed & Implant Prosthodontics

Dr. Himanshu Aeran, Dr. Rubina Gupta, Dr. G.K Thakral, Dr. Sheweta Dogra

**Abstract :** For the success of any restoration, it should have a healthy, harmonious relation with the periodontium. The precise reproduction of the abutment provides clinicians with crucial clinical information that allows them to fabricate exact-fitting, biointegrated restorations. To achieve this proper recording of finish line in the impression is a must. Another critical aspect of impression making is controlling blood, crevicular fluid, water and saliva. Hence, gingival retraction is required while making impressions for fixed dentures as well as Implant prosthesis.

The various techniques of gingival retraction include non-surgical methods (mechanical with retraction cords & chemomechanical with cord dipped in haemostatic agents) & the surgical methods (Lasers, Electrosurgery & rotary curettage). The uses, advantages & disadvantages of various techniques are discussed. The literature regarding the gingival retraction techniques used for Several Impression techniques in Implant is very limited. Hence, the uses of various retraction methods in Implant Dentistry are also discussed.

**Keywords :** Gingival retraction, Impressions, Fixed Partial Dentures, Implants.

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## Introduction

For the success of any restoration, it should have a healthy, harmonious relation with the periodontium. Key to achieving such a relationship is an accurately made impression for indirect restorations or a properly placed direct restoration into the prepared cavity[1]. Although, from periodontal point of view, it is preferable to place the margins of restorations supragingivally, for esthetic or other reasons, the dentist may be forced to place them subgingivally[2].

In cases of subgingival margins, the exposure of the gingival sulcus without damaging the periodontal tissue and the control of haemorrhage are prerequisites to the treatment of cervical lesions and improving the quality of impressions prior to fabricating indirect restorations. Poor marginal fit, which is the major cause of failure of cast restorations usually, results from incomplete marginal detail in the impression[3,4].

Gingival displacement is defined as the deflection of marginal gingiva away from the tooth. The aim of gingival retraction is to atraumatically allow access for the impression material beyond the abutment margins and to create space so that the impression material is sufficiently thick so as to be tear-resistant[5]. The critical

sulcular width seems to be approximately 0.2 mm at the level of the finish line for there to be sufficient thickness of material at the margins of impressions so that they can withstand tearing or distortion on removal of the impression[6].

Control of moisture in the sulcus, particularly when a hydrophobic impression material is used, is also necessary because moisture can cause an incomplete impression of the critical finish line[7].

The techniques of gingival tissue displacement can be broadly classified as nonsurgical and surgical methods. The non-surgical methods include mechanical & chemomechanical while the surgical methods include Lasers, Electrosurgery & rotary curettage.

Recently, Implants have become the mainstream treatment for tooth loss. Several impression techniques used in implant dentistry require gingival displacement while making impressions. Although, the literature concerning gingival retraction for impressions in fixed prosthodontics is extensive, unfortunately, it is not so in case of implants. Hence, the use of various techniques in Implant prosthodontics will also be discussed.

**Non-surgaical Gingival Retraction Methods**

A) MECHANICAL: Over the years, a lot of techniques have been suggested for the gingival retraction mechanically. Some of them include Temporary crown filled with thermoplastic stopping material or bulky temporary cement[8], Anatomic compression caps, Copper band impression technique[9], Temporary acrylic coping, Matrix impression system[10], Modified custom tray technique[11], Gingival protector, Matrices and wedges, Rubber dam, Plain retraction cords etc.

The most commonly used method is the use of retraction cords. Plain retraction cords can be gently forced into the gingival sulcus, using a cord packing instrument, to displace the gingiva laterally from the tooth. The techniques used can be single cord or dual cord technique.

In the single cord technique, the cord is placed into the sulcus starting from mesial side & then pushed into the sulcus around the tooth with gentle pressure. The cord is left there for at least 10mins12 & then removed just before making the impression.

In the dual cord technique, a smaller diameter cord is placed in the sulcus. A second cord of larger diameter is placed over the first cord in the sulcus. After waiting for the desired time, the second cord is removed & the impressions are taken with the first cord still in the sulcus. The double-cord packing technique is effective and safe for impression taking as long as the following steps are taken: The gingival tissues should always be in good periodontal health. Retraction cords should never be forced into the sulcus. Always remove both cords before dismissing the patient[13].

This technique can cause significant discomfort for the patient and offers several potential clinical disadvantages for the dentist, of which unpredictable tissue recession is the most significant[14].

The use of a single retraction cord often provides inadequate gingival retraction. The dual-cord technique reduces the tendency for the gingival cuff to recoil and partially displace the setting impression material[13]. According to Hansen et al, 98% of prosthodontists use cords, with 48% using dual-cord technique and 44% using single-cord technique4. Placement of retraction cords can cause injury to the sulcular epithelium and underlying connective tissues[15], as shown by the results of experiments involving dogs' teeth[16].

According to Feng et al, gingival retraction causes an acute injury that heals clinically in 2 weeks as is indicated by the Periodontal Indices[17]. Also, on removal, plain cords are associated with bleeding in more than 50% of situations, although wetting the cords before removal may help control the bleeding[18].

In case of dental implants, the use of plain cords is not advocated since the junctional epithelium is not as adherent, is more permeable and has a lower regenerative capacity than the junctional epithelium around teeth[19].

For implants, the mechanical method that can be used involves a hollow impression coping used as a retraction sleeve to temporarily deflect the tissue prior

to making the impression. The coping typically is plastic, which will not nick or damage the implant surface and can be used as a punch if the tissue has overlapped the margins of the implant. The stability of a well-fitting and secure healing cap also will determine the gingival health of the peri-implant apparatus[20].

**B) Chemomechanical Method**

The plain cords work on the pressure principle. Unfortunately, the use of pressure alone often will not control sulcular haemorrhage. Preimpregnating and/or soaking a cord with a haemostatic can control the sulcular haemorrhage and improve its tissue retraction qualities. The chemicals used along with retraction cords (gingival displacement medicaments) can be broadly classified[21] into vasoconstrictors (Epinephrine, Sympathomimetic amine) and astringents (Aluminum sulfate compounds (aluminum potassium sulfate [Alum] and aluminum sulphate, Aluminum chloride, Ferric sulphate).

The retraction cord can either be dipped into these chemicals before placement or these chemicals can be used in an injectable matrix. A study carried out by Csempesz et al indicates that 20 minutes of soaking time is necessary for saturation of the cords before use[22]. A miniature camera study showed that to achieve 0.2-mm crevicular width, the retraction cords must be in place for four minutes before making the impression[23]. Placing retraction cords for longer than this amount of time gained no further advantage. In another miniature video camera study, Laufer et al measured the closure of the gingival crevice following removal of medicated retraction cord. They found that the closure rate of the transitional line angle area was significantly faster than that of the mid-buccal area during the first 90 s. An average sulcular width of 0.2 mm was reached at the transitional line angle after less than [30s24].

Epinephrine commonly is used to medicate retraction cords as it provides effective vasoconstriction and hemostasis during retraction[25]. Using Doppler flowmetry, it was found that permanent hypoperfusion can be achieved only by the means of cord impregnated with 0.1% epinephrine[26]. However, it should be used with caution because it may cause tachycardia particularly if it is placed on lacerated tissue[18]. Many studies have been carried out to check its efficacy & its harmful effects. In one study, clinicians were unable to detect any advantages of using retraction cord dipped in epinephrine[27]. Csillag et al found that the prolonged increase in crevicular fluid production and hyperemic response after cord removal can be prevented by application of 0.01% epinephrine solution without systematic changes, if patient stress and gingival trauma are avoided during cord placement[28,29]. On the other hand, Stark et al found that following the use of an 8% r-epinephrine-impregnated retraction cord, there was a rise in blood pressure values, which were maintained at the higher level for 20 to 30 minutes[30].

Sympathomimetic amines are several vaso-active substances which, when used topically, have relatively few side-effects with prominent vasoconstriction action. They act as act as alpha-agonists. These substances are the active ingredients in various nasal or ophthalmic decongestants: tetrahydrozoline HCl, 0.05%, oxymetazoline HCl, 0.05%, and phenylephrine HCl, 0.25%. Bowles et al found that tetrahydrozoline HCl, 0.05%, oxymetazoline HCl, 0.05% produced tissue displacement greater than that of any of the other agents. Cardio-vascular changes included a slight increase in systolic pressure in the phenylephrine HCl, 0.25% group, and a slightly lower mean arterial pressure and pulse rate in all three experimental groups[31]. Feng et al also found tetrahydrozoline to be an excellent gingival retractor[32].

