In the past 10 years, different synthetic bio resorbable membranes have been proved to facilitate better healing as compared to non-resorbable e-PTFE barriers. However, one consistent drawback of these bio resorbable membranes is the relatively great variation and low predictability in achievable clinical attachment and bone gain.

Along with patient specific characteristics like, wound healing potential, immune system etc., membrane specific problems like, early membrane exposure, bacterial contamination and early resorption of the membrane also has been attributed to this limitation.

In 2002, Christgau et al,[8] studied the effects of a new experimental resorbable membrane called Poly dioxanon on GTR in intra bony defects. They compared this new membrane with a well established Poly lactic acid matrix barrier, made of Poly lactic acid and acetyl Tributyl Citrate.

Polydioxanon is made of homopolymer of p-dioxanon (PDS), which is a synthetic, polyester which resorbs completely in six months. It has a bilayered structure with the tooth-facing layer as an occlusive PDS film, which prevents proliferation of gingival epithelium and connective tissue. The gingival-facing layer consists of 200 microns long PDS slings, which allow connective tissue integration along entire membrane.

This study showed that while 45% of the sites treated with PDS membranes were exposed, only 6% of sites treated with PLA membranes became exposed. Also, the free gingival margin along the exposed sites also remained inflammation-free, indicating a stable connective tissue integration, inhibiting a further epithelial downgrowth along outer side of the PLA membrane. Same results have been obtained by Gottlow et al., in 1994 and Lundgren et al., in 1995.

Also, there was a high incidence of spontaneous exfoliation of PDS membrane after 5 - 6 weeks, indicating lack of connective tissue formation at PDS slings and an epithelial down growth along gingival-facing side of the membrane. The possible reasons given by the authors for this are:

a. The structure of PDS membrane being too thick leads to inter-proximal flap dehiscence.
b. The inner layer being occlusive, would have prevented sufficient nutrition of the overlying flap.
c. They would have allowed plaque accumulation on exposed parts resulting in inflammation.

Other observation was PDS membranes degraded slowly in the first week compared to other degradable membrane. They behaved more like non-degradable membrane barriers. And the space beneath them was occupied by fibrous-looking connective tissue as in non-resorbable barrier membranes.

After the exposure of PDS membrane, the exposed area receded greatly as compared to control sites after six months. However, PDS membrane showed similar statistical reduction in Probing Pocket Depth (PPD) as of PLA membrane. There was 57.1 % gain in attachment as compared to 62.5 % gain in PLA treated sites after 24 months. This result corresponds to the similar findings by Eickholz et al in 2000. The authors hypothesizing two reasons for this behavior, one is the usage of antibiotic prophylaxis and a control regimen with Chlorhexidine and other one as already mentioned earlier, the occlusive layer would have prevented bacterial penetration into the space beneath.

## GUIDED BONE REGENERATION (GBR) - MATERIALS AND MECHANISMS

### 1. The GTR Barrier Membranes:

In 2001, Wang and Carroll,[9] explained the principles and clinical procedures of using barrier membranes composed of absorbable collagen in GBR aimed at repair and regeneration of ridge dehiscence defects around implants. Indications and contraindications for using resorbable collagen membranes were also examined.

GBR is a technology developed from the idea of GTR. It shares in common with GTR the use of barrier membranes to achieve bone regeneration. Hence, the ideal requisites of GBR barrier are basically same as for GTR except that there are some additional requirements like:

a. **Scaffolding:** The space will be occupied initially by fibrin clot acting as scaffold for in growth of progenitor cells from the adjacent bone or morrow.
b. **Stabilization:** Membrane must stabilize the clot without disturbance from overlying flap. Use of suture, mini bone screws, bone tacks are advised.
c. **Framework:** In defects like dehiscence or fenestration, the membrane must be supported to prevent collapse. Bone-replacement grafts like Autografts, Allografts, Xenografts, Alloplasts or combinations can be used for this purpose. They act like internal framework. Stiffer membranes like Titanium-reinforced membranes also can be used.

The disadvantages of Non-resorbable membranes are:

a. Membrane exposure due to flap sloughing
b. Second surgical procedure required to retrieve the membrane is tedious and disturbs healing.

The resorbable collagen membrane eliminates all the disadvantages of the nonresorbable e-PTFE

membranes. Collagen is the principal component of connective tissue and provides structural support for tissues.

They have the ability to stimulate platelet attachment and to enhance fibrin linkage leading to initial clot formation. They also promote clot stabilization and maturation enhancing healing and regeneration. They have the chemotactic ability for fibroblasts, which enhances cell migration. Added to the advantages of elimination of second surgery to retrieve the barrier membranes, they are easy to manipulate and adapt to root surfaces. They are either weak immunogens and do not elicit an antibody response at all. It is degradable enzymatically hence will be incorporated with the flap which will support new connective tissue attachment. It allows sufficient time for the cells to get established at the wound site. The membranes cross-linked with formaldehyde have been shown to last 6 - 8 weeks by Blumenthal et al.

**INDICATIONS:**

a. Localized alveolar ridge deficiencies
b. Osseous fill around immediate implants
c. Dehiscence and Fenestrations
d. Bone defects around implants
e. Residual bony defects
f. Repair of sinus membrane perforations

**CONTRA-INDICATIONS:**

a. Presence of any systemic problems
b. Presence of active infection at the site
c. Poor Oral hygiene - absolute contraindication
d. Smoking - relative contraindication
e. Situations where space cannot be created/ maintained
f. Poor soft tissue quality - inflammation

While explaining the general principles of GBR, their advantages and disadvantages, indication and contraindications, authors have supported their article with the help of three cases where in they used absorbable collagen membranes to augment

- A horizontal edentulous alveolar ridge defect,
- An extraction site defect associated with immediate implant placement
- A horizontal ridge defect along with implant placement.

A detailed explanation regarding surgical principles and post-operative care also has been provided. The authors conclude by saying that if absorbable collagen membrane works well for GTR procedure, they should work better for GBR procedures. Additional bone grafting materials for space creation/maintenance will improve the treatment outcomes. This type of combination of regenerative materials usually works better than the combination of non-resorbable barrier membrane with any graft material. The mechanism that was explained for this success is that collagen not only works as tissue matrix but also regulates cell function. They provide binding sites for various soluble growth factors (BMP) and cell-attachment proteins are able to carryout anchorage-dependent functions like division, migration, growth and differentiation. They may also serve as a carrier to deliver growth factor, or medications to the defect sites.

While confirming that bone regeneration using Collagen membranes is a promising aspect of science, they caution that long-term studies are required to confirm success rate of implants placed in regenerated bone.

