History of Prosthodontics

DR. R.D. DAS*, DR. S.J. NAGDA**

"The only guide to what lies ahead is in the past"

History is defined as a study of past events. It is indeed very important to be aware of the historical antecedents especially in the contemporary times, when changes are occurring so rapidly. Only by keeping an eye steadily on what went before can we progress with intelligence and confidence.

With this intention, we bring this series of articles on history of prosthodontics.

Records of the replacement of lost teeth by artificial means date back into ancient times. Earliest efforts probably applied only to a few teeth, served principally to repair damaged appearance and to restore the facility of normal speech. With the passage of time, eventually the scope and function of dental prosthetic appliances gradually increased. Impelled most likely by the same ambition which prompt modern invention and research, prosthodontics together with all other branches of dentistry slowly grew to it's present stage of development.

We invite our readers to contribute and share articles of interest that they might have come across. We will begin by writing the articles erawise and elaborate on specific topics from time to time.

THE ANCIENT ERA (THE B.C. ERA)

From the earliest times humans have been suffering from dental problems and have found variety of means to treat them. The first person to attend to the dental problems was the physician but by the Middle Ages the barber surgeons of Europe had specialized in care of the teeth. These fellow surgeons learned dental treatment by trial and error method and also by observation. They made more progress in their new fledged field than the doctors in the long established field of medicine.

*Lecturer, **Professor & Head, Dept. of Prosthodontics
Nair Hospital Dental College, Mumbai

Among earliest recorded examples of dental prosthesis are the gold structures of Phoenicians, Etruscans, and a little later the Greeks and Romans.

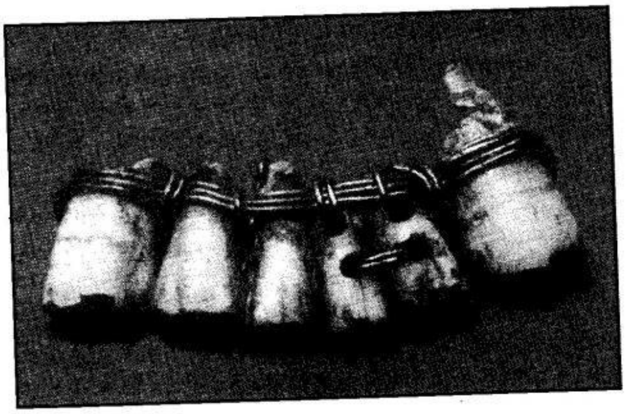

Fig. 1

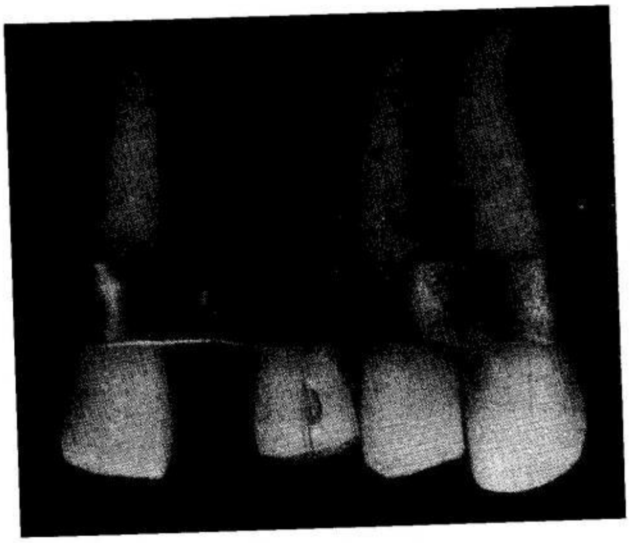

Fig. 2

Dating back to 1600 B.C. - 687 B.C., the *Phoenicians* reported prosthetic appliances binding lost and artificial teeth by gold and silver wires, bands and rivets using human and oxen teeth. Similar prosthesis was also reported by *Etruscans* during 753 B.C. - 300 B.C.. They also reported of gold crowns. During 600 B.C., there were earliest reports of cast gold inlays in *Peru*. From 450 B.C. - 218 B.C., *Roman* history reports practice of dentistry prior to medicine. There was use of removable appliances and extensive restorations. It shows laws governing the disposition of dental gold of the dead.

Greeks during 377 B.C. - 162 B.C. made prosthesis, but *Hippocrates* did not mention in his literature about it. Dating 320 B.C., *Hebrews* practiced use of gold and silver teeth. *Ancient Japanese* also show practice of dental prosthesis. *Chinese history* reports teeth of bone and ivory sawed and filed to proper form and fastened to natural teeth by copper wires and catgut ligatures. *Siam history* reports kings having complete mandibular teeth carved from coconut shells.

During the end of ancient era, the beginning had been made and mankind was conscious of the desirability of replacement of lost tooth tissues, only his tool and supplies were simple. The person who practiced dentistry depended on nature to provide the materials and artisans to fashion the restoration.

Abstract

BIS - GMA based resins in dentistry : Are They Safe ?

The authors critically surveyed research dealing with the release of resin components from dental composites and the potential of these agents to mimic or disrupt estrogenic cell responses.

Bisphenol A is present as an impurity in some resins (BIS - GMA) and as a degradation product from other resins (BIS - DMA); so its estrogenic effect was targeted. The outcomes of this review revealed that short-term administration of BIS - GMA and/or bisphenol A in animals or cell cultures can induce changes in estrogen - sensitive organs or cells. However, considering the dosages and routes of administration in the modest response of estrogen sensitive target organs, the authors conclude that the short term risk of estrogenic effects from treatments using these resins is insignificant. Long Terms effects need to be investigated further.