Astringents impregnated in retraction cords include aluminum chloride, ferric sulfate, alum (potassium aluminum sulfate) and zinc chloride. Zinc chloride is caustic to gingival tissues and thus is not recommended. Alum acts mainly as an astringent and is considered to be safe and moderately effective as a tissue-displacing agent[31]. The least irritating chemical is buffered aluminum chloride, & the cord may be left in the sulcus for up to 15 minutes without permanent damage[33]. Use of cord impregnated with aluminium chloride is reported to be the safest and most effective method of gingival retraction[2]. Hansen et al found that

54% prosthodontist used buffered $AlCl_3$ to soak cord, whereas more than 35% used ferric sulphate or aluminium[4].

Alum and ferric sulfate may be irritating and even corrosive at high concentrations, while increased concentrations of zinc chloride may damage bone and tissue permanently[13].

0.1% HCl-epinephrine is suggested in patient without cardiovascular disease. For patient with cardiovascular disease, the better substitute is 25% $AlCl_3$. 15.5% Fe2 (SO4)3 will not be used until its concentration is fallen[34].

Ferric sulfate acts as a clotting agent, and often, when the string is removed, the clot is pulled out with it, and hemorrhage begins anew. Also, ferric sulfate does not cause actual shrinkage of the tissues. A study revealed that the biologic effects of ferric sulfate solution are more satisfactory than aluminum chloride solution[35]. But due to its iron content, ferric sulfate stains gingival tissues a yellow-brown to black color for several days after being used as a retraction agent[19]. The use of ferric sulfate has shown to produce internalized discoloration of the tooth structure causing compromised esthetics[36].

The two main drawbacks of using chemicals with retraction cords are the occurrence of rebound hyperemia that often occurs after cord removal, which affects effective impression making[26, 28], and inflammatory reactions induced by these chemicals, which can affect the subepithelial connective tissue[37]. Studies on the chemicomechanical and purely mechanical cord retraction techniques have shown various degrees of necrosis and/or stripping of the gingival sulcus[38].

Chemicals in an injectable matrix uses 15 percent aluminum chloride in a kaolin matrix. It opens the sulcus, providing significant mechanical retraction[39, 40]. When compared with having a cord packed into the sulcus, an injection resulted in less pain for patients and was easier and quicker to administer. Furthermore, its effectiveness in reducing the flow of sulcular exudate is similar to that of epinephrine-soaked cords[19]. It also is safe, with the results of one study showing no reports of adverse effects[35]. Gingival recession associated with an injection of aluminum chloride into the gingival sulcus is almost undetectable[41]. The injectable matrix is hydrophilic and can be flushed away relatively easily from the gingival crevice[42].

Because of the tissue Injury & the inflammatory reaction caused by these chemicals, their use around implants is questionable. The delivery of chemicals via an injectable matrix shows promise for peri-implant tissue retraction, because it preserves the gingival tissues with no risk of lacerating or inflaming the junctional epithelium. In patients who have deeply placed implants with subgingival margins, however, its value may be somewhat limited by the extent to which such matrices are able to retract effectively[19].

The retraction cord achieves the desired retraction, but placing a retraction cord is not an easy method[43]. It needs physical manipulation of the tissue, leading to gingival bleeding. Thus, use of a retraction cord has the risk of epithelial attachment injury & pain during cord placement. It can also be uncomfortable for patients in the absence of anesthesia, and when inappropriately manipulated it can lead to direct injury and gingival recession44. Other studies using clinical and histopathological evaluation of gingival retraction in humans show that gingival retraction with the cord caused destruction of the junctional epithelium, which took about eight days to heal. The average postoperative gingival recession seen with cord retraction was 0.2±0.1 mm.

To overcome these problems, new products and techniques have been introduced into the market like Retraction Strips & Retraction Pastes. New retraction strips have synthetic retraction material that is chemically extracted from a biocompatible polymer (hydroxylate polyvinyl acetate) that creates net-like strips without debris or fragments. The material, which can be easily shaped and adapted into the sulcus without local anesthesia, is highly effective for absorption of intraoral fluids such as blood, saliva, and crevicular fluid[3]. Once inserted around the tooth, the sponge-like strips expand with absorption of fluids and exert pressure on gingival tissues to cause displacement[7]. Retraction pastes displace the gingiva

when injected into the sulcus. Because of the passive technique used to place these pastes, they are significantly less traumatic to the tissue than conventional retraction cord. Hence, they are preferred for gingival tissue displacement.

According to Beier et al, the pastes are less traumatic alternative method of gingival retraction in cases of epigingival and subgingival (<2 mm) preparation margins. However, when there were deep subgingival margins and a beveled preparation, the material was less effective than the single cord retraction technique[45]. Although these pastes cause greater temporary gingival inflammation; which also showed slower recovery, they do not induce bleeding during or after retraction[44]. According to Phatale et al, the retraction procedure with the newly advanced material in the form of retraction pastes like Expasyl or Magic Foam Cord appears very safe and easy to use. Histologically, they are found to be better than the cord, with respect to the periodontium. The patient tolerance was observed to be very good. No anesthesia was required and the material exhibited total biocompatibility[46]. Kazemi et al also supported the evidence that gingival inflammation is less with the retraction paste. Though the cord provided much greater sulcular width than the paste system, it was clinically acceptable in both the cases[47].

Cranham et al also advocate displacement paste over cord48. These pastes are also advocated around cement-retained implant prostheses[19]. They are also preferred when taking a digital impression for CAD/CAM prostheses since the artefacts caused by retraction cord fibres can be avoided[49].

But, the amount of retraction offered by these pastes is limited, especially with extremely subgingival margins[19]. The high cost of retraction pastes, commercially available with or without hemostatic agents, has also prevented them from becoming a mainstream commodity.

**Surgaical Gingival Retraction Methods:**

**A) Electrosurgery**

D'Asonval is credited for being the direct progenitor of electrosurgey. His experiment in 1891 demonstrated that electricity at high frequency will pass through the body without producing shock/pain, producing an increase in the internal temperature of tissue. It is also called as 'Troughing' and 'Gingival dilation'. A trough is created around the tooth by removing superficial cell layers from the gingival sulcus' inner lining through application of an electric current. This trough extends from the crestal height of the gingiva to a point 0.3-0.4mm apical to the finish line.

The indications include: areas of inflammation and granulation tissue around tooth, in cases where it is impossible to retract the gingiva, to enlarge the sulcus and also to control hemorrhage & to remove irritated tissue that has proliferated over the finish line[50, 51, 52]. The contraindications include: Patients with cardiac pace makers, TENS, Insulin pump etc., very fine marginal gingiva with little or no attached gingiva, presence of inflammable anesthetics or agents & Delayed healing due to debilitating disease, radiation therapy. Wöstmann et al found that the use of gingival retraction cords as well as electro-surgery lead to acceptable clinical gingival retraction[53].

Gingival electrosurgery for crevicular troughing involves a considerable risk of producing permanent periodontal damage[54]. Sulcus damage with electrosurgery was reported to vary depending on the type of unit used[55]. Stark et al found that use of a fully rectified current electrosurgical unit caused a substantial amount of tissue loss and elevated blood pressures when used for the purpose of gingival retraction prior to impression making[30].

Electrosurgery is not recommended around implants because there is significant risk that the contacting electrode may arc by conducting electric current though the metal implant structure to the bone rather than via the more dispersive gingival tissue pathway[19]. The concentrated electrical current at the tip of electrodes can generate heat, which may cause osseous or mucosal necrosis[56].

**B) Rotary Curettage :** was first described by Amsterdam in1954, the technique was developed by Hansing and subsequently enlarged by Ingraham. It is

also called as 'Gingettage'. It involves the use of a high-speed turbine to remove the sulcular epithelium and create a trough around the margins. For healthy, disease-free tissue around natural teeth, rotary curettage has little effect on gingival margin heights if adequate keratinized gingiva is present[57], although slight deepening of the sulcus may result[58].