**PRODUCT INFORMATION:**

| SOURCE | MAIN COMPOSITION | COMMERCIAL NAME |
|---|---|---|
| Bovine Tendon | Type I Collagen | Biobar, BioMed,BioMed-Extend |
| Bovine Dermis | Types I & III Collagen<br>Primary Collagen (Atelocollagen) | Periogen,Tissue Guide |
| Porcine Dermis | TypesI & III Collagen | BioGuide |
| Calf Skin | 96% Type I collagen<br>4% Chondroitin-4 sulfate | ParoGuide |
| | 88% Hydroxylapatite<br>9.5% Type I collagen<br>2.5% Chondroitin-4 sulfate | Biostite |

**2. OSTEO-CONDUCTIVE MATERIALS:**

One material, which has been used to treat intrabony defects, is Perioglass. It is a bioactive alloplastic glass with particle size range of 90 to 710 microns. They have been found to bond to both bone and soft tissue. Basic components of this bioglass material are Silicon Dioxide (45%), Sodium Oxide (24.5%), Calcium Oxide (24.5%) and Phosphorous Pentoxide (6%). It forms a biologically active hydrated calcium phosphate layer at the surface, which forms the bond. This layer forms within hours of placement of this material. Bone has been found to form around each particle of this graft. (Hench and Wilson in 1984, Wilson and Low 1992).

It is different from normal Osteoconduction in that bone seems to grow away from any growing wall of bone. This is due to undifferentiated cells with osteogenic potential colonizing the surface of the particles and beginning the process of bone formation simultaneously at various sites of the defects. Hence, it has been suggestd that particulate form of this material is more beneficial for treating intrabony defects.

In a study by Zamet et al,[10] where they used this biomaterial, they treated 22 patients with moderate to advanced periodontitis. All the presurgical indices like Pocket Probing Depth, Plaque and calculus index, bleeding on probing, gingival recession were recorded presurgically and were compared 3 months and 1 year postsurgically. Radiographic analysis using CADIA System also was carried out. CADIA is a Computer Assisted Densitometric Image Analysis System which analyses standardized sequentially exposed radiographs and their density change over time. This system was described in 1994 by Fourmosis et al. It is a highly specific, sensitive and accurate instrument in periodontal radiographs (Bragger et al, 1988). While general examination of comparison of indices showed great degree of defect fill, CADIA indicated significant improvement in bone density at the sites treated with Bioglass. however, the area adjacent to the sites (both experimental and control) showed no significant difference in bone density, indicating that this material is active locally rather than exerting effects on surrounding bone. So, up to one year it acts as bony fill and later the density increases due to formation of hydrated calcium phosphate layer on the surface of the particles, which explains the formation of bond between particles and bone. In conclusion, bioactive glass is a great adjuvant to periodontal surgeries in treating intrabony defects.

Another study conducted by Rabalais et al yielded good results in using Durapatite ceramic material as an alloplastic implant in periodontal osseous defects in human beings. However, in an augmentation procedure done by Kent et al, with Durapatite, a subperiosteal pocket developed over mandible or maxillary alveolar ridge by detachment of the periosteum from the crest of the ridge. They feel that the periosteum should not be detached beyond the external oblique ridge laterally in the mandible so as to prevent migration of particles away from denture-bearing area. Prosthetic evaluation of their study indicated that augmentation was >100% in some patiens with mean augmentation of 48% in the mandible and 30% in the maxilla. They also observed that the contour of the ridge changed to a more prosthetically favorable convex from either knife-edge or concave form.

Post-operative changes in the ridge height was 10% indicating that this is a good material for augmenting deficient alveolar ridges.

In a more recent study by Larsen et al, on non-resorbable Durapatite implant to augment alveolar ridges, most radiographs gave evidence of good to excellent Hydroxyapatite apposition to bone. They also evaluated the patient's comfort of wearing a denture before and after augmentation. Most patients were highly satisfied with retention and stability of their denture. They also showed little bone resorption.

The conclusion of Kent and Larsen et al study says that prosthetic and surgical procedures using Durapatite were easier to perform and that they produced more permanent and superior results thatn other materials. As there are advantages to these materials there are disadvantages also. There are procedural complications like extrusion of particles, incomplete wound closure, inferior alveolar nerve anesthesia, migration of small portionof the material, and loss of vestibular depth. However, these disadvantages are less severe as compared with other materials where in tissue necrosis, osseous sloughing and celluitis may result.

Alloplastic materials like Hydroxyapatite have been tried to induce bone and to augment the alveolar ridges. This material has close chemicaland crystal resemblane to bone mineral. Durapatite is a new, non-resorbable hydroxyapatite ceramic material which has been well accepted by the host site. It is different from other Hydroxyapatite in that it has high density and purity owing to its manufacturing process.

Jarcho et al, have shown that Durapatite elicits no foreign body response and the bone surrounding the implant are normally calcified and form strong bond with them. As augmentation material, Chang showed that Durapatite material is more useful for Subperiosteal implantation rather than supra periosteal site. Only a fibrotic union occurs with host tissue in supra periosteal site leading to mobility of the material. he rationalizes that this lack of osteogenesis may be due to lack of adequate fixation, which is due to mobile subcutaneous soft tissues.

Based on his studies, Chang suggests loading of the site augmented with Durapatite can be started between 3 and 6 months after augmentation. Total load application can be done safely after 6 months. However, the first impression can be made after one month.

Low, King, Krieger,[11] analyzed the efficacy of bioactive ceramics (BIOGLASS) in the treatment of periodontal defects. The study was conducted on a small group of 12 volunteers who had initial pocket depths of greater than 6 mm. Parameters for evaluation of the progress included Probing Depth Measurement, Attachment Levels, and measurement of Bone Fill, as initial mean, at 3 months, at 6 months and at 24 months. Further, 5 patients were also evaluated as long term follow-up for these parameters. Clinically, the study showed encouraging results at all levels in all parameters, except a mild difference in Probing Depth levels. The initial mean

Probing Depth was 7.71 +-1.40 mm. At 3 months, it reduced to 4.74 +-1.09 mm and at 6 months, even more reduction to 4.34 +- 0.79 mm was noticed. However, there was no significant reduction between 6 months and 24 months.

Attachment Level at initial measurement was 14.11 +- 3.58 mm, at 3 months and 6 months it was 12.11 and 12.55 mm respectively. At 24 months, it was 12.19 mm. However, the gain was not statistically significant.

Bone Fill measurements revealed significant apposition of bone at all levels and the reasurements were statistically significant. Amount of fill at 3 months was 2.76 mm, at 24 months 3.47 mm.

The statistical analysis through Scheff's Test, the authors demonstrated significant improvement in all clinical parameters. However, certain limitations of the study are, the small study group, difficulty in measuring the bone fill as the material used also was highly radio opaque, similar to bone. Also, if such studies are to be compared with other studies, the clinical parameters shouldnot vary. Earlier, Yukna et al, used resorbable coral material and gained 1.7 mm attachment level and a reduction in Pocket depth of 3.0 mm. Rummelhart et al used Demineralized freeze-dried bone graft to report 1.7 mm attachment gain. They also suggested that the ultimate test for regeneration is histologic assessment, which is difficult in human studies due to ethical considerations.

A recent article in 2002 by Wong Kevan,[12] England, dscribes the usage of calcium sulfate during a procedure of Exarticulation and reimplantation (XRP) of a maxillary Lateral Incisor with a development defect. He pointed out that biomedical form of calcium sulfate has a potential to regenerate periodontium and bone. However, he cautions careful exarticulation of the involved teeth, as atraumatically as possible, minimized amount of tooth exposure outside socket and filling of socket with amount of calcium sulfate just required to fill the cavity. He points out that normally, during exarticulation, and reimplantation (XRP) ther is some damage and denudation of the root surfaces, which undergo resorption or ankylosed later. This phenomenon can be prevented by the application of calcium sulfate, which promote selective formation of new periodontal tissues like new periodontal ligament, new cementum, and alveolar bone with Sharpey's fibres.