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Evaluation and Comparison of The Flexural Strength of Two Different Fiber Reinforced Composites at Varying Length and Thickness

- An Invitro Study

DR. ANIL R. SHET*, DR. SABITA RAM**

ABSTRACT

STATEMENT OF PROBLEM

Ceromers have good esthetic properties and improved strength without any metallic substructure and so it may be the material of choice in fixed prosthodontics. When the length span of a bridge increases, increasing the length of Fibres with increased thickness enables the material to bear the load to which a long span restoration would be subjected. If so, how effective are these materials as far as the flexural strength is concerned ?

PURPOSE OF THE STUDY

Evaluation and comparison of the flexural strength of two different Fiber Reinforced Composites has been done with increased length and thickness of the material so as to predict the use of the material in long span bridges.

MATERIALS AND METHODS

A total of thirty two samples; sixteen each of Vectris and Fiberkor were made. Out of these sixteen of each group; eight samples were made of 2.5 mm thickness and a length of 12 mm, 16 mm, 20 mm and 24 mm (two of each) and other eight samples were made at the same lengths but at a thickness of 3 mm. These thirty two samples were tested for flexural strength by a 3 point bending test on a Hounsfield Tensometer.

RESULTS

The mean flexural strength of the Vectris at 12 mm and a thickness of 2.5 mm was 275 MPa and the thickness of 3 mm was 300 MPa and that of fiberkor was 235 MPa and 283 MPa at the respective thickness of 2.5 and 3 mm. Also the mean flexural strength of Vectris and Fibrekor at a thickness of 3 mm and 24 mm length was 600 and 590 MPa respectively.

CONCLUSION

Simultaneous increase in the length of Fiber Reinforced Composite and the increase in thickness showed better load bearing capacity and increased flexural strength which was equivalent to the maximum load which mandibular molars could bear.

CLINICAL SIGNIFICANCE

Fiber Reinforced Composites can be used in long span bridges provided the thickness of the substructure is increased by incorporation of more amount of fibers.

Replacement of teeth with fixed restoration is an important stage in the rehabilitation of a patient. The conventionally used materials are the base metal alloys; veneered with ceramics or resins, to improve esthetics. The substructure in the metal have drawbacks of impaired esthetics and at times sensitivity to the material[1]. The ceramic causes more abrasion of opposing teeth and the chipped ceramic from the substructure is difficult to repair. The resins are not brittle but have a high degree of wear and water sorption and do not have a bond to the metal, which results in early discoloration and detachment.

To improve the physical properties of resins and to overcome the disadvantage of ceramics, a new ceromer material was developed in the year 1971[2]. These ceromers were not available for fixed prosthodontics restorations till recently[3]. They have a veneering system which is ceramic optimised polymer and a coring system which is a fiber reinforced composite.

*Lecturer,
**Associate Professor & Post Graduate Teacher
Dept. of Prosthodontics, Government Dental College and Hospital, Mumbai-1.

The modified polymers have increased strength and are light in weight[2,3,4,5]. The wear resistance is less than that of ceramics but more than the resins and so are not detrimental to the opposing teeth[1,6]. They have more resiliency as compared to ceramics, so are better suited for restoration on implants[7,8]. The increased resiliency decreases the load transferred to the substructure of the implant and in turn to the bone which helps in preservation of bone.

The ceromers are available in two systems :

- TARGIS/VECTRIS system[9,10]. (IVOCLAR VIVADENT) where Targis is the veneering material and Vectris is the core material.

- SCULPTURE/FIBREKOR system[11,12]. (Jeneric Pentorn Inc.) wherein sculpture is the veneering system and, the Fibrekor is the core material. These fiber-reinforced composites coupled with an overlay of wear-resistant, stain resistant ceramic-optimised polymer provided patient with a restoration with uncompromised esthetics, comfort and durability[12].

The potential time, cost and complexity involved in the fabrication of polymer based restorations are less than those associated with ceramometal restorations[12]. These materials have been advocated for single crowns or short span bridges as recommended by the manufacturer[10,12,14]. As they have good esthetic properties and no metallic substructure[13], their use for long span bridges must be given due consideration.

REVIEW OF FIBER REINFORCED COMPOSITES

C.K. Schreiber[2], *Johan Friskopp*[23], *Yazdanie et al*[5], *H.D. Stipho*[24], *Richard Mullarky*[16], *Ruyter et a*[18] used carbon fibers to increase the strength of acrylic appliances.

James S. Schakeford[3] classified composite materials into three types :

a) Human-made fiber-reinforced composite

b) Natural fiber-reinforced composite

c) Aggregate Composite

G. Malquarti et al[14], *Martin Rosentritt et al*[25], *Martin A. Freilech*[1] gave the use of these fibers for fixed prosthodontics.

Robert L Nixon[15] advocated overall reduction of 1.5 mm with a shoulder finishing line and a proximal box of 2.0 mm x 2.0 mm x 2.0 mm for molars and 1.5 mm x 1.5 mm x 1.5 mm for premolars. Also rounded internal line and point angles that reduced stress localization and walls that tapered 10° to 15° were indicated.

M.A. Freilech and A.L. Karmekar[20,21] *and Ajay Juneja*[6] studied flexure strength of Fiber Reinforced Composites by 3 point bend test on a Tensometer.

MATERIALS AND METHODS

The materials used in this study were grouped as follows :

1. Materials for master die.
2. Materials used for fabricating Vectris substructure.
3. Materials used for fabricating Fibrekor substructure.
4. Materials used for measurement of flexural strength of the samples.

1. Materials for master die

→ Extracted premolar and molar were prepared to receive full coverage according to the preparation recommended by Rober Nixon[15].

→ Putty/light body impression material was used to make impression of the prepared premolar and molar.

→ Nickel-chromium alloy was casted to prepare metal dies from the above obtained impressions by the lost wax technique.

2. Materials used for fabricating Vectris substructure (Fig. 1)

Vectris is a fiber-reinforced material, which was used to fabricate metal-free translucent framework for the samples.