It involves preparation of the tooth subgingivally while simultaneously curetting the inner lining of the gingival sulcus. The goal is to eliminate the trauma from pressure packing and the need for electrosurgical procedures. The gingettage is advised only in cases where there is absence of bleeding from probing, Sulcus depth is less than 3 mm & adequate keratinized gingiva is present.

Azzi et al studied the clinical & histological effects of electrosurgery, retraction cord, and the rotary gingival curettage technique in dogs. They found that though all methods induced some kind of minor damage, Recession of clinical magnitude was induced only by rotary gingival curettage. Apical migration of the junctional epithelium was not seen[2].

Rotary curettage is inappropriate for use around implant restorations because of poor tactile control when cutting soft tissue, which could lead to bur contact damage to the implant surface and over instrumentation. The absence of keratinized gingiva at the base of the gingival sulcus surrounding the implant could lead to an exaggerated response to rotary curettage, including deepening of the sulcus and gross recession[19].

### C) Lasers

Soft tissue lasers have been advocated as a means of removing controlled amount of tissue before impression making[59]. Compared with other retraction techniques, diode lasers with a wavelength of 980 nanometers and neodymium: yttrium-aluminum-garnet (Nd:YAG) lasers with a wavelength of 1,064 nm are less aggressive, cause less bleeding and result in less recession around natural teeth (2.2 percent versus 10.0 percent)[60]. Gabbar & Aboulazm revealed that with the application of pulsed Nd: YAG laser the gingival tissues showed faster healing with less haemorrhage and less inflammatory reaction in comparison with the chemomechanical methods of gingival retraction. Hence, they propagated the use of laser in gingival retraction as a simple convenient, painless method[61].

Scott compared the use of the standard two-cord retraction technique with that of a 2,780 nm erbium-class dental laser. He found that using an erbium laser to achieve the trough prior to placing an indirect restoration results in little or no postoperative discomfort for the patient; in addition, the erbium laser reduces intraoperative complications related to tissue recession and patient discomfort while providing consistently accurate impressions[14].

The use of Nd:YAG lasers is contraindicated near implant surfaces, because they tend to absorb energy, which causes them to heat up and transmit the heat to bone, owing to the effects of this laser's wavelength on metal62. There is also a tendency for Nd:YAG lasers to damage the fragile subjunctional epithelium at the sulcus base around implants.

The prime chromophore of the CO2 laser, which has a wavelength of 10,600 nm, is water, and it reflects off metal surfaces[19]. When used near metal implant surfaces, CO2 lasers absorb little energy, with only small temperature increases (< 3oC) and minimal collateral damage. CO2 lasers do not alter the structure of the implant surface[62] & hence can be used in Implant cases. But their method of exposing implant margins is to create a trough by excision rather than by displacing soft tissue. Therefore, their use may not be practical around deeply placed implant fixtures where a large defect could result. In addition, in anterior applications in which esthetics is critical, it may not be desirable to create a trough around the margins, as it may have a detrimental effect on patients' appearances[19].

### Conclusion

The precise reproduction of the abutment provides clinicians with crucial clinical information that allows them to fabricate exact-fitting, biointegrated restorations. Marginal Integrity is one of the criteria for a successful FPD. To achieve this proper recording of

finish line in the impression is a must. Another important aspect is controlling blood, crevicular fluid, water and saliva while taking impressions. Water and saliva can be controlled by air spray. Blood and crevicular fluid can be controlled by retraction cords, hemostatic agents, electrosurgery or rotary gingival curettage[63].

Several techniques have been advocated for relatively predictable and safe gingival retraction in fixed prosthodontics. Unfortunately, no scientific evidence has established the superiority of one technique over the other.

With the increase in number of Implant cases, an acceptable technique for gingival retraction is must. The existing techniques, though effective in fixed denture cases, are of limited or no value for Implant prosthesis. Judicious clinical judgment & skill of the operator are the deciding factors for the selection of any one of the various methods of soft-tissue management.

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REVIEW ARTICLE

# Safety And Compatibility Of Dental Materials And Implants In MRI Environment

Dr. B. Vijay Kumar, Dr. Indirapadmaja.B, Dr. Sumanth Kumar V., Dr. Swetha K.

**Abstract :** Magnetic Resonance Imaging (MRI) is being used more and more frequently as a diagnostic tool. Though it is used widely in cerebral imaging, it's the choice of imaging in TMJ Disc Disorders and Soft Tissue Pathologies of Maxillofacial Regions. An increasing number of patients with metal implants are being referred for MRI Investigations. Because high magnetic fields are used, knowledge on how these will affect implanted material and the patient is of great importance. Ferromagnetic properties of implants are seldom revealed by the manufacturer. But doctors advising MRI should know the composition of the alloy, its size, shape and position in the body. Though many of the dental implants are MRI safe, they do cause some artefacts, specially healing caps, cover screws and other restorations made on the implants. This article reviews the literature for ferromagnetic properties and safety/compatibility aspects of dental materials in an MRI environment.

**Key words :** MRI, alloy, distortion, Ferromagnetic properties, implant, T1fse

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## Introduction

MRI has been used in medicine for over twenty years as a high performance non-invasive diagnostic tool .These days, increasing number of patients are being referred for MRI investigation with a subsequent increase in the number of patients presenting with old and new metal implants. The question arises whether it is safe for these patients to enter a magnetic resonance (MR) environment. In the early days of MRI, the presence of metallic implants in a patient was considered a general contraindication for this type of imaging modality, and such a general exclusion criterion is thus a major obstacle in many clinical situations. Experience has shown that the presence of many metallic implants does not significantly disturb the magnetic field applied. However, based on experimental data and clinical observations, some ferromagnetic implants and electronic devices are regarded as potentially hazardous to patients undergoing MRI. This review of literature is focused on the MR safety as well as the compatibility of dental materials, implants and their components used in dentistry.

## Interactions of MR Environment

Implants and devices may be divided into two groups, namely active (especially electronically activated devices, e.g. cochlear implants, implantable cardiac defibrillators, or any other activated device including ventilator and monitoring devices) and passive (clips, sutures, prostheses and any other device that serves its function without power supply). The dental implants and their components, dental posts, cast partials, implant supported bars and

precision attachments are some of the passive devices used in dentistry[1,2].

A device is MR-safe when it is used in the MR environment, but presents no additional risk to the patient or other individuals, although the quality of diagnostic information may be affected. MR procedures may be contraindicated due to various interactions between the MR environment and medical devices, which include torque, translational force, heating induced electrical currents, magnetic field interactions, artifacts, and misrepresentation.

MR compatible equipment is MR-safe and can be used in the MR environment with no significant effect on its operation or on the quality of diagnostic information. No metal is totally non-magnetic or non-ferromagnetic, as all metals possess some degree of magnetism.

Translational attraction is assessed by using the deflection angle test measured at the point of the 'highest spatial gradient' for the specific MR system. The deflection angle test central to MR safety testing for metallic implants and devices is as follows: For deflections less than 45° in the deflection angle test, the magnetically induced deflection force is less than the force of gravity on the implant. It implies that any risk imposed by the application of the magnetically induced force is no greater than any risk imposed by normal daily activity in the earth's gravitational field. There are no concerns about movement or dislodgement in people with implants and devices made from non-ferromagnetic or weakly ferromagnetic materials with a deflection angle between 0° and 44°. A torque value in any implant/device that is less than that produced by normal daily activities (which include rapidly accelerating vehicles or amusement park rides) is assumed to be safe. Translational attraction/deflection and torque could lead to movement or dislodging of ferromagnetic implants. This may cause discomfort or even serious injury to a patient[1].

Translational attraction effects on external and implanted ferromagnetic objects in the immediate area around the MR system are usually responsible for possible danger. Translational attraction is proportional to the static magnetic field strength, spatial gradient strength, and mass, shape and magnetic susceptibility of the object. Deflection angles and magnetic field interactions of an implant can differ significantly between long- and short-bore MR. They are usually much higher in a short-bore. Higher magnetic field strength MR systems are rapidly increasing worldwide. Previously investigations were performed with magnetic fields only up in lower field strengths may experience much more interaction in higher field strengths. According to Faraday's law any change in a magnet field could induce a current in a conductor. This conductor in the MR environment could be cable, jewellery, metal external fixation devices or even a patient's arms if he holds his hands together above his head. The current induces heat in the conductor and that could present as burns on the patient.