He also observed a new material Mineral Troxide Aggregate, which is an excellent root canal sealant. It also provides suitable substrate for the formation of hard tissues in vitro, especially the cementum. Hence, this can be used for obturating the rots and denuded, traumatized surfaces of teeth treated with XRP. The formation of new cementum on denuded root surfaces would prevent the resorption often observed in reimplanted teeth.

Further studies are suggested to investigate the efficacy of XRP.

## 3. BONE INDUCING MATERIALS - OSTEO-INDUCTION: EMPS AND BMPS

### 3. a. Enamel Matrix Proteins (EMP)

Enamel Matrix Protein has been also gaining popularity in the treatment of intrabony defects. It has been tried on wound healing in periodontal pocket management and gingival recession. While showing enhanced healing of periodontal soft tissue wounds, it has been found to have no clear benefit in improving gingival recessions.

Hagewald et al,[13] in 2002 evaluated the efficacy of Enamel Matrix Protein (EMP) in the treatment of recession defects. The control site utilized a placebo, Propylene Glycol Alginate. Measurements of height and width of Gingival Recession presurgically and one week, 3 weeks and 3 months postsurgically were noted. Height of keratinized tissue, Probing Attachment Level (PAL), Probing Pocket Depth (PPD), and alveolar bone level (ABL) were also measured using Florida Probe. 12 months after the therapy, the reduction in Gingival Recession was almost same for both control and experimental site indicating that EMP does not play a major role in Gingival Recession.

However, keratinized tissue gain was statistically significant in EMP group. Hence, this study questions the use of EMP for surgical recession treatment.

Trombelli et al,[14] in the same year, conducted a study of EMP in treatment of deep intrabony defects. They reported results of 35 consecutively treated cases. Probing Pocket Depth, (PPD), Clinical Attachment Level, Gingival Recession and Radiographic depth of the defect were recorded after 9 - 12 months of surgery. Average clinical attachment level and radiographic depth were 4.7 mm and 3.9 mm respectively. A significant correlation was found between presurgical PPD and Clinical attachment level gain.

An almost similar study by Wennestrom and Lindhe,[15] to evaluate the effects of EMP on wound healing in the dento-gingival region yielded positive results. They applied EMP subgingivally and examined the sites after 1, 2 and 3 weeks.

The results indicated that EMP topically applied in instrumented pockets enhances the early healing of periodontal soft tissue wounds.

Hirroka in 2001,[16] scrutinized the biologic concepts for its use as regenerative substance for

developing tooth roots and their supporting tissues. They have explained the role of EMP in the development of normal Periodontium.

EMPs are proteins secreted by Hertwig's epithelial sheath of developing tooth bud. They play an important role in Cementogenesis on roots and in development of Periodontal Ligament apparatus.

During development of a tooth bud, the Inner Enamel Epithelium produces EMP mainly composed of Amelogenin, which forms enamel. After the coronal portion of the tooth is formed, the epithelium invaginates and continues to proliferate alongwith Outer Enamel Epithelium as Hertwigs epithelial root sheath. It stimulates the connective tissue of mesenchymal origin in dental papilla to lay down root dentin. It also secretes the EMP on the newly formed root dentin surface. (Simultaneously, Hertwigs Epithelial root sheath breaks up into Epithelial Rests of Malassez). The EMP on root dentin stimulates mesenchymal cells around the dental follicle and Cementoblasts are induced to form Cementum. The initial Cementum is Acellular in nature and the principal fibers of periodontal ligament are embedded in it. Once the Cementum is formed, a series of cell inductions occur in dental follicle to form periodontal ligament and alveolar bone proper.

This Enamel Matrix Protein has been harvested from developing porcine teeth. It is stable, freeze-dried, purified form of EMP used for Periodontal Tissue Regeneration. Several experimental studies have been carried out with this product. Hammarstrom et al, used it on Monkeys where they created artificial dehiscence defects using a dental bur, and then after acid etching the root surfaces, EMP was applied. After 8 weeks, the sites were compared with control group histologically.

The test site with EMP showed encouraging results with almost complete regeneration of acellular cementum, which was firmly attached to root dentin. The regenerated collagen fibers were found to extend into regenerated alveolar bone proper. There was no gingival recession or formation of long Junctional Epithelium.

Similar results were obtained by Heijl, when these procedures were conducted on human mandibular central incisors, suggesting a True Regeneration capacity of EMP.

There are several studies conducted on determining the ability of Enamel Matrix Derivative to influence specific properties of periodontal ligament cells in regeneration. In 1997, Gestrelius et al,[17] investigated certain properties like migration, attachment, proliferation, biosynthetic activity and mineral nodule formation. They determined that EMD formed protein aggregates, which provide a unique environment for cell-matrix interaction.

They observed that

a. Enhanced proliferation of Periodontal Ligament cells but not the epithelial cells.
b. The protein production increased.
c. Promoted mineral formation of PDL cells
d. It had no effect on migration or spreading of cells

It has been proved that Extracellular Matrix Proteins are the local substances, which stimulate regenerative capacity of cells at healing site. The inductive reactions can result from the interactions of these matrix proteins with the cells with potential to regenerate, or from diffusible signals like growth factors.

In 1997, Hammarstrom demonstrated that EMD is involved in regeneration of acellular cementum. EMD represents extracellular Matrix with regenerative capacity. EMD contains purified hydrophobic amelogenins, which form insoluble aggregates (Matrix) under physiological conditions.

### PRODUCT INFORMATION

EMDOGAIN is freeze-dried EMP, of which major protein is Amelogenin. It is carried in a viscous carrier Propylene Glycol Alginate at pH5.5. It is stored in refrigerator at 2 - 8 degree centigrade and prepared about 15 minutes prior to its application. The carrier is drawn with a large bore needle and is spread over the EMP to dissolve it. Then it is drawn into the syringe and applied over the site.

## 3. B. BONE MORPHOGENIC PROTEINS (BMP)

BMP is a group of osteo-inductive Proteins first noted by Urist in 1965. They have been used successfully in combination with biodegradable membrane barriers for ridge augmentation and regeneration procedures. Two articles have been reviewed here, one for each procedure that was conducted.

Among a plethora of BMPs, rhBMP-2 has been found to have high osteo-inductive potential. rhBMP-2 is a characterized protein developed by recombinant DNA technology. It requires a suitable carrier system to induce its therapeutic effects. There are several carrier membranes, which could be used for this purpose. Among them Poly (L-Lactide)-based material, Poly (L-Lactide)/Tricalcium Phosphate (PLLA/TCP), (Poly Glycolic Acid-Trimethylene Carbonate (PGA-TMC) have been used by Lee et al, in 2003,[18] for ridge augmentation procedures.

