*Post*poning tooth loss - an emerging trend

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The basic aim of dentistry today is to preserve & protect oral structures. State of the art techniques, instruments & materials have now made it possible to save teeth that seemingly have no hope of survival. One of the best examples that elicits an excellent response from patients is the preservation of their anterior teeth.

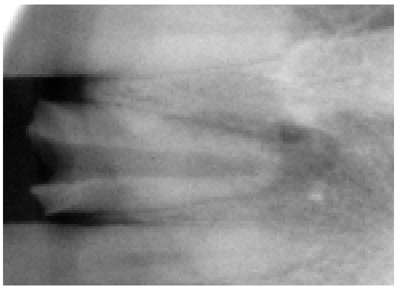
Anterior teeth are quite susceptible to trauma as they are relatively unprotected when compared to the posteriors. Most broken anteriors may be kept in place following successful endodontic treatment, but the challenge lies in successful reconstruction. In such instances posts have become an asset to the phase of rehabilitation.

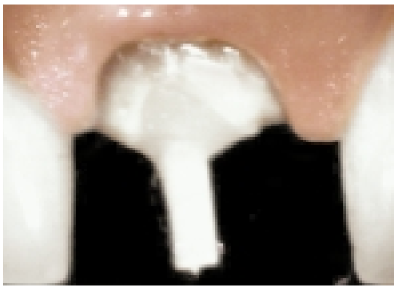
Posts are indicated in two situations, one where the post is used to reinforce existing coronal tooth structure & the second where in the absence of sufficient coronal tooth structure the post & a core around it replace the missing tooth structure. Posts are available in various forms. They may be tapered (smooth or threaded) or parallel (smooth or threaded). Smooth posts are also referred to as passive posts because their retention is solely based on intimate contact & the cementing medium used. Threaded posts actively engage into the dentine by way of their threads. Current concepts concentrate on minimizing the amount of stress generated by the post on the remaining tooth & on restoration designs that impart overall strength to the restoration. Parallel posts generate less stress than tapered ones & a smooth surface is sometimes preferred to the threaded. The design of the restoration & the way the post is placed should allow dissipation of