In order to evaluate whether a device is now safe or compatible in the MR environment we need to keep in mind the things that could happen to this device.

In summary the relative risk of injury depends on:

- Ferromagnetic properties of the foreign body
- Geometry and dimensions of the object
- Strength of the static magnetic field
- Strength of the spatial gradient of the MR system
- Amount of force with which the object is fixed within the tissue (i.e. counterforce or retention force)
- Whether it is positioned in or adjacent to a particularly sensitive site (vital neural, vascular, or soft tissue including eyes)

Many of the dental implants, devices, materials, and objects evaluated for ferromagnetic qualities exhibited measurable deflection forces, but only the ones that have magnetically activated components present a potential problem for patients during MR procedures. The other dental implants, devices and materials are held in place with sufficient counter forces to prevent them from causing problems by being moved or dislodged by exposure to MR systems operating at 1.5 Telsa or less[1,3].

**Image Distortion**

Metallic objects (dental crowns, fixed bridges, splints, surgical fixtures, micromeshes, microplates and clips) are often encountered in the orofacial region of patients indicated for MR examination. Dental implants are used in reconstruction of prosthetic defects in the oral cavity and in modern surgical methods in traumatology[4].

While MRI has been extensively used for head and neck imaging, the diagnostic value of the image may be compromised by the presence of metallic prostheses in the mouth[4,5,6,7]. As a matter of fact, the presence of metallic objects introduces local in homogeneities into the main magnetic field which may result in artifactual images. These in homogeneities may cause image distortions due to the magnetic susceptibility of the objects, and they may lead to areas of anomalous intensity.

A major factor causing image distortion8 originates from dental prostheses producing disturbances in head and neck images. It was pointed out that below 0.5 Tesla, the distortions produced by some noble alloys are of little consequence. However, the magnetic susceptibility effects are not to be neglected insofar as they are limiting factors for spatial resolution. The magnetic susceptibility of the samples may cause significant artifacts8 (even for low susceptibility values. These artifacts can hinder observation when the perturbed areas are adjacent to dental alloys. Magnetic susceptibility measurements were performed to correlate the size and orientation of the artifacts.

The gold- and palladium-based samples induced artifacts with both image reconstruction techniques of 2DFT and PR 360°. (*2DFT:Two-dimensional Fourier Transform imaging method.

****PR 360°:** Imaging method of projection reconstruction at 360. Silver-based alloys produced less distortion of the magnetic field than other alloys[4].

**Dental Alloys**

There are three types of substances with different magnetic susceptibilities that need to be considered in MRI, namely, paramagnetic, diamagnetic, and ferromagnetic[9].

Although the artifacts caused by ferromagnetic substances such as iron, nickel, and cobalt have been widely reported[10,11,12]. Magnetic susceptibility is one of the physical properties of material and can be defined as the ratio of magnetic response of a material to the applied magnetic field. There are three types of substances, according to their magnetic susceptibility. Diamagnetic substances have no unpaired orbital electrons. When such a substance is placed in an external magnetic field, a weak magnetic field is induced in the direction opposite the magnetic field. Thus, diamagnetic substances have a small negative magnetic susceptibility and are basically non-magnetic.

Paramagnetic substances have unpaired orbital electrons. Their induced magnetic field, under the external magnetic field, has the same direction relative to the external magnetic field. Consequently, their presence causes an increase in the effective magnetic field. Ferromagnetic substances are strongly attracted by a magnetic field and thus have high potential for MRI artifacts. Iron, cobalt, and nickel are three types of ferro magnets[13,9].

In dentistry Palladium based alloys have also been detected to be paramagnetic[4]. Currently, most clips and many implants are made of nonferromagnetic materials such as titanium. Even so, when a patient with a "nonferromagnetic" metal in the body is subjected to MRI, an artifact is produced which causes a drop-out of signal near the metallic surface[14]. Dental implants, orthopedic screws, and aneurysm clips are some examples of titanium alloys that produce metal artifacts on MR images, thus obscuring the images of tissues near the metallic objects.

Some studies reported that titanium had no significant metal artifacts in spinecho sequences[15]. In contrast, several authors have reported that titanium alloys produced high- to moderate-magnitude artifacts in the spin-echo sequence[16]. It was confirmed that the appearance of moderate-magnitude artifacts from commercially pure titanium and titanium alloys in the T1 FSE sequence[9], which is least sensitive to metal artifacts. They also confirmed the appearance of high-magnitude artifacts in T2 FSE and GE sequences, which are highly sensitive to metal artifacts[9].

The contradictory results reported in the literature might be due to differences in the parameters used in MRI, such as magnetic field intensity and specific sequences, trace amounts of ferromagnetic substances from the samples, and geometric factors in the imaging.

Titanium alloy imaged in a low magnetic field intensity of 0.35 T also showed no artifact[15]. However, diagnostic efficacy of MRI in the low-magnetic field is generally limited.

In a study it was reported that, with 11 casting alloys six dental casting alloys in the T1 fast speed echo ( FSE )sequence had shown minimum artifacts. These 6 alloys were composed of one paramagnetic element with other diamagnetic substances (KIK-Noble; Au 45, Pd 46, In 4, Sb 3- %by mass), KIK-Wing; Pd 81, In 6, Sb 9), Bior17Au 98.3, Ti 1.7) (PGA3Au 70, Pt 6, Cu 4.7, Ag 19) or only pure diamagnetic substances (New Silver and K14 Inlay). New Silver (Ag 65, Zn 18, Sn 17) and K14 (Au 58.4, Cu 28.2, Ag 8, Zn 5). Inlay showed artifacts in both T2 FSE and GE sequences. Bior[17], titanium with a high percentage of gold, and PGA3 platinum, with high percentages of gold and silver, have showed minimum artifacts in T1 FSE but showed artifacts of only moderate magnitude in T2 FSE and GE. The main elemental composition of 2 other dental casting alloys (KIKNoble, KIK-Wing) is palladium. Pure palladium is one of the elements that has the highest positive magnetic susceptibility among paramagnets[10]. Specific composition of KIK-Wing, which is currently utilized in restorative and prosthodontics dentistry, does not significantly disturb the magnetic field. It thus seems an ideal composition regarding metal artifacts in all three sequences of MRI[9].

It has been found that precious-metal alloys and amalgams are slightly diamagnetic (20x10-6 to -40x10-6) and do not influence the B0 homogeneity significantly except in their very close vicinity. The highest conductivities were found in the group of precious-metal alloys (4.0-6.2 S.m/mm2), while the conductivity of amalgams was marginally lower (3.4-4.1 S.m/mm2). These properties make these materials prone to cause B1 artifacts. The Co-Cr and Ni- Cr alloys were found highly paramagnetic (370x10-6 to 1370x10-6) and less conductive (0.80-1.3 S.m/mm2). As a result, these materials lead to large B0 in homogeneities, overshadowing any B1 effects. Large differences exist, however, within this group[2].

There would thus be no difficulty in the diagnostic interpretation of MRI s from head and neck regions in patients with dental casting alloys that do not disturb the magnetic field. The following table shows the signal intensity variations in T1and T2 fast spin echo(fse) MRI for different alloys.

T1-weighted MR images of bovine muscle, in which type III gold, amalgam, stainless steel, titanium endosseous implants, silver palladium and vitallium screw are embedded showed that all of the above.