Suitability of a carrier system depends on its ability to enable vascular and cellular invasion of the site and allow BMP to act as a differentiation factor. It

should also be reproducible, absorbable, moldable, non-immunogenic, and space provider to define the contour of resultant bone. Some of the biomaterials used as carriers for BMP are Collagen, Decalcified Bone Matrix, Deproteinized Bovine bone mineral, Hyaluronan, Hydroxylapatite and various Poly (-Hydroxy acids) and Titanium.

PLLA/TCP has several advantages over others. It is biocompatible, moldable, absorbable, provides space for bone regeneration and its augmentation. Added to this, it also has all the properties required for biodegraded barrier and of a carrier for bone-inducing agents.

## RELEASE KINETICS OF RHBMP-2

According to Winn et al, who studied BMP in type I collagen, initial burst effect had a half life of 10 minutes and is carrier-independent, where as the secondary release had half-life of 1 - 10 days and was carrier dependent. According to Uludag et al, again a two-phase release was noticed. However, the initial release burst varied highly followed by a gradual second release phase. This in vitro study also showed 2-phase release system, 70% of the loaded rhBMP-2 was released one day and subsequent release was over 28 days. Morphogenetically, it has been determined that rhBMP-2 must be biologically active during the whole of the wound healing phase after surgery. To achieve this, Sykaras et al, have suggested that a controlled application of this protein would be effective to maintain the chemotactic gradient required for cell response.

In another study done by Wikesjo et al,[19] for evaluating the effect of this proteins on periodontal repair, they have used PGA-TMC as a carrier membrane. This membrane is dome shaped with 100-120 microns pores, which are laser etched to allow fibrovascular penetration. The results obtained by them also were significantly impressive, in that the regeneration of alveolar bone height increased in these sites. Cementum regeneration was limited and functionally oriented periodontal ligament fibers were rare in thee sites. At 8 weeks, the PGA-TMC membranes remained intact and bone formed into its micro and macropores. At 24 weeks, it completely resorbed.

At 48 weeks, the newly formed bone consisted predominantly for lamellar and woven bone. Fatty marrow and fibro-vascular tissues also were observed at the sites receiving rhBMP-2. In CEJ area, ankylosis was a common finding in areas receiving this protein. Bone formation was 90% in rhBMP-received sites as compared to a 40% in control sites at 24 weeks post surgery.

Limitations of Bioresorbable devices include, early or late resorption, adverse inflammatory reactions during resorption process leading to foreign body reactions. Takakis and Trombelli, also reported abscess formation with foamy macrophages.

## ADJUNCTIVE THERAPY TO GTR/GBR

Considering the limitations of the GTR materials, various researchers have tried to reinforce the treatment with the help of adjunctive procedures like, use of Chlorhexidine, application of 25% Metronidazole, fixation of the membrane with the use of Titanium pins etc..

In 2003, Chen et al,[20] and Reddy et al,[21] incorporated 0.0015% Chlorhexidine and studied their anti microbial action on the Periodontal ligament cells. They concluded that it inhibited growth of Actinomycetem comitans and did not interfere with the attachment of periodontal ligament cells.

At the same time, Machtei et al,[22] studied the effect of 25% Metronidazole applied over the membrane in smokers. They found good results after 1 year, i.e. the vertical attachment level was significantly greater than that was in the control group.

In 1998, Kirsch, Ackerman et al,[23] reinforced the PTFE membranes covering the implants with Titanium pins, which simplified the adaptation procedure of these barrier membranes. This enhanced the ease of their application and space maintenance. It also minimized the post-operative complications like, membrane exposure, dehiscence and gingival recession.

In 2002, Wagle et al,[24] studied the effect of applying a Glycoprotein, Fibronectin, on the wound healing. They concluded that demineralized root surfaces bind 2 times more the amount of fibronectin as compared to non-demineralized root surfaces. however, this study requires further investigations to be applied to the GTR concepts.

## TREATMENT EFFICACY EVALUATION METHODS

1. Radiographic analysis using CADIA System (explained earlier)
2. Traditional Histologic evaluation
3. Digital subtraction and Bone level measurements (Eickholz P, Hausmann E),[25]

## FUTURE OF GUIDED TISSUE REGENERATION/ GUIDED BONE REGENERATION DEVICES

The presently available devices represent first and second-generation devices. The future should see

devices that maintain biocompatibility and exhibit improved performance. There are several modifications that are being explored for their applications throughout the body.

One modification is the alteration of surface properties by incorporation of adhesive molecules. The material should have physiological activity, which means that the surface should stimulate cell and tissue bonding. Extending this concept a little further, by applying a specific adhesive molecule, tissue selectivity canbe imparted to the material.

The adhesion molecules like proteins and peptides, which are involved in cell-cell and cell-matrix interactions, are being currently pursued for biological applications. Ability of a device to attract a particular cell type by virtue of its capacity due to adhesive molecules would significanlty enhance tissue integration. It has been also found that the adhesion molecules affect bacterial cell adhesion, i.e. in an ideal device this would help in bacterial cell repulsion.

Further modifications in achieving bacterial cell repulsion has led investigatiors to incorporate anti microbial agents in the GTR material. For example, tetracyclines, which have anti-inflammatory and collagenase-inhibiting properties, may be coated on the GTR device to achieve this goal.

Other probable modification is incorporation of growth and differentiation factors, which have potential to grow bone and cementum also. Incorporation of growth factors is being actively investigated.

In summary, future devices will likely be designed and manufactured to exert one or more biological activities, which should ensure a more predictable regenerative outcome in defects and clinical situations that remain a challenge today.

## CONCLUSION :

Loss of tooth has a tremendous impact onthe self esteem level of an individual. With the changing trend towards conservatism, a periodontally involved tooth is no longer sacrificed as it used to be earlier. The shear need for avoiding removal of a strategic tooth has given rise to an upsurge in scientific research attempts for new biomaterials and techniques that could save these teeth.

"Regeneration" of virtually any biological tissue is the magic word in the field of medicine. This concept has been exploited to the extent of reconstructing the lost supporting structures for the periodontally involved tooth. Extensive research in this field of dentistry has helped mankind to that extent where in the teeth that were labeled 'hopeless' in the previous era, can serve as abutments for a fixed prosthesis. However, the load-bearing capacity of these abutments has not been explored.

The concept of guided tissue regeneration has changed significantly the outlook for periodontal regeneration. The future of guided tissue regeneration promises to be exciting, as new materials or modified ones, especially in combination with biological factors, will become available. Although considerations of material properties and design should be important to the clinician in chosing a particular device, the ultimate test for the success or failure of any device is clinical outcome. Nevertheless, the clinician should take into consideration that, clinical evaluation alone can, not provide information on the relevant underlying biological reaction. Observations from discriminating animal models clearly delineating the biological potential, coupled with ensuing properly designed and conducted clinical trials should form the basis for sound clinical decision making and choice of therapy or device.