- Inlay wax : which was adapted in the shape of a single beam to simulate the substructure.
- Putty silicone : was used to fabricate a silicone key all around the dies and centrebeam to facilitate the adaptation of the Vectris and prevent it from getting stuck below the finishing line in the undercut of the die[10].

The type of Vectris selected in this study was Vectris Pontic, as this type of Vectris which has long unidirectional fibers has more strength than the woven form which is used in the Vectris framework[1,5,16,17].

- Vectris glue with Applicator : This material prevented the Vectris components from slipping during the framework forming procedure. The desired amount of material is dispensed with the applicator.
- VSI former (Fig. 2, Fig. 3) : The dies were then placed in a Vectris VSI former which operates accordingly to a highly technical vacuum pressure principle and features integrated light curing. It requires to be cured for 10 minutes.

3. **Materials used for fabricating Fibrekor substructure : (Fig. 4)**

Fibrekor consists of a series of parallel S-glass fibers[12] ('S' - High strength) each ranging in thickness from 6 mm to 10 mm.

They are incorporated with dimethacrylate based resin i.e. polycarbonate dimethacrylate (PCDMA) with a fiber content of about 60% by weight[12]. Fibrekor is available in strip forms. The dimensions of the strips are either 3 mm or 6 mm in width and 0.2 mm in thickness.

Fibrekor light curing unit i.e. Cure-Lite Plus (Jeneric / Pentron Inc. Wallingford, C.T. U.S.A.) is used. Samples are light cured for five minutes. For heat curing of samples under vacuum, Conquest Curing Unit (Jeneric/Pentron Inc. Wallingford, C.T. U.S.A. They are heat cured for 20 minutes at 230°F. (Fig. 5)

4. **Instruments used for measurement of flexural strength of the strips**

Tensometer (Hounsfield No. 4427)[6,18,19,20,21]. was used to test a 3 point bending test which consists of two metallic plates, the dies were mounted on one plate and a pointed steel beam was mounted on the other plate and a load measuring from 90N[22] onwards quantity was applied to test the flexural strength.

METHODS

1. Fabrication of Dies

A premolar and a molar prepared to receive full coverage according to the preparation recommended by *Rober Nixon*[15] wherein shoulder/deep chamfer finish line (1.2 - 1.5 mm) was recommended and proximal step (1.5 - 2 mm axial depth) at the coronal half to two/thirds of the axial wall that faced the edentulous area and a shallow (1.5 mm) isthmus on the occlusal surface was recommended. This provides vertical support for the fiber reinforced composite.

Impressions of these two prepared teeth were made by putty/light impression technique and following the lost wax technique metal castings were prepare from Nickel-Chromium alloys. These dies were then finished and polished. These dies were screwed into a rectangular slot on the circular metal plate. The slot on the circular metal plate enabled us to adjust the distance between the two dies to varying lengths required for the study.

2. Fabrication of Samples

A total number of thirty two samples were prepared and measured by digital vernier calliper.

3. Measurement of Flexural Strength

Samples of the Vectris and Fibrekor were tested for the flexural strength. The testing was done on a tensometer (Hounsfield No. 4427) using a three point bending test[2,6,19].

Each sample was placed on the dies and was placed onto the fixture of the tensometer and the load was applied. The flexural strength was calculated by the following formula : $S = \frac{3PL}{2BD^2}$

where P = the maximum load applied in N
L = the length of the samples in mm
B = the width of the samples in mm
D = the thickness of the samples in mm
S = the flexure strength of the samples in MPa

RESULTS

Mean flexural strength of samples per group are listed in table 1.

Also statistical analysis by ANOVA showed that there was an increase in the strength due to increase in length as well as the thickness of the Vectris and Fibrekor samples.

Also the graph shows the comparison of mean flexural strength of Vectris and Fiberkor at various lengths.

DISCUSSION

Fiber-reinforced technology had been used earlier in various industries e.g. aeronautical and shipbuilding industries[3]. They were commonly used due to increased strength and their light weight.

Fig. 1 : Photograph showing the materials used for fabricating Vectris substructure