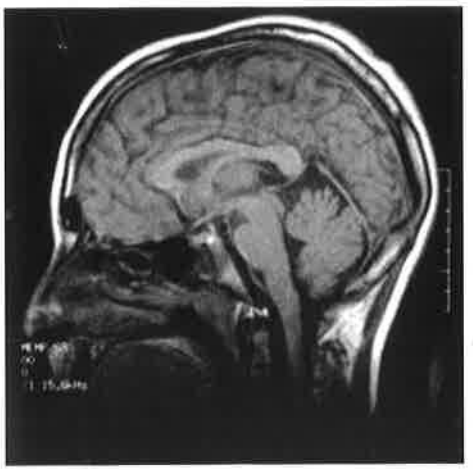

**Figure 1 MRI scan of the naso ethmoidal complex in a 13 year old child**

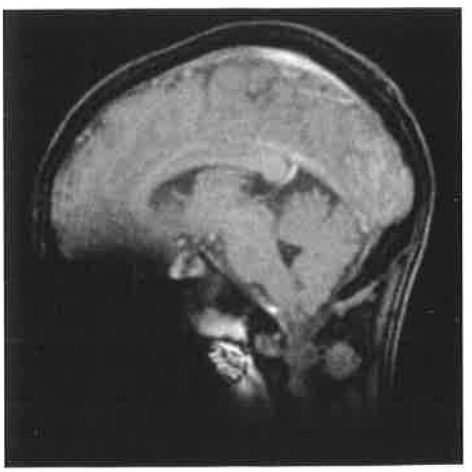

**Figure 2 MRI scan of patient with metal orthodontic brackets in place**

**Table 1. Description of dental appliances and artifact category: [18]**

| Dental appliance | Use | Mass[g] | Composition | Artifact category |
|---|---|---|---|---|
| Gold crown | Artificial crowns/ inlays | 1.0 | 69% Au, 10%, 12.5% Ag, 3.5% Pa (+3.0 pt), traces of Fe,Zn,In,Sn | 1 |
| Amalgam crown | Filling | 0.64 | 69.3%Ag, 17.9%Sn, 11.8% Cu, 1% Zn. | 1 |
| Zinc phosphate cement | Luting crowns. | 0.20 | Possible trace amounts of iron and iron oxide,85%-90%zincoxide, phosphoricacid, 10%magnesiumoxide,water. | 2 |
| T.M.S. pin | Intraradicular post inserted into root canal for stability before filli ng | 0.02 | 66%-70% Fe, 17%-19% Cr, 8%-10% Ni, 2% Mn, 1% Si, plus traces | 4 |
| Parapost | Braces | 0.17 | 70% Fe, 17%-19% Cr, 8%-10% Ni, 2% Mn, 1% Si, plus traces | 4 |
| Orthodontic bands (type 304, Rocky Mountain) | Preformed crowns on deciduous teeth | 0.067 | 65%-71% Fe, 18%-20% Cr, 8%-12% Ni, 2% Mn, 1% Si, plus traces | 3 |
| Stainless steel crown | | 0.15 | 65%-70% Fe, 17%-19% Cr, 10%-13% Ni, 2% Mn, 1% Si, 0.12% C, plus traces | 2 |

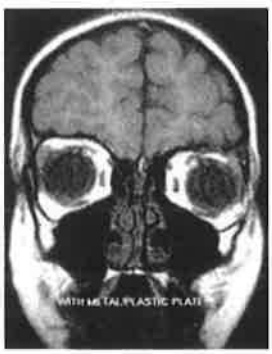

**Figure3 MRI scan with patient wearing aesthetic brackets on occlusal splint**

Produced artefacts ranging from a void to a complete alteration of anatomy are being studied. Gold (type III) produced greatest artifact, where as amalgam and titanium produced the least [17].

A 0.5 tesla spin echo sequence transverse sectional images through tooth area with dental restorations in place shows no significant artefacts (category 1) with amalgam, gold crowns, inlays, aluminum crowns, micro-filled resins and poly vinyl crowns. Minimal artefacts defined as a 2cm or less ring

**Table 2. Composition of the orthodontic appliances (%) [19]**

| | Metal brackets and tube | | Band and | |
|---|---|---|---|---|
| Ceramic brackets | | (%) | SS | (%) |
| Alumina oxide 100% | Fe | =70 | Fe | =62 |
| | Cr | 15-17.5 | Cr | 16-18 |
| | Ni | 3-5 | Ni | 10-14 |
| | Cu | 3-5 | Mo | 2-3 |
| | Si | =1 | Mn | =2 |
| | Mn | =1 | C | =0.08 |
| | Nb | 0.15-0.45 | Si | =1 |
| | C | =0.07 | P | =0.045 |
| | P | =0.04 | S | =0.03 |
| | S | =0.03 | - | - |

**Table 3. Six kinds of orthodontic appliances [19]**

| Appliances | Incisors | Premolars | Molars | Arch wires |
|---|---|---|---|---|
| Type 1 | DB ceramic brackets | DB metal brackets | DB tube | Without SS |
| Type 2 | DB ceramic brackets | DB metal brackets | Band tube | Without SS |
| Type 3 | DB metal brackets | DB metal brackets | Band tube | Without SS |
| Type 4 | DB ceramic brackets | DB metal brackets | DB tube | With SS |
| Type 5 | DB Ceramic brackets | DB metal brackets | Band tube | With SS |
| Type 6 | DB metal brackets | DB metal brackets | Band tube | With SS |

DB, Direct bonding; SS, stainless steel; band tube, band welded with tubes

on at least one image with minimal distortion of surrounding structures (category 2) are demonstrated with orthodontic bands, zinc phosphate cements, and ss crowns. Endodontic and restorative posts [T.M.S. PIN, PARAPOST] showed artefacts of more than 5cms (Category 4). Metal braces typically ruin the MR images of orofacial region but the examination is satisfactory for the brain and cervical spine [18].

**Implants And Components**

Neither torque force nor any migration was recorded for any of the components made of commercially pure titanium when examined in such a strong magnetic field as used in a 1.5-T magnet. This fact can be regarded as a sign of validity of the test situation. Besides the fixation magnets and the magnet keepers, only healing caps showed any ferromagnetic properties. These screws have a long axis, but the mass is minute (0.03 to 0.07 g); and they do not cause any problems, as long as they are secured to the abutments. Moreover, these cover screws are used only during a short period of time during the initial healing phase.

Around non ferromagnetic implants such as commercially pure titanium, artifacts are likely to be limited to a narrow area adjacent to the implant. The MRI films of patients with Brånemark implants showed only minor artifacts, as long as the fixation magnets were removed. A patient with intra oral or extra oral Brånemark implants may be exposed to an MRI examination without any risk; the resulting artifacts are minor[17]. If the patient has any fixation magnets or magnet keepers attached to the implants or the prosthesis for its retention, these should be temporarily removed, not only to avoid major artifacts, but also to eliminate the risk of implant loss.

The extent of artifacts caused by metallic dental devices depends on the magnetic susceptibility and the electrical conductivity of the device, its shape and orientation in the magnetic field, its placement in the oral cavity and on numerous MR measurement parameters, related to the MR scanner specifications, the desired type of contrast, volume of interest, and practical experiment time limitations[18]. Dental manufacturers and dentists, however, can impact only the device composition, stress state of its crystalline structure and, to a limited extent, its shape, size and orientation.

Since the MR-relevant physical parameters of a metallic material – its magnetic susceptibility and electrical conductivity – depend on its microstructure in a complex way, the two parameters are convenient indicators of the MR quality of the material. The ideal material would have zero electrical conductivity _ (S/m) and a magnetic susceptibility identical to that of the observed tissue. As the magnetic susceptibility of most soft tissues appears to be within ±10–20% of that of water, _water1, the ideal material for soft tissue imaging is characterized by the difference in magnetic susceptibility __= _−_water equal to zero. It was found that all the metallic dental materials investigated that had difference susceptibility |_−_| < 1500×10−6 (amalgams, alloys of precious metals, titanium alloys, nickel–chromium alloys and cobalt–chromium alloys) can be considered MR compatible for brain and neck MRI. With some caution, the same may apply to metallic dental materials with difference susceptibility 1500×10−6 < |_−_water| < 3660×10−6 (aluminum bronzes) with a slight chance of the artifact reaching the imaged area for large restorations and long-TE 2D GE(gradient echo)[18].

For orofacial MRI, the artifacts measured in this study by 2D GE with TE = 10msmay be significantly reduced (more than twice) by choosing much shorter TE (such as TE = 2.65 ms, TR = 6.9 ms, flip angle 12◦, shown to provide a good representation of the anatomy of this region)[19]. Hence, all metallic dental materials with difference susceptibility |_−_water|<30×10−6 (amalgams and most alloys of precious metals) can be considered MR compatible. Materials with difference susceptibility 30×10−6 < |_−_water| < 200×10−6 (titanium alloys and Orplid Keramik 2) will produce only limited artifacts constrained to the vicinity of the metallic device, depending on its size, shape and orientation. Materials with difference susceptibility 200×10−6 < |_−_water| < 1500×10−6 (nickel–chromium and cobalt–chromium alloys) are still acceptable for observing the anatomy of the orofacial region at a suitable distance from the device. Acceptability of the materials with difference susceptibility 1500×10−6 < |_−_water| < 3660×10−6 (aluminium bronzes) will depend on the geometry of the dental device and the pulse sequence used. These materials may severely affect the quality of orofacial MRI[18].