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# An evidence based review on Pre-prosthetic Endodontic Therapy

Ajay Bharija *, K. Chandrasekharan Nair **


## ABSTRACT

*Purpose - Last two decades have witnessed a phenomenal increase in fixed prosthodontic therapy. This is accompanied by a significant increase in endodontic therapy. Pre-therapeutic intentional endodontics is also becoming widely popular. Justifiability of such a treatment method is not endorsed universally by practitioners.*

*Aim - Aim of this paper is to explore the evidence on the justifiability of intentional endodontic treatment on otherwise asymptomatic vital teeth before tooth preparation to receive a fixed prosthesis.*

*Methodology - Medline search was conducted using medical subject headings viz. endodontic treatment, fixed prosthesis, vitality of pulp, crowns and bridges. Based on the search relevant articles were retrieved and analyzed for evidence.*

*Conclusion : 1) Tooth preparation endangers pulp vitality if adequate care is not taken. 2) Vital teeth with crowns are subjected to endodontic treatment within five years. 3) 15% of the teeth served as abutments for fixed restorations showed pulpal necrosis.*

*Based on the conclusions drawn the authors do not find concrete proof to object to the practice of pre-prosthetic endodontics.*


## INTRODUCTION:

In the past two decades there is a phenomenal increase in fixed prosthodontic therapy. This has been accompanied by a significant increase in endodontic therapy related to the abutments. Pre-therapeutic intentional endodontics of the abutments is also becoming widely popular. Endodontic treatment of abutments is neither justified nor endorsed universally by the practitioners.

The process of tooth preparation and restoration is damaging to the pulp and the changes are either reversible or irreversible and which can manifest either immediately after tooth preparation or after considerable delay. Complications range from sensitivity to non-vitality of the pulp. Treating such complications after the completion of fixed prosthodontic treatment, on most occasions involve the hazardous task of forceful removal of the prosthesis which no doubt is an unpleasant task both for the patient and for the operator. Perhaps this scenario compels the practitioners of fixed prosthodontics to opt for intentional root canal treatment of the abutment teeth. This paper is an attempt to find evidence on the justifiability of such endodontic practice.

*Presented at 30th IPS Conference held at Patna November 2002.*

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## METHODOLOGY:

Medline search was conducted using medical subject headings viz. endodontic treatment, fixed prosthesis, vitality of pulp, crowns and bridges. Based on the search relevant articles were retrieved and analysed for evidence. The findings are described under different headings.

## PRESERVATION OF TOOTH STRUCTURE:

A fixed prosthesis while restoring the lost portions of the tooth, must preserve remaining tooth structure. The chances of creating pulpal injuries are more with complete crown preparation and great care is exercised to prevent it. The chemical action of certain dental materials viz.bases, restorative resins, solvents and luting agents can also cause pulpal damage, particularly when they are applied to freshly cut dentine. Pulpal damage under restorations has been attributed to bacteria that either were left behind or gained access to dentin because of microleakage. Many dentists now use an antimicrobial agent after tooth preparation, although the benefit has not been documented in clinical trials[1].

Frictional heat is produced whenever a revolving bur or stone contacts tooth surface. Greatest amount of frictional heat is generated during the use of large diamond points especially while preparing the teeth for a full crown. The heat generated during preparation has a desiccating effect by boiling away dentinal tubule fluid. Blushing of the dentin during crown preparation is presumably caused due to the vascular injury of the pulp[2]. Exposure of dentinal tubules increase dramatically with the removal of structural dentine. At the surface of the dentin or at the dentino-enamel junction dentin tubules range between 15000 to 20000 per square mm. At the pulpal surface the number of dentinal tubules increases three fold to 45000 to 60000 square mm and the diameter of the tubule also increases[3].

Structurally, the dentinal tubules are tapered in outline, measuring approximately 2.5 $\mu$m in diameter near the pulp, 1.2 $\mu$m in the midposition of the dentin and 900mm near the DEJ[4]. Therefore deep preparations expose a large number of wide dentinal tubules to trauma, dental materials, and bacterial products. Dentin permeability is greatest on thin axial surfaces, particularly mesial surfaces. These surfaces are often extensively reduced during the preparation of full veneer crowns and especially on mesially tipped abutments. Pulpal irritation becomes significant when the dentin thickness is reduced to 0.3mm[3].

**RECOMMENDED TOOTH REDUCTION[7]**

| Crown Type | Occlusal Reduction | Labial Reduction | Lingual Reduction | Axial Reduction |
|---|---|---|---|---|
| Full Metal Crown | 1-1.5mm | 1.2mm | 1mm | 6°Taper |
| Anterior Metal Ceramic Crown | 2mm | 1.2mm | 0.7mm | 6°Taper |
| Posterior Metal Ceramic Crown | 1.5-2mm | 1.2mm | 0.7mm | 6° Taper |
| All Ceramic Crown | 1.5-2mm | 2mm | 1.5mm | 1.2-1.4 mm |
| Partial Veneer | 1-1.5mm | – | 0.8-1mm | 6° Taper |

Bergenholtz and Nyman have reported that 15% of the teeth which were initially vital and which served as abutments of extensive fixed restorations for an average of 8.7 years showed pulpal necrosis[5]. A study by the same authors showed that 9% of the crowned teeth compared with 2% of uncrowned controls lost vitality during long term review. None of this was attributable to caries[6].

In another study of endodontic complications of restored teeth done by the same authors, it was evaluated that 0.3% of crowned teeth and 4.0% of abutment teeth became endodontically involved when no caries, fracture, or other causative factors were present. Among restored teeth that became endodontically involved for no known reason, 12% deteriorated in the first 3 years after the restorative treatment. The necrosis rate tripled by the seventh year and increased to 50% by the twelfth year[3].

Even higher levels of pulp death were recorded by Felton et.al where 13.3% of teeth restored with full coverage crowns, compared with 0.5% of unrestored controls lost vitality during the 3-30 year review period[6].

## CONCLUSION:

Full coverage restorations have reasonably good longevity ranging from 15 to 17 years if all other conditions are favourable[7]. However there is no evidence to prove that the crowns were sustaining without trouble. A trouble free healthy existence of a prosthesis will be the cherished dream of any patient. Hence dentists are tempted to do intentional root canal treatment. Long term effects of endodontically treated teeth are yet to be documented. Till further evidence is obtained, the justifiability of pre-prosthetic endodontic therapy cannot be questioned. However this does not give a licence to do endodontic treatment on all the teeth, which would receive a fixed prosthesis.

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# Implants and the Growing Patient

David Livingstone *, Y. M. Shastry **, Shyam Singh ***


## ABSTRACT

*Growth changes in the facial skeleton must be understood before placing an implant in actively growing patients. Rigid osseointegrated implants lack the compensatory growth mechanism of the natural dentition. Remodelling associated with skeletal growth in the region of the implant placement site could cause the implant to either become unsupported by bone or submerged within it. Cessetion of facial growth should occur prior to implant placement in adolescents. When placed in the growing patient, dental implants should be closely monitored and carefully restored with implant prostheses designed to accommodate growth and development.*


## INTRODUCTION

Implants are widely used in the adult population. Placement of implants in children and adolescents is much less frequent. Anodontia, either congenital or acquired, occasionally creates the opportunity for use of implants in younger patients. The use of implants in younger patients creates special problems because of the changes that occur during growth. Understanding the normal growth of the jaws therefore will help in placing implants in younger individuals.