Fig. 3 : Photograph showing the Metal Dies mounted on a circular plate

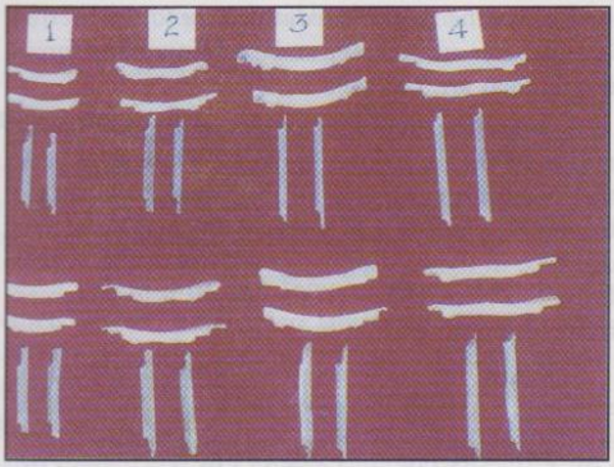


Fig. 4 : Photograph showing the trimmed samples

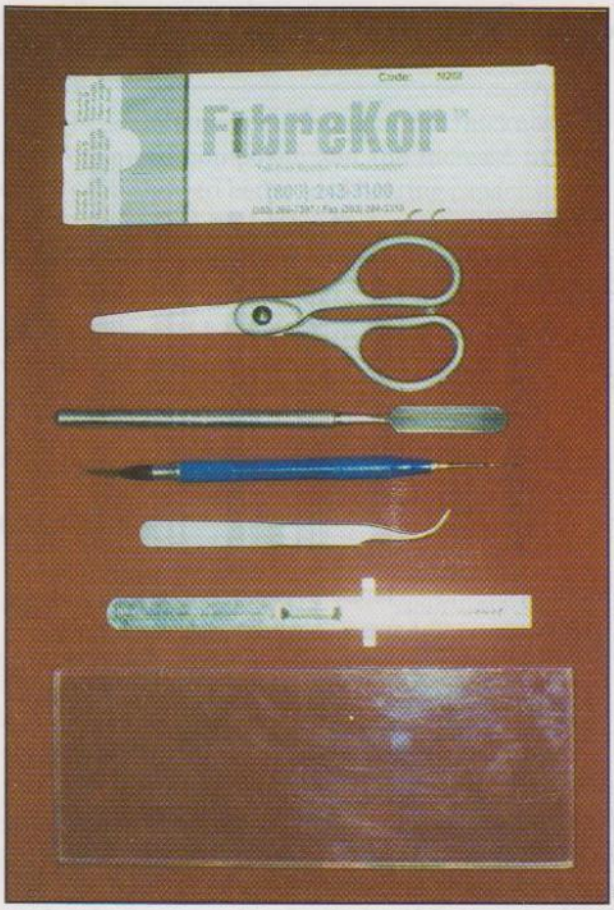


Fig. 2 : Photograph showing the materials used for fabricating Fibrekor substructure

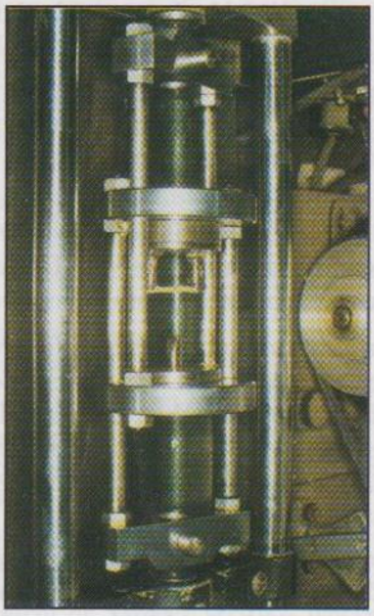
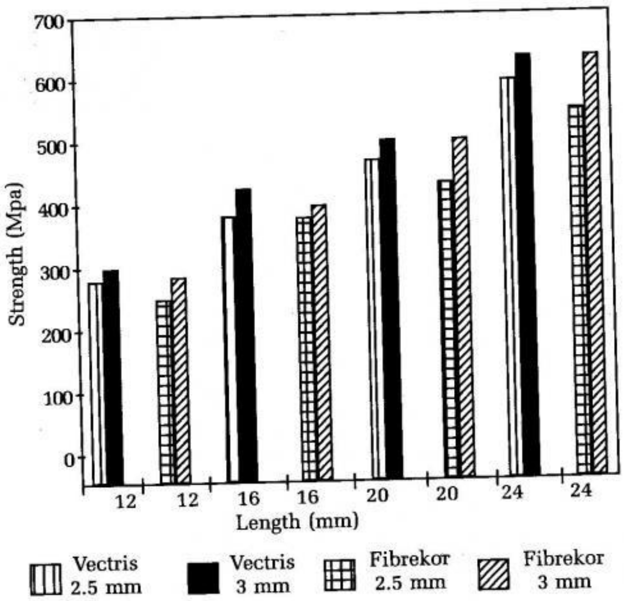


Fig. 5 : Photograph showing the die on the tensometer

Graph 1 : Flexure Strength of the samples in MPa



The principle of fiber reinforcement of composites involved the incorporation of thin filaments of a material foreign to the base resin, which imparted increased flexural strength, fracture resistance, and increased tensile strength to the finished product[24]. This technology was utilized in dental prosthesis.

These ceromers are available in two systems : 1. Targis / Vectris[9,10] 2. Sculpture / Fibrekor[11,12].

In the Sculpture/Fibrekor system, the Fibrekor component replaces the metallic substrate normally used in the porcelain fused to metal system and sculpture is the veneering material on the porcelain substrate.

Similarly in the Targis/Vectris system, Vectris is a fiber-reinforced material used to fabricate metal free translucent frameworks for crowns and bridges.

When a substructure is made by fiber reinforced composite, the composite bar experienced more interlaminar shear stress than pure tensile stresses or compressive stresses. The latter are very common in a flexural loading in the oral environment during mastication of food[21].

Therefore the property of flexural strength was considered in this study. When the thickness of the material increased, the load bearing capacity of the fiber reinforced composite increased. Therefore a study was carried out to evaluate and compare the flexural strength of two fiber reinforced composites at increased length and increased thickness and evaluate if increasing the length and along with it increasing the thickness was adequate for using the material for long span bridges.

Maximum flexural loads and strengths of the specimens prepared from fiber reinforced composites are listed in the table. (Table 1)

As expected, maximum flexural loads of all the fiber reinforced composites increased with the increase in thickness of the sample. It was found that the load bearing capacity of the fibers increased as the thickness of the Vectris sample was increased by 0.5 mm in the Vectris. Similar results were found in Fibrekor.

TABLE 1

Mean flexure strength of the samples per group

	Vectris		Fibrekor	
Length	**Thickness**		**Thickness**	
	2.5 mm	3 mm	2.5 mm	3 mm
12 mm	275	300	235	283
16 mm	345.6	383	345.6	360
20 mm	420	479.16	384	474.16
24 mm	547.2	600	489.2	590

The width of all the samples was 3 mm

Also the flexural strength increased from 235 MPa to 283 MPa for Fibrekor and from 275 MPa to 300 MPa for Vectris. According to *Philips*[22] the strength of the molar i.e. compressive forces exerted in molar area are 305 MPa and the compressive forces in premolar are 248 MPa.

As the length of the samples increased from 12 mm to 24 mm at a dimension of 2.5 mm thickness, the load bearing capacity of the Fibrekor decreased from 200 N to 157.5 N respectively. Also there was decrease in the load bearing capacity of the Vectris from 250 N to 195 N as the length was increased from 12 mm to 24 mm respectively.