Scientists have described MRI defects of clinically significant proportions when prosthetic magnetic keepers are included in the image. In this study, the area of MRI defects extended not only to the oral cavity but also to the sinus, cervical spine, and brain. It is therefore necessary to remove the magnetic dental attachments for patients who have MRI examinations of the craniofacial region[20,21].

An immediate MRI examination is occasionally necessary for patients who have symptoms requiring prompt diagnosis. For these patients, there is not enough time for referral to their dentists for removal of magnetic keepers before conducting an MRI. The removable magnetic dental attachment solves this problem because it is easily removed with cotton pliers. With the use of the nonmagnetic alloy keeper, the temporo mandibular joint can be examined with the teeth in occlusion without dimensional change.

## Conclusion

All MR rooms should have an up-to-date list of devices and a copy of F G Shellock's Pocket Guide to MR Procedures and Metallic Objects, which is about as complete as it gets. Its better to have classification of prosthetic biomaterials compatable with MRI.

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REVIEW ARTICLE

# Lasers In Prosthodontics – A Literature Review

Dr. Jose Julian, Dr. Babu Cherian, Dr. Kurian George, Dr. Susan Paul, Dr. Rejani S Chandran

**Abstract :** Dentistry has changed tremendously over the past decade to the benefit of both the clinician and the patient. One technology that has become increasingly utilized in clinical dentistry is that of the laser. Initally introduced as an alternative to the traditional halogen curing light, the laser now has become the instrument of choice, in many applications.

## Introduction

The word LASER is an acronym for light amplification by stimulated emission of radiation. The first LASER was invented by Theodore Miman, at the Hughes Aircraft Company USA, in 1960. Maiman's laser used a solid ruby as an 'active medium', which was energized or 'pumped' by an electrical source.

Many other kinds of lasers were invented soon after the solid ruby laser- the first uranium laser by IBM Laboratories (in November 1960), the first helium-neon laser by Bell Laboratories in 1961 and the first semiconductor laser by Robert Hall at General Electric Laboratories in 1962; the first working neodymium-doped yttrium aluminium garnet (Nd: YAG) laser and CO2 laser by Bell Laboratories in 1964, argon ion laser in 1964, chemical laser in 1965 and metal vapour laser in 1966. In 1967 lasers were applied into practice by Gordon. Since 1970 dental laboratories used them to weld metals. In 1995 pulsed Er-YAG laser and in 1997 Er,Cr: YSGG lasers were developed[2,3,10].

In dentistry, the first laser was used on an extracted tooth 47 years ago. But, the commercially available lasers have only been used in dental practice during the past 18 years. Every field of dentistry has been positively affected by laser technology.

## Types of lasers used in dentistry

1. Carbon Dioxide laser
2. Neodymium: Yttrium-Aluminum-Garnet
3. Erbium: Yttrium-Aluminum-Garnet
4. Erbium, Chromium : Yttrium - Selenium - Gallium Garnet
5. Argon laser
6. Holmium :Yttrium-Aluminum-Garnet
7. Gallium-Arsenide (Diode laser)

## Lasers in prosthodontics

Laser use during soft tissue procedures for fixed, removable, and implant dentistry can enhance esthetics, improve impression outcomes, and provide a foundation for the restorative appliance nearer to

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ideal in fit, form, and function. This objective can be accomplished through precise control of soft tissue removal, improved visualization by hemostasis, and more predictable healing. Compared with conventional techniques, laser treatment has many advantages. These include:

- Reduced overall treatment time due to less mechanical trauma and edema
- Decreased bacterial contamination of the surgical site
- Reduced swelling, scarring, and wound contraction at the surgical site
- Excellent hemostasis, leading to superior visualization of the surgical site

**Clinical applications of lasers during removable prosthetic reconstruction**

The successful construction of removable full and partial dentures mainly depends on the preoperative evaluation of the supporting hard and soft tissue structures and their proper preparation. Lasers may now be used to perform most preprosthetic surgeries[7,11]. These procedures include:

- Hard and soft tissue tuberosity reduction.
- Surgical treatment of tori and exostosis.
- Treatment of unsuitable residual ridges including undercut and irregularly resorbed ridges.
- Treatment of unsupported soft tissues
- Removal of soft tissue abnormalities such as hyperplastic fibrous tissue.

**Application of lasers in fixed prosthodontics**

- In Laser sulcular gingivoplasty - which improves impression techniques and minimizes gingival recession.
- To establish greater clinical crown length before crown placement.
- Frenectomy
- Removal of gingival overgrowth before recementation of bridge [4,7].

**Application of lasers in implantology**

The advantages of using lasers in implant dentistry are the same as for any other soft tissue dental procedure. These advantages include increased hemostasis, minimal damage to the surrounding tissue, reduced swelling, reduced infection, and reduced pain postoperatively. The increasing popularity of the erbium family of lasers, with their hard tissue ablation capability, has added the potential for its use for osteotomy and decontamination of infected and ailing implant bodies[1,5] .Due to the hemostasis provided by lasers, there is the significant advantage of improved visibility during surgery. Impressions can be taken immediately after second-stage surgery because there is little blood contamination in the field due to the hemostatic effect of the lasers.

There is also minimal tissue shrinkage after laser surgery, which assures that the tissue margins will remain at the same level after healing as they are immediately after the surgery[5,7].

**Laser welding in prosthodontics**

It is a unique welding technique used to join metals through the heating effect of a concentrated beam of coherent monochromatic light. It is currently receiving considerable attention in the field of Prosthodontics and the use of this technology became more effective with the introduction of compact high power pulsed Nd – YAG laser. Two types of laser welding equipments that are in use are solid state lasers (eg. Nd- YAG) and the gas lasers (eg.CO2 laser). Applications of laser welding in Prosthodontics include fixing secondary crown on partial dentures, welding a transverse bar break with filler alloy, welding butt joint on clasp shoulder, welding of ill fitting bridges and connecting crowns, correction of porosities by using filler alloy of same material, correction of ill fitting or damaged implant supported frameworks to get an accurate fit etc [8,9]

Laser welding is an easier and simpler method to connect dental alloys. It can be performed quickly and directly on the master cast and the welds are precise and well defined. Inaccuracies and distortions due to

the duplicating process of the model are reduced. Laser welded pieces may have high corrosion resistance. Laser energy can be concentrated in a small area and so there is a smaller heat affected zone. The welding can be performed in close proximity with acrylic resin and ceramics. Their disadvantages include high cost, requirement of highly skilled labor, high maintenance cost and micro-cracks can occur due to heat generated during welding procedure[8,9]

## Conclusion

Patient comfort is always a priority and painless dentistry is always a goal, with the use of lasers in the dental practice a multitude of procedures can be performed. The laser is not merely a "hightech" gadget: it is an extremely useful piece of equipment for the dental practice.

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REVIEW ARTICLE

# Gingival Retraction – A Comprehensive Review of Materials and Techniques

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**Abstract :** Important aspect of successful fixed dental prosthesis is accurate final impression of the prepared teeth . One of the problems associated in the process of the impression making is the recording of marginal details. A number of materials and methods have been described in literature for the retraction of gingival tissue.

The extent of hemorrhage influences the preference for a specific retraction cord. Outweighing the benefits over disadvantages the dentist should carefully select the suitable material and method for a particular clinical situation. This article reviews the literature and the currently available materials and methods.

**Keywords :** Gingival retraction, tissue displacement, gingival hemostasis, retraction cords, retraction pastes, retraction gels

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## Introduction

The clinical success and longevity of restorations depend on a number of factors. Factors attributed to restoration accuracy have included the degree of clinical expertise; properties of impression, stone and die and restorative materials; and the conditions under which impressions are made and restorations completed. When tooth preparations require sub-gingival margins, it is essential that the operative site is clear of debris, dry and that the margins are accessible. This requires gingival retraction, which can be carried out using a number of methods, including retraction cord, copper bands, rubber dams, electro surgery, and lasers, as well as polymers and pastes.