## GROWTH OF THE MAXILLA:

Growth of the maxilla can be in the anteroposterior, transverse and vertical direction. Anteroposterior growth of the maxilla is due to passive displacement caused by downward and forward growth of the cranial base and by enlargement of the maxilla itself. As the maxilla grows forward and downward, the space formed at the sutures that connects the maxilla to the cranium is filled by proliferation of bone. The transverse skeletal growth of the maxilla is due to the increase in width of the cranial base. The midpalatal suture is an important growth site that must be allowed to grow. When the maxilla widens, the circumferential and inter dental gingival fibres prevent the central incisors from separating. Implants lack this compensatory mechanism and so can affect esthetics.

*Key Words : Dental implants, growth and development.*

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Vertical skeletal growth of maxilla occurs by sutural lowering by passive displacement and apposition of bone in the alveolous. The nasal floor is lowered by resorption of bone on the nasal side and apposition on the palatal and alveolar surface. Vertical dental growth in females aged 9-25 years were studied and it was found that the maxillary incisors erupted 6mm downward and 2.5mm forward. Changes of this magnitude cannot be compensated by static implants and this could lead to defective alignment and occlusion.

The maxillary arch circumference decreases during the growing period. The arch length decreases as the permanent first molar erupts, increases as the incisors erupts and it decreases as the primary molars are lost.

## GROWTH OF THE MANDIBLE:

The mandible grows longer by periosteal apposition of bone on the posterior aspect of the ramus. Bone is removed from the anterior surface of the ramus. Progressive posterior remodelling creates space for the second primary molar and then subsequently for the permanent molars. The chin prominance increases at adolescence due to resorption above the chin and a small amount of bone deposition at the chin. Exposure of an implant placed at this site can occur because of infradental resorption.

The mandible appears to grow downward and forward. The ramus grows higher by endochondral replacement at the condyle accompained by surface remodelling. The mandible also exhibits a rotational pattern as it grows. When the condyle grows vertically or vertical and forward, the vertical growth in the ramus exceeds that of the symphyseal area and the mandible "rolls" downward and forward. The effect of rotational growth is to upright the ramus, flatten the mandibular plane and decrease the gonial angle. The incisors are likely to erupt more facially than vetically in this type of growth.

In patients with steep mandibular plane and vertical growth the condyle grows upward and backward. Little or no rotational growth occur and the gonial angle remains obtuse. In these children, the mandibular incisor erupt vertically and retrocline leading to a reduction in arch length. The vertical dental growth is greater in males than in females. Dental height in males continue to increase beyond age 15, whereas in females little increase in height occurs after age 13 or 14. Width of the mandible

increases primarily in the posterior region because of its 'V' shape. The arch length decreases by 2mm as the permanent molars erupt and moves mesially.

## IMPLANTS IN MAXILLA:

During growth, teeth normally continue to erupt, and they simultaneously form alveolar bone with vertical growth. An osseointegrated implant behaves like an ankylosed tooth. Implants placed in the posterior maxilla in children may become buried to the point that the apical portion may become exposed at the nasal and antral floor remodel (Fig. 1, 2). Static osseointegrated implants cannot compensate for dental eruption or changes in angulation to maintain the occlusion. Hence they would ultimately be deficient in height and/or positioned at non-esthetic or nonfunctional inclinations (Fig. 3, 4). In the anterior maxilla, because of the resorption in the infradental fossa and nasal floor there can be loss of implants.

*Fig. 1*

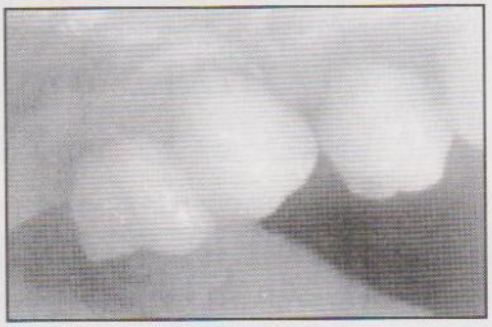

*Fig. 2*

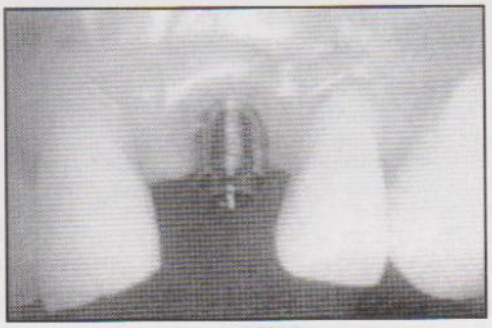

*Fig. 3*

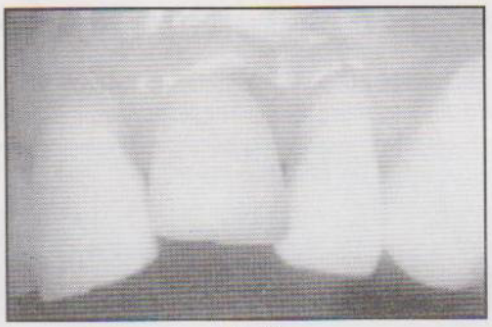

*Fig. 4*

## IMPLANTS IN MANDIBLE:

In children with strong rotational pattern, the posterior teeth continue to erupt throughout growth to maintain the occlusal plane. Implants, which are non-eruptive, will be deeply buried with the alveolar process. In contrast, children whose mandible does not exhibit a rotational pattern do not exhibit extreme submergence of implants.

Because the mandible has a V configuration, posterior teeth naturally erupt at ever increasing widths. Consequently there is no need to widen the arch as in maxilla. For this reason, an implant is not likely to be esthetically or functionally malpositioned because of transverse movement of adjacent teeth during growth. Successful implants in the mandible are also favored by the lack of a complicating suture. The symphyseal suture begins to close within months of birth. There is no danger of implant surgery traumatizing a growth site and there is little possibility that prosthesis placed across midline could limit transverse growth (Fig. 5).

Mandibular midline implant, therefore have a better prognosis in young patients than those placed in other areas of the mandible. Prosthesis design must allow for the average increase in dental height of 5-6mm and for the anteroposterior variation caused by different direction of mandibular growth.

Patients with ectodermal dysplasia have psychiatric, functional esthetic problems. In such cases endosseous implants can be used. The prosthesis is

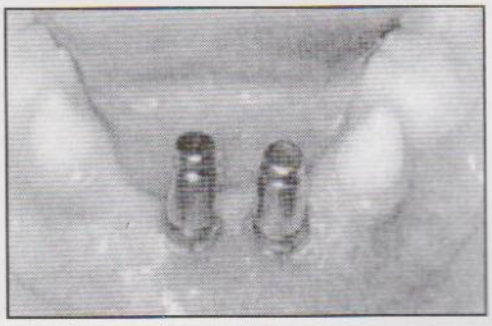

*Fig. 5*

designed as a detachable frame with denture teeth processed in light activated acrylic resin (Fig. 6, 7). This design facilitates periodic adjustments for further growth and development. These patients exhibit slow growth of the alveolar process and so have a low incidence of implant submersion.