But as the length increased from 12 mm to 16 mm and also with increased thickness; the flexural strength of the Fibrekor and Vectris increased to 360 MPa from 283 MPa and 383.33 MPa from 300 MPa respectively.

The significant increase of the flexural strength was seen in 24 mm length and 3 mm thickness when the maximum load applied was 297.5 N for Fibrekor and 300 for Vectris. The flexural strength of Fibrekor was 590 MPa and that of Vectris was 600 MPa.

Also the fibers used in the Fibrekor as well as Vectris were 'S' glass fibers. These 'S' glass fibers are high strength fibers which impart greater strength to the substructure[1,17,19].

Also the fibers in Fibrekor/Vectris are long, continuous, unidirectional and densely packed[1,17,25]. These types of geometric configuration imparted greater strength to the substructure compared to the other short, woven fibers.

The degree of flexion was more in Fibrekor as compared to the Vectris.

As the flexural strength increased by increasing the length as well as the thickness; this materials could be advocated in long span bridges by incorporating more amount of fibers i.e. increase the thickness of the substructure.

CONCLUSION

a) The flexural strength of the Fibrekor as well as Vectris system decreased with the increase in length of the edentulous span.
b) With simultaneous increase in the length of fiber reinforced composite and the increase in the thickness showed better load bearing capacity and increased flexural strength.
c) This load bearing capacity of the fiber reinforced composite was equivalent to the maximum occlusal load which a mandibular molar could bear.

SUMMARY

In this study, evaluation and comparison of flexural strength of two fiber reinforced composites at increased length and increased thickness was done.

Total of thirty two samples were made out of which sixteen samples were fabricated in Vectris and sixteen in Fibrekor. Out of each sixteen, eight samples were fabricated at a thickness of 2.5 mm and lengths of 12 mm, 16 mm, 20 mm and 24 mm (two of each) and other eight samples were fabricated at a thickness of 3 mm at the above same lengths.

All these samples were tested for flexural strength on a Hounsfield Tensometer by a 3-point bending test[2,6,19].

The simultaneous increase in the thickness of fiber reinforced composite and the increase in the length span showed better load bearing capacity and increased flexural strength which was equivalent to the load which mandibular molars could bear.

Considering these results, the fiber reinforced composites could be used in long span bridges provided its thickness is increased. Further clinical studies will be required to prove the utility of this material for metal free restorations in Fixed Prosthodontics.

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Abstract

Design optimization & Evolution of Bonded Ceramics for The Anterior Dentition : A Finite Element Analysis

Finite element method was used to explore the stress distribution of incisors restored with porcelain vencers. The design of the palatal finish line was analysed as a function of incisal overlap & initial tooth substance loss (coronal fractures).

The treatment of intact & fractured incisors was investigated using different designs of porcelain veneer. The palatal finish line varied from butt margins to extended chamfers. The stress distribution was assessed in a 2 dimensional finite element model, reproducing a buccolingual cross section of an incisor. A palatal 50 N horizontal force was applied to incisal edge to simulate extreme functional load. The palatal surface tangential stresses were calculated. Because of the geometry & natural elastic modulus of mineralized tooth structures, a concentration of tensile stresses is formed at the palatal concavity of teeth restored with porecelain veneers. Long chamfers extending into the palatal concavity are unfavourable because thin extension of ceramic are generated. Minichamfers or butt margins are generally recommended, especially in the presence of moderate crown fractures or severe wear.

Pascal Maye, Dr. Med Dent / William Douglas BDS, MS, PhD.

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The Morphology of Tragus
Part 1 : The Confusion About Tragus Terminology

PROF. DR. E.G.R. SOLOMON, MDS (BOM) DR. MED. DENT (GERMANY) FICD*

ABSTRACT

Tragus of the ear is associated in Prosthodontic practice as a landmark to establish occlusal plane and to locate the arbitrary hinge axis point. Innumerable references show how the tragus is related to the formation of ala-tragus and tragus-canthus lines. Nevertheless, it is controversial as to which part of the tragus should be taken as a reference for these two lines. The anatomical configuration of the tragus of the ear is variable. Further the several tragal references recommended in the literature are not always definable nor recognisable. Therefore its dependability as a posterior reference for ala-tragal line and tragus-canthus line is subjective and questionable.

INTRODUCTION

Certain facial landmarks such as the ala of the nose, tragus of the ear, pupil of the eye, angle of the mouth, vermillion border of the lips, outer canthus of the eye, philtrum of the lip and the chin have a close relationship to the various clinical procedures in prosthodontics. The human ear, besides its esthetic, auditory and protective function is also useful structure to locate certain reference planes.

Tragus** of the ear has been recognised as a reference landmark for the ala-tragus line popularly known as Camper's line[7], which is considered as a guide to form occlusal plane while establishing jaw relation. Based on the premise of parallelism between ala-tragus line and occlusal plane, the Fox plane has been developed to orient occlusal plane in maxillary occlusal rim parallel to ala-tragus line. Without tragal reference the development of occlusal plane in complete denture would be rather difficult. The tragus is associated with another horizontal plane, the tragus orbital plane which helps to orient the head horizontally in an upright position. Tragus is also a useful landmark to define tragus-canthus line. The arbitrary hinge axis point which is synonymous to arbitrary center of condylar rotation is situated anteriorly on this eye-ear line.

The tragal references recommended for the formation of the ala-tragus and tragus-canthus lines are conflicting and controversial[32] (Fig. 1). Further, the ambiguity of the tragal nomenclature makes it difficult to select which part of the tragus should be considered to define these lines.