Selection of the appropriate method depends on clinical demands and preferences, the individual patient, and consideration of the potential advantages and disadvantages. Ideally, gingival retraction should be quick, user-friendly, patient-friendly, painless, and inexpensive. Modern techniques and materials have made gingival retraction minimally-invasive and tissue friendly thereby preserving periodontal health as well as enabling easy access to sub-gingival margins.

According to Shillingburg [1], the three most common methods of finish-line exposure are chemomechanical (retraction cords), surgical (electro-surgery), and mechanical (copper bands). Retraction cords impregnated with medicaments are used to retract, displace, constrict, or shrink the gingival tissues. One of the problems with this method is that the medicament used may cause adverse local and systemic side effects.

Several reviews of the literature regarding finish line exposure have been published. Ramadan [2] concluded that any tissue-displacement technique must be conservative and should not cause tissue detachment from the tooth. He argued that impregnated cords or electrosurgical subgingival troughing procedures produce effective and safe tissue displacement. Nemetz and Seibly [3] reviewed chemical agents used in finish-line exposure and stated that the clinician should select appropriate technique for the given clinical situation. Azzi showed that all methods of finish-line exposure can cause some type of tissue damage [4]. Various methods of finish line exposure are discussed by several authors [5].

According to a 1985 survey, 95% of North American dentists routinely used gingival retraction cords [6]. There are approximately 125 gingival retraction cords in various shapes, sizes and medications available in the market. A gingival retraction agent should be (1) effective for its intended use, (2) safe - both locally and systemically, and (3) the effects should be spontaneously reversible, wearing off in a short time, leaving no permanent tissue displacement.

## Gingival Retraction Techniques

### Mechanical Methods

One of the earliest techniques for mechanical displacement of gingival tissues was the use of the rubber dam. Specialized gingival retraction retainers (clamps), when placed, displace the gingival tissues to allow for access to tooth preparation [7]. But it can not be used with polyvinyl siloxane impression material, because the rubber inhibits polymerization. Copper band or tube can be used for retraction of gingival mechanically. But use of this can cause incisional injuries and a minimal amount of gingival recession.

Among the most popular methods of gingival displacement is the use of gingival retraction cord. Gingival retraction cords can be woven, braided or twisted in a variety of configurations to provide for different diameters and thicknesses. Use of plain cord is disadvantageous as the use of pressure alone may not control sulcular hemorrhage. It should not be used dry [8].

### Chemo-mechanical methods

Retraction cords impregnated with chemicals not only enlarge the gingival sulcus but also control seepage of fluids from the walls of gingival sulcus. Cord should remain in the sulcus for a considerable period of time. After removing the retraction cord from the sulcus, impression should be made immediately, otherwise sulcus will be closed [9].

A survey by Hansen et al [10] showed 98% of prosthodontists use cords. Out of which 48% use a dual cord technique and 44% use single cord technique. They determined that 54% prosthodontists prefer to use buffered aluminium chloride to soak retraction cord, where as more than 35% routinely use ferric sulphate or aluminium chloride. They reported the use of a double - cord technique in almost half of the clinical situations.

With this technique, a thin cord is placed without overlap at the bottom of gingival crevice. A second cord is placed on top to achieve lateral tissue displacement. The latter is removed immediately before impression making, and initial cord is left in place to minimize seepage (Figures 1&2). The dual

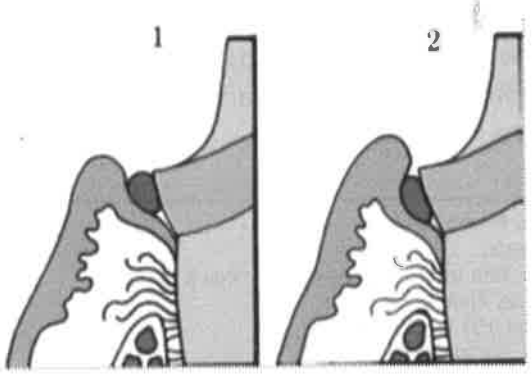


**Figure 1 : Single cord technique**

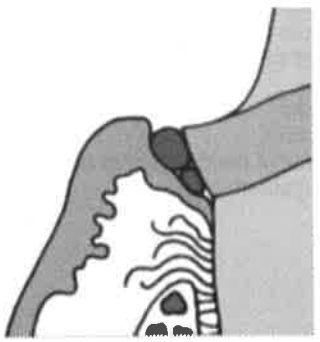

**Figure 2 : Double technique**

cord technique possesses the advantage of declining the tendency of gingival cuff to recoil and partially displace the impression material as it sets [11].

The filaments or fibers of conventional cords also may cause residual contamination of gingival sulcus, creating foreign body reactions and exacerbating inflammation. Healing of the sulcus can take 7 to 10 days. When packing retraction cord, use of minimal force is essential to protect Sharpey's fibers, any excess force may cause crevicular bleeding, gingival inflammation and shrinkage of marginal tissues.

It has been reported in the literature that a wide variety of chemicals have been used for effective displacement of gingiva. The three criteria for a gingival retraction material are : (1) effectiveness of gingival retraction and hemostasis (2) absence of irreversible damage to gingiva (3) causing no systemic side effects.

Most commonly used materials are discussed below :

**1. Epinephrine**

Although epinephrine provides effective vasoconstriction and hemostasis[12], 33% of its application is accompanied by significant local and systemic side effects. "Epinephrine syndrome", which is characterised by tachycardia, hyperventilation, raised blood pressure, anxiety and postoperative depression, can occur in patients who are susceptible to epinephrine [13].

**2. Aluminium sulphate and aluminium potassium sulphate**

These agents are hemostatic and retractive, and result in minimal postoperative inflammation at therapeutic concentrations, although severe inflammation and tissue necrosis can occur with the use of concentrated aluminium potassium sulphate solutions [14]. These act by precipitating tissue proteins with tissue contraction, inhibiting transcapillary movement of plasma proteins and arresting capillary bleeding[15].

**3. Ferric sulphate**

Iron present in ferric sulphate stains the gingival tissue yellow-brown to black color for few days after its use [16]. It inhibits the setting of polyvinyl siloxane and polyether impression materials [17].

**4. Aluminium chloride**

It acts by precipitation of tissue proteins, but causes less vasoconstriction than epinephrine [18]. It is least irritating of all the medicaments used for impregnating retraction cords but it has disadvantage of inhibiting the polyvinyl siloxane and polyether impression materials [19]. Ramadan (1968) in his thesis stated that this agent proved more effective in keeping the sulcus open after removal of the cord (10-20 percent of original opening eight minutes after the cord is removed) than are epinephrine medicated cords (50 percent closure of sulcus observed over a similar time). After 12 minutes, only sulci packed with aluminium chloride remained open at 80 percent of the original space created. However, the elimination of residues of aluminium chloride, after removing retraction cord and before proceeding with the impression procedure, becomes all the more important owing to its ability to interfere with complete setting of polyether and polyvinyl siloxane impression materials.

The two main drawbacks of using chemicals with retraction cords are the occurrence of rebound hyperemia that often occurs after cord removal, and inflammatory reactions which can affect the subepithelial connective tissue.

**Recent retraction cords**

1. Stayput impregnated combines the advantages of an impregnated retraction cord with the adaptability of a fine metal filament.

- ensures quick haemostasis
- can be preshaped
- is pliable and adaptable
- shows good contrast to the gingiva
- is impregnated with aluminium chloride, causing no cardiovascular problems

Stayput non impregnated is also available and can be impregnated individually as required.

2. Comprecord is an air texturised retraction cord which consists of polyester and polyamide yarns. It's distinctive features are outstanding absorbency and simplicity of handling. The new technology of air texturising gives the cord a stable structure and a great total volume which makes Comprecord highly absorbent. Handling is facilitated by the pliable structure of the cord. Therefore Comprecord can be placed easily in the sulcus without fraying or shedding fibres. It is colour coded and available in sizes xfine, fine, medium and thick.

**Polymers and pastes**

**Polymers**

Studies have shown that the use of polymers with a sponge-like texture cut into 2-mm strips is an effective method. The polymer swells when exposed to moisture and gently pushes the gingival tissue away from the finish line, enabling detailed impression-making. In addition, it was found that the gingivae returned to a normal position within twenty-four hours.