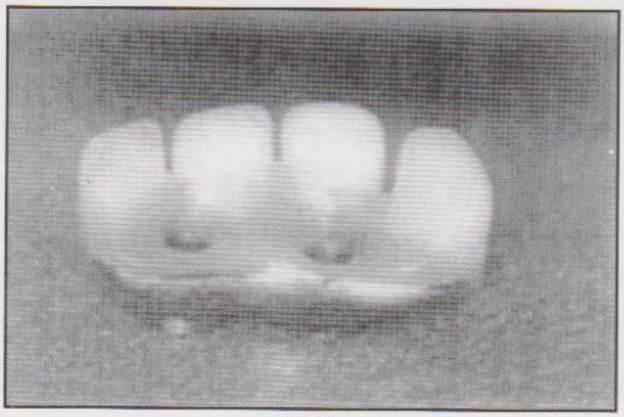

*Fig. 6*

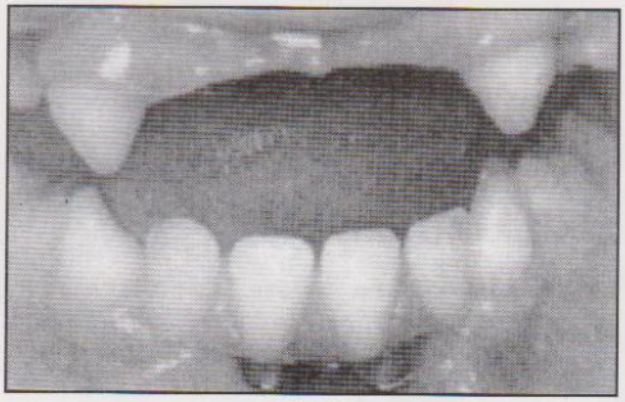

*Fig. 7*

## TIMING OF IMPLANT PLACEMENT:

Loss of alveolar bone following avulsion or extraction of a tooth is a common clinical occurrence that makes implant placement difficult. For this reason, implants are frequently placed immediately after or within a few months following tooth removal to reduce the amount of bone loss. Because of the changes that occur in both the dentition and growing jaws, extreme caution must be used in placing implants in children. Whenever possible implant placement should be delayed until age 15 for girls and age 18 for boys. Implants placed after these ages have the most predictable prognosis. If implants are deemed necessary in a child care must be taken during implant placement and subsequent prosthesis design. These patients must be monitored to assure that if the implant is adversely affected by growth it should be removed[1,2].

## CONCLUSION:

Remodeling associated with skeletal growth in the region of implant placement site could cause the implant to either become unsupported by bone or submerged within it. When placed in growing patient, dental implant should be closely monitored and carefully restored with implant prosthesis designed to accommodate growth and development.

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# Abstract


**EFFECT OF LIGHT SOURCE AND TIME ON THE POLYMERISATION OF RESIN CEMENT THROUGH CERAMIC VENEERS**

***Purpose :*** *Ceramic veneers provide conservative esthetic restoration for teeth but are at risk for ceramic fracture or debonding. This study evaluated the knoop hardness of resin cement polymerised through different ceramic veneer materials with the use of different polymerisation units.*

***Material & Methods :*** *Three different light sources (a conventional halogen light, a plasma arc light and a high intensity halogen light) were used to polymerise variolink II resin cement through veneer discs. Feldspative porcelain (Ceremo II), presavel ceramic (IPS Empress) and aluminous porcelain (vitadur alpha) discs of equal diameter and thickness were used as on interface between the polymerising light tips and the light - polymerised resin cement. Polymerising times of 5, 10, 15 and 20 seconds were used with the light intensity light units (Apollo 95E and krentiv 2000) while 20, 40, 60 and 80 seconds were used with the conventional halogrm halogen light (optilux). Knoop indenter hardeness testing was performed to establish the level of resin polymerisation through the ceramic materials. The data were analyzed with 1-way analysis of variance and a past - hoe scheffe test ($p<.05$).*

***Results :*** *The knoop hardness of variolink II luting agent varied with light source, veneer material and polymerisation time, Hardness increased with polymerisation time. The hardness of krentiv light-treated specimens was significantly different at all polymerisation times, with this hight, more than 20 seconds was required to establish maximum resin cement hardness. The hardness of Apollo hight treated specimen was significantly different at all polymerisation times except 15 and 20 seconds. No significant differences in hardness were found between specimens polymerised with the halogen hight for 60 or 80 seconds.*

***Conclusion :*** *The results of this study suggest that high-intensity polymerising light achieve clinically acceptable level of polymerisation in less time than conventional polymerising light, nevertheless, manufacturer - recommended polymerisation times may be insufficient.*

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# Prosthodontic Rehabilitation of A Facial Defect

Sushil Kar, mds*, T. Sreelal**


## ABSTRACT

*The Prosthodontist is often called upon to play a role in the rehabiliation of patients who have undergone radical maxillofacial surgery. Ideally the patients should be seen pre-operatively so that casts, measurements, and photographs can be made. Usually the patient is first seen by the prosthodontist after healing is partially or fully completed. There are no preoperative records available and old photographs should be used to help attain an aesthic results.*


## INTRODUCTION

The patient was first examined several months after the surgery had been performed. The defect was large and disfiguring. More than half of the nose including the medical septum, left eye, left maxilla and left sinus had been excised. The palatal tissue at the margin of the defect was inflamed and extremely sensitive (Fig 1,2,3).

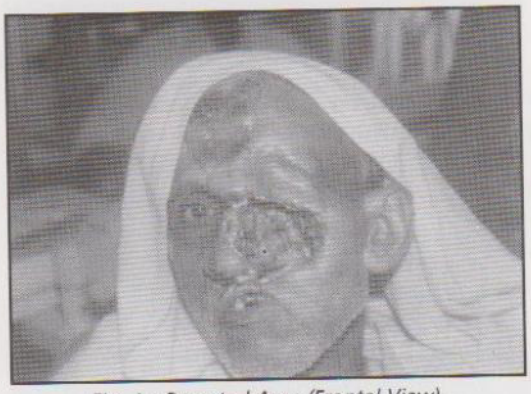

*Fig. 1 : Resected Area (Frontal View).*

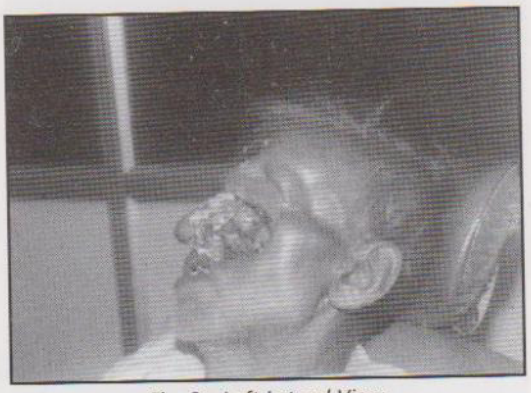

*Fig. 2 : Left Lateral View.*

* *Final Year,* ** *Head of Department,* Dept. of Prosthodontics, GDC, Trivandrum.

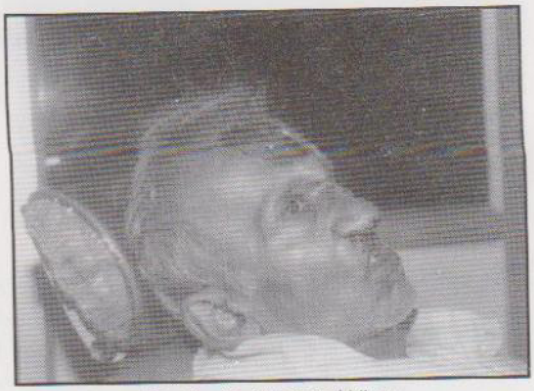

*Fig. 3 : Right Lateral View.*

The inadequate mouth opening of the patient to tolerate any pressure on the portion of the palate adjacent to the defect made the patient to fabricate a plate only retained by clasps and render the patient to use screw gag. The plate in addition seperated the oral cavity to that of nasal cavity. The plate to be wear by the patient until adequate mouth opening obtained with screw gag.

## PROCEDURE :

### PRELIMINARY IMPPRESSION OF THE FACIAL DEFECT :

- The material used for the primary impression was the putty impression material (addition silicon from Dentsply). Alginate was avoided because of the risk of tearing and being retained into the defect.
- The defect area was lined with cotton gauge after sterilized and applied with betadine.
- Putty material filled onto the defect and externally contoured simulating the other half (Figure 4, 5).

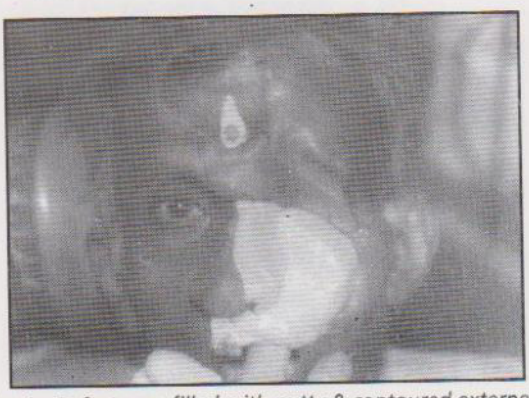

*Fig. 4 : Defect area filled with putty & contoured externelly.*

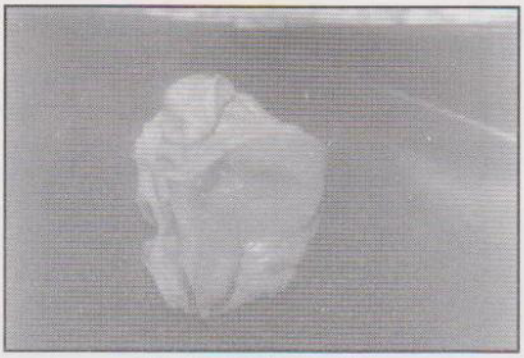

*Fig. 5 : Putty Impression.*

- Petroleum Jelly was applied on the face particularly at the hair line and eyebrow areas and thin mix of alginate was poured over the face protected at the periphery by boxing with Modelling wax should be shield properly at the edge to prevent the leakage and distortion of the impression.(Fig 6)
- The impression was supported by the plaster from above. the patient was asked to take breaththrough the mouth. Impression removed from the mouth after 15 min (Care has been taken as plaster was not set completely) and poured with stone (Fig 7).
- The tissue surface of the putty was poured separately with plaster for the fabrication of special tray for the final impression.

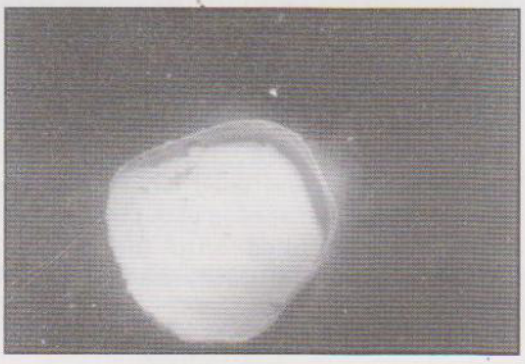

*Fig. 6 : Impression of the face (Aliginate Impression supported by plaster).*

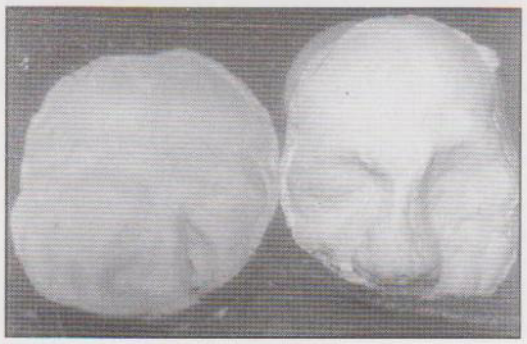

*Fig. 7 : Stone Replica.*

**FINAL IMPRESSION:**

- The special tray was trimmed carefully at the periphery and seated into the defect to check the fit (Fig 8).
- Thin rolled of putty was then made and applied at the border of the tray and molded carefully. Again a sheet of putty was mixed and applied on the relieved surface of the tray. Light body addition silicon then mixed thoroughly and applied over the putty and final impression of the defect area including the border was taken (Fig 9,10).
- The impression poured with stone for the fabricationof heart cure bulb which will be open externally. Undercuts was blocked out nicely with modeling wax.( Fig 11,12)

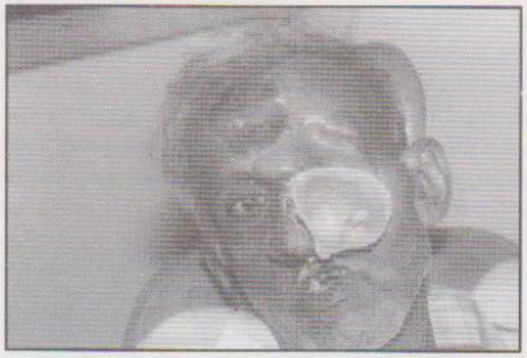

*Fig. 8 : Special tray checked for accuracy.*

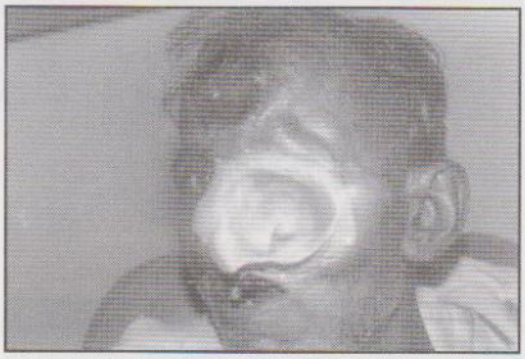

*Fig. 9 : Final Impression (Putty-Wash) being taken.*

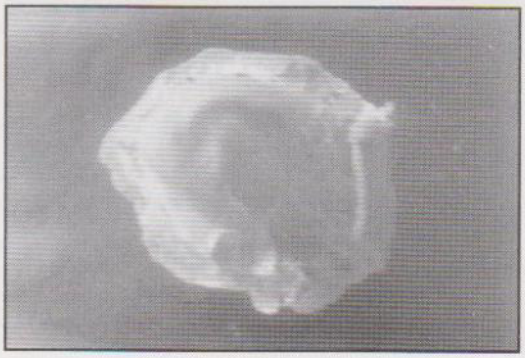

*Fig. 10 : Final Impression.*