Tragal references recommended to locate arbitrary hinge axis point

Tragus of the ear is an useful guide to locate the arbitrary hinge axis point for the placement of the condylar extension of the facial type of arbitrary face bow (Fig. 1). Some[1,31,36] believe the arbitrary center of condylar rotation is situated 10-13 mm anterior to the posterior margin of tragus on a line joining the superior border of the tragus to the outer canthus of eye, while others[5,12,16,17,31,35] believe that it is present anteriorly to the same distance from the middle of the tragus to the outer canthus of the eye. In Glossary of Prosthodontic Terms[10] there is no mention of the tragus-canthus line. The other tragal terminologies mentioned in the literature as reference for eye-ear plane are the front of the ear[23,27], base of the tragus[31], middle of the superior edge of tragus[30],

*A.B. Shetty Memorial Institute of Dental Sciences, Managalore

*** The term tragus is derived from the Greek root, "Tragos", meaning "Goat" in illusion to hair growing on a goatee and is defined as a cartilaginous tongue like projection in front of the external auditory meatus of the ear[33]. It is a small curved flap below the crus of the helix and in front of the concha of ear which projects posteriorly partly overlapping the meatal orifice[25].*

Presented at the 11th Meeting of International Academy of Gnathology-Asia Section, Yokohama, Japan 1997.

superior tragus notch[2], posterior margin[20], apex[19], top[12,22,37], foot, upper third[15,27] upper border[18], upper part of tragus[34], upper free margin[8], inferior border[37], upper margin of external auditory meatus[21], and the center of external auditory meatus[23,30] (Table 1). There are also a few who do not specify the exact location on the tragus but mention in a vague manner that the hinge axis point is situated anteriorly on a line joining the tragus to the outer canthus of the eye.

TABLE 1

Tragal references used to establish tragus-canthus line (eye-ear plane) to locate arbitrary hinge axis

Author	Tragal reference
Hickey, et al	Top of tragus
Sheldon Winkler	Top of tragus
Merill G. Swenson	Top of tragus
Heartwell and Rahn	Middle of tragus
Neill and Nairn	Most posterior point on the curve tragus
Roy MacGregor	Apex of tragus
Shallhorn, Beyron, Beck	Posterior margin of tragus
Teteruck and Lundeen	Foot or base, inferior border of tragus
Kratochvil	Centre of tragus
Osbrone and Lammie	Point of tragus
John Lazzari	Upper border, top
Craddock and Symmons	Upper free margin
Beyron	Centre of tragus
Gysi	Centre of tragus
P.M. Walker	Posterior and Superior
Weinberg	Middle and Posterior border
Lauritzen and Bodner	Middle of tragus
Joseph Grasso, Boucher	Upper third
Hobo	Upper third
Schlosser	Upper border of ear
Monson	Middle of tragus
Ramfiord, Ash & Beyron	Posterior border of middle tragus
Bergstron	Middle of tragus
Beck	Centre of tragus
Bosman	Upper border of ear
Solnit A and Curnutee D C	Superior tragus notch

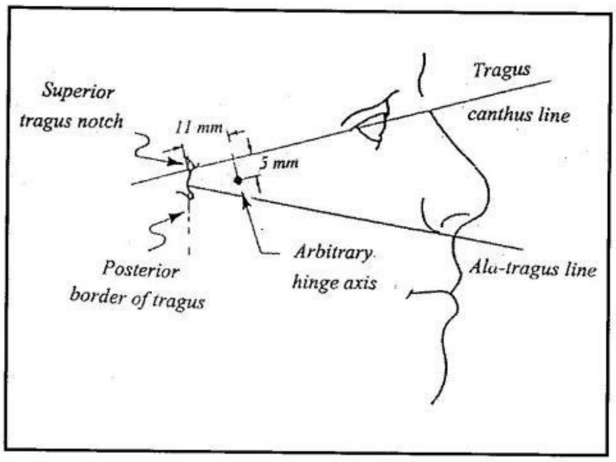

***Fig.1** : Tragus-canthus and Ala-tragus lines*

Considering this enormous nomenclature, the location of arbitrary center of condyle based on such reference landmarks becomes questionable. A consideration of anterior or the posterior margin, foot of the tragus superior border, superior notch of the tragus or middle of the superior border of the tragus or just in front or middle of the tragus as a reference for establishing tragus-canthus line appears confusing. The choice of the tragal location for the tragus canthus plane in therefore a matter of either convention or convenience that is not supported by scientific evidence.

The same uncertainly also prevails in defining ala-tragus line.

A few of the standard procedures recommended to locate arbitrary hinge axis point are as follows :

1. *11-5 Arbitrary Hinge Axis location* : This is established by scribing a horizontal line on the side of the face that extends from the superior notch of the tragus of the ear to the outer canthus of eye. The square end of an inch scale is placed in line with the posterior border of the tragus and a point is marked 11 mm anteriorly on tragus. From this point, a downward measurement of 5 mm is made at right angle to tragus-canthus line to locate the arbitrary hinge axis point (Fig. 1).
2. *Beyron's point* : It is located 13 mm anterior to the posterior margin of the tragus on a line from the center of tragus to the outer canthus of eye.

3. *Bergstrom's point :* It is marked 11 mm anterior to the posterior margin of the tragus on a line parallel to and 7 mm below the Frankfort horizontal plane.

4. *Gysi's point :* It is located 10 mm anterior to the posterior of the tragus on a line from the center of the tragus to the outer canthus of eye.

5. *Lundeen's point :* It is located 13 mm anterior to the tragus on a line from the base of tragus to the outer canthus of eye.

6. *Simpson's point :* It is situated 11 mm anterior to the superior border of the tragus on Camper's line.

7. *Weinberg's point :* It is situated 11-13 mm anterior on a reference line drawn from the middle and the posterior border of tragus

Tragal references recommended for ala-tragus line

Peter Camper (1722-1789) the Dutch anatomist from Amsterdam described a horizontal line from porus acousticus to spina nasalis which formed an angle with a vertical line drawn from the stirn (prominence of forehead) to Spina nasalis anterior known as the Camper's angle[6] (Fig. 2). It was 80° to 90° in Europeans, 70° in Negros and 60° in Apes. This horizontal line drawn from the center/middle of the external auditory meatus of the ear to the lower part of the nose was later popularly known as Camper's line. Camper failed to relate Camper's line to occlusal plane. Clapp[7] in 1910 was the first to relate Camper's line/plane to occlusal plane. Since then various tragal reference have been suggested to denote which part of the tragus should be taken to develop the ala-tragus line. Three tragal references are commonly recommended to obtain the ala-tragus line. These are the superior border[10,12,37], middle or tip[10,14,38] and the inferior margin or border of the tragus[11,24]. The Glossary of Prosthodontic Terms and some of the standard textbooks have recommended superior border as tragal reference for A-T line. (Fig. 1)

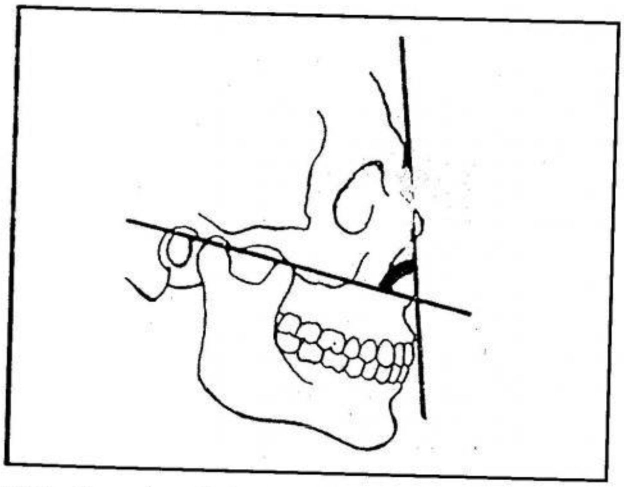

Fig.2 *: Camper's angle described by Peter Camper*

The landmarks generally associated with the superior border are top, upper border, middle of superior tragus notch, upper part, upper free margin and upper third. Heartwell and Winkler recommend superior border while Hickey and Zarb in their text book do not specify which part of the tragus should be considered but just mention it as "tragus". It is not known whether these observations are personal preferences or those based on investigations. The several other tragal references reported by various authors is shown in Table II.

DISCUSSION

The Glossary of Prosthodontic Terms-7 contends that ala-tragal line and Camper's line are synonymous. It is also the general belief of Prosthodontists that these two mean one and the same. Likewise the ala-tragus plane and Camper's plane. However the definitions of ala-tragus line and Camper's line described in the glossary contradict each other. GPT-7 defines ala-tragus line as "a line running from the inferior border of the ala of the nose to some defined point on the tragus of the ear usually considered to be the tip of the tragus". This means that there are other defined points on the tragus which have to be considered besides the tip. In the same glossary Camper's plane is defined as a plane established by the inferior border of ala of the nose and the superior border of the tragus of the ear. It is not understood as to how the glossary recommends the superior border of the tragus as a reference for Camper's plane. This certainly raises a doubt whether the superior border or the tip of the tragus should be selected as the post tragal reference in defining this reference line/plane.

TABLE II

Tragal references recommended to establish ala-tragal line (Camper's plane) to orient occlusal plane

Authors	Tragal Reference	Anterior Reference
Clapp (1910)	Lower margin of external auditory meatus	Lower margin of ala of the nose
Dalby (1914)	Lowest point of external auditory meatus	Lowest point of ala
Wilson (1917)	Inferior border of external auditory meatus	Ala of nose
Clapp and Trench (1926)	Superior border of external auditory meatus	Ala of nose
Prothero (1928)	Tragus	Ala of nose
Landa (1947)	Middle point of tragus	Ala of nose
Hartono (1967)	Inferior margin of tragus lower margin	Lowest points of ala of nose
Nikzad Javid (1974) (Survey of 33 Dental Schools in USA & Canada)	Middle of tragus	Under ala of nose
Niekerk, Miller and Bibby (1985)	Inferior border of tragus	Ala of nose
Winkler, Heartwell	Superior border	Inferior border of ala
Xier, Zhao (1993)	Mid point of tragus	Ala of nose
McGregor (1994)	External auditory meatus of ear	Inferior border of ala of nose
Glossary of Prosthodontic terms GPT-7 (1999)	Tip of tragus (Ala-Tragus line)	Inferior border of ala
GPT - 7 (1999)	Superior border of tragus Camper's line	Inferior border of ala
Sharry (1981)	Tragus	Ala of nose
Boucher CO (1953)	Superior border	Inferior border of ala of nose
Sprately	Center of Tragus	Center of ala of nose
Hickey, Zarb, Bolender	No mention of the exact part of tragus	Ala of nose
Neill and Narin	Center of Tragus	Ala of nose

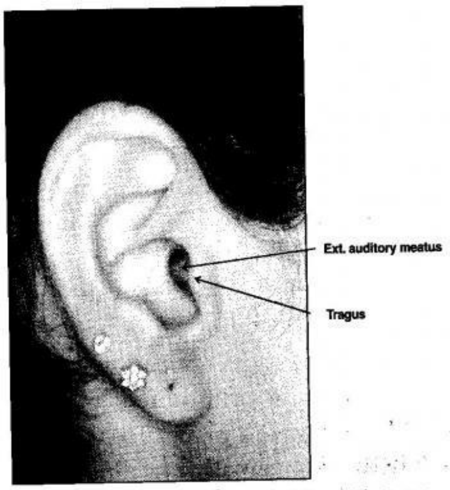

***Fig. 3** : Morphology of external ear (lateral view) Tragus covers the ext. auditory meatus*

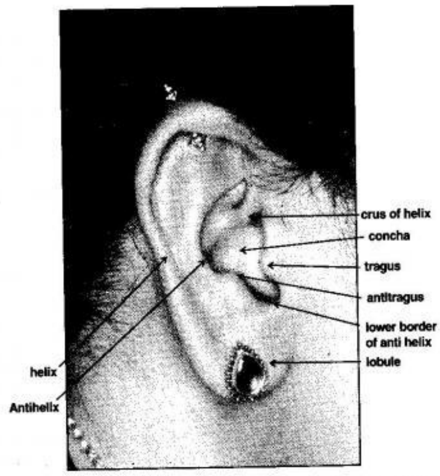

***Fig. 4** : Ext. auditory meatus is visible only in a posterior lateral view of the ear. It is not an ideal landmark like tragus.*

Role of External Auditory Meatus

"Tragus" and "external auditory meatus" are used interchangeably without discretion by some authors. External auditory meatus is an opening which is not a precisely definable or recordable point like other soft tissue landmarks. The opening of the external auditory meatus is visualised only from a posterior position and not from the side of the face. Tragus covers external auditory meatus when viewed laterally (Fig. 3-4). This makes its location from the side of the face impossible and therefore its reference for linear measurement is not ideal. Further, landmarks such as the lower margin, lowest point, inferior border, superior border of external auditory meatus are difficult to define.

Abstract

Dentin Bonding - state of the Art 1999

The adhesion of restorative materials to the hard components of tooth structure has been a goal pursued by many researchers ever since Buonocore established the foundation for adhesive and preventive dentistry. Based on the industrial use of phosphoric acid to obtain better adhesion of paint and resin coatings to metal surface, Buonocore proposed that phosphoric acid could be used to transform the surface of enamel to "render it more receptive to adhesion". Subsequent research indicated that the formation of taglike resin prolongations into the enamel microporosities was the leading bonding mechanism of resin to phosphoric acid etched enamel. The enamel bonding agents of the 1960s and 1970s progressively evolved into complex multibottle or universal adhesive in the early 1990s, which were designed to bond to enamel, dentin, composite, amalgam, porcelain, & non precious Metal, Although bonding to enamel has been a dependable technique, bonding to dentin still represents an overwhelming task because dentin is naturally a wet organic tissue penetrated by a tubular mass containing the odontoblastic process, which communicates with the pulp. This intrinsic moisture may actually benefit the chemistry of the newest adhesive system which must be applied on moist dentin to be effective. Infact, the collapse of the collagen that occurs on airdrying may prevent the adhesive monomers from penetrating the network of nano-channels formed by the dissolution of hydroxyapatite. Crystals between collagen fibrils. In view of the complexity of the mechanisms, objective of this review article is to summarize the most recent concept in dentin bonding.

Jorge Perdigao, Manuela lopes.
Compendium, Dec., 1999; Vol. 20, No. 12 : Pg. 1151-1162.

Part 2 : Reliability of Tragus Morphology and its Reference to Establish Camper's Plane

PROF. DR. E.G.R. SOLOMON, MDS (BOM) DR. MED. DENT (GERMANY) FICD*,
PROF. N. SRIDHAR SHETTY, MDS (BOM) FICD**, DR. VIBHA MARLA, BDS***

ABSTRACT

An investigation was done to study the anatomical features, variations and the location of various landmarks of tragus to ala-tragal line in view of its importance as a useful reference in establishing Camper's plane. 2048 tragi forms were studied in subjects of 18-25 age group comprising of both sexes. Besides the shape of the tragus, the preciseness of the superior border, middle and inferior border of the tragus was studied, as these landmarks have been recommended as references to form the ala-tragus line/ plane. It was found that the tragus had several morphological variations and it was classified as typical pointed, rounded, notched and rudimentary tragus. The middle of the tragus was definable only in typical pointed tragus. The preciseness of superior border and inferior border was not always definable. Therefore its validity as a reference is questionable. Camper's plane was found to be parallel to the occlusal plane when the tragal reference point was situated between the superior border and the middle of the tragus and not from the usual hitherto recommended reference points.

INTRODUCTION

The tragal terminologies mentioned in Table II - Part I is an evidence to the uncertainty prevailing in the selection of the tragal references to orient the Camper's plane. This is because of lacunae in the morphological description of tragus. In the Glossary of Prosthodontic Terms of tragus. In the Glossary of Prosthodontic Terms there is no definition of this important structure. No other reference is available to describe the morphology of tragus. Several indiscrete landmarks on the tragus have therefore been suggested as a reference to define Camper's plane.

**Post-graduate Professer in Prosthodontics*,
A.B. Shetty Memorial Institute of Dental Sciences, Managalore
** *Dean*, A.B. Shetty Memorial Institute of Dental Sciences, Managalore
*** *Post-graduate student*

An investigation was hence conducted to study tragus morphology, the incidence of various tragus forms and the definability of the tragal landmarks suggested by various authors. Further the reliability of advocating these tragal references to establish an alatragus line which is parallel to occlusal plane was determined. This was obtained by an examination of 2048 tragi in 1024 subjects between 18-25 years in both sexes.

METHOD

The outline form of tragus was traced with an indelible marker on a transparent polyster film mounted in a plastic frame that was positioned over the ear (Fig. 1). The tracing was done superiorly from the crus of the helix of the ear to the lower border of the antihelix inferiorly to identify the tragus outline with its upper and lower borders. These tracings and the photographs of the ear constituted the data to record the morphology of tragus and to classify tragus forms.

The other objective of the study was to determine the validity of using the commonly recommended superior border, middle and inferior border of the tragus as a reference for Camper's line. For this purpose seven different landmarks (Table - IV) on the tragus were compared to ascertain which of these would produce an ala-tragal line which is parallel to occlusal plane. Two metallic plates, a J plate which could be placed between the tragus and the inferior border of the ala of the nose and an occlusal plane indicator (Fox plate) were designed to relate ala-tragal plane and occlusal plane and to observe parallelism between them. The Fox plate was placed stationary at the occlusal level to indicate occlusal plane while the J plate was then aligned between the selected seven landmarks and ala of the nose to ascertain the tragal level at which parallelism was seen to occlusal plane (Fig. 2).