Merocyl strips were found to be effective in retraction of gingival tissue and exposing the margins of preparations for impression making.

**Pastes**

Displacement paste – Chemicals in an injectable matrix – Expasyl Initially described by P. Lesage, a French dental surgeon, which was first known as "PRG paste", has been launched in 1999 by the Pierre Rolland laboratory under the name of EXPASYL (Figure 3).


**Figure 3: Expasyl retraction paste system**

**Composition**

- Kaolin white clay
- Aluminum chloride-15%
- Coloring agents
- Excipients.

Expasyl comes in a paste form and is packed in cartridges, each cartridge serving for 2 to 3 retractions.

**The complete kit includes**

- A dispenser sterilizable by autoclaving
- 20 cartridges of Expasyl
- 40 single-use bendable cannulas.

In contrast to any chemicomechanical method, the injectable aluminium chloride, resulted in less pain and discomfort, was quicker to administer [21].

The strength of the epithelial attachment is 1 N/mm. A very low pressure (0.01 N/mm) enables opening of the sulcus and a recovery that is immediate and a pressure of 0.1 N/mm enables a sulcus opening of 1.5 mm and a delayed recovery up to 2 minutes per 0.5 mm opening. The paste is injected into the sulcus, exerting a stable, non-damaging pressure of 0.1 N/mm. When the paste is left in place for 1 minute, this pressure is sufficient to obtain a sulcus opening of 0.5 mm for 2 minutes. This injectable matrix contains white clay to ensure the consistency of the paste and its mechanical action, while aluminium chloride enhances the haemostatic action.

The essential requisite for its effective use is the sulcus should be absolutely dry during placement. Expa-syl's main advantages are that it takes less time to inject and is less traumatic to the tissues than traditional retraction cord. But it is not cost effective, so may not be preferred by the clinicians. Placement process is easier than cord technique, with less tissue trauma, but the amount retraction is less than that obtained with cord.

Displacement may be improved with the use of comprecap, hollow cotton rolls, while the paste is being dispensed into the sulcus [22]. Gingival retraction will last for four minutes after the Expasyl™ has been rinsed and removed from the site. Application of an air

and water spray will remove the paste from the sulcus thoroughly.

Poly vinyl siloxane - Chemicals in an inert matrix

A polyvinyl siloxane material for gingival retraction was introduced in 2005. It works by generating hydrogen, causing expansion of the material against the sulcus walls during setting. It does not cause any inflammation or irritation of the tissue. It is easy to place in the sulcus and has no adverse effects. The drawbacks are that it may not improve the speed or quality of retraction obtained.

A polyvinylsiloxane expandable gingival retraction paste is available as Magic FoamCord Gingival Retraction System. This is also applied around the preparation margins using a pre-loaded syringe. After syringing the material around the margins, a cap (Comprecap) is used over the material and tooth. This is used to apply pressure for 5 minutes to obtain gingival retraction. The impression is made after the paste has been removed. This paste does not contain a hemostatic agent, and hemostasis must be obtained prior to applying the paste and cap (Figure 4).

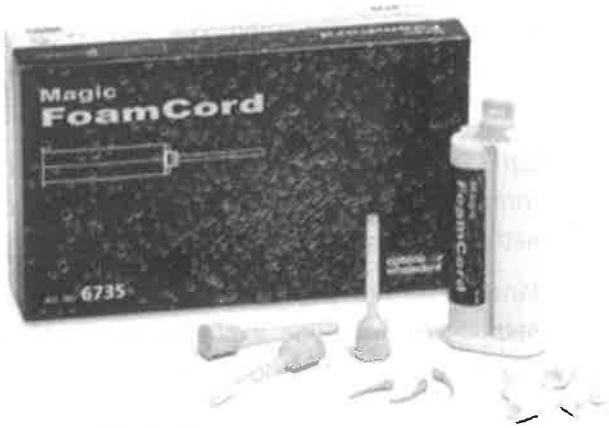


**Figure 4 : Magic foam cord retraction system**

A third gingival retraction paste system (Gingi-Trac™)

The paste contains an astringent, and if necessary a hemostatic agent can be applied prior to the application of GingiTrac™ (Figure 5). It also uses a pre-loaded syringe to apply the paste around the margins.


**Figure 5 : Gingitrac retraction paste system**

For single tooth use, a cap (GingiCap™) is used to apply pressure for up to 5 minutes after the paste has been applied. The cap is first filled with the paste, then placed over the tooth and paste syringed around the margins (Figure 6). For multiple tooth preparations, a plastic tray is first used with a firm paste matrix over which the GingiTrac™ paste is syringed before the tray is placed over the arch and held in position for 3–5 minutes. Surgical retraction methods

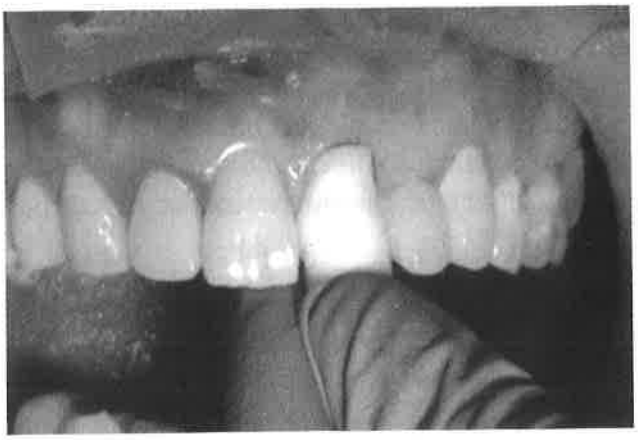

**Figure 6 : Comprecap placement**

**Lasers**

Lasers have many applications, including their use as a gingival retraction method. Lasers produce a high-energy, collimated beam of light that is converted into thermal energy. They predictably vaporize tissue at 100 to 150 degrees Celsius, create an adequate trough that permits detailed and accurate impressions, and preserve biologic width. Erbium-based lasers are absorbed on the surface and the Nd:YAG series energy is absorbed deeper in the tissues. A third type of laser, the diode laser (Odyssey, Vivadent), is also utilized for soft-tissue procedures. It results in minimal

discomfort, and is not associated with tissue recession seen with the use of the doublecord gingival retraction method. Lasers can be used without anaesthesia and offer hemostasis.

Causes less bleeding, less tissue inflammation, faster healing than retraction cord, and was painless, simple, and convenient compared to other retraction techniques. Surgical wounds created by lasers heal by secondary intention, and incision lines show disorganized fibroblast alignment. This reduces tissue shrinkage through scarring, which helps preserve gingival margin heights[23].

**Rotary curettage**

This is a toughing technique, to produce a limited removal of epithelial tissue, while chamfer finish line is being prepared on the tooth, using a rotary instrument. It causes sulcus deepening with less damage to periodontium. This can be used only on healthy tissue, with no inflammation on gingiva. If used improperly, it may result in potential destruction of periodontium. Azzi and colleagues [4] studied the effect of retraction cords, electrosurgery and rotary gingival curettage on gingival recession and loss of attachment in dogs. They found that cords had the smallest effect on the gingiva and rotary curettage had the largest effect.

**Electrosurgery**

An electrosurgery unit works by passage of a high-frequency current (1 to 4 million Hz) through the tissue from a large electrode to a small one. It has been recommended for enlargement of the gingival sulcus and control of hemorrhage to facilitate proper recording of gingival finishlines while making impression.

Electrosurgery cannot stop bleeding once it starts. If hemorrhage occurs, it must be controlled with pressure and/or chemicals and then the vessels can be closed with a coagulating ball electrode.

If used on inflamed tissue, because of its proximity to bone, may cause lateral heat production. Bone is very sensitive to heat. This procedure may also cause gingival recession which is undesirable for the prognosis of a restoration.

**Summary**

The multi-faceted benefits and indications of tissue management render it an important process in assessing clinical success. Traditional gingival retraction methods include retraction cords, copper bands, electrosurgery and more recently laser surgery. In addition, pastes have been introduced that function as gingival retractors. While selecting a method for tissue management during restorative procedures, it is necessary to consider the advantages and disadvantages of each method, the individual case and patient, and to strive for minimally-invasive methods that optimize impression making and restoration placement, while at the same time preserving periodontal health. Recent innovations have achieved minimally invasive tissue retraction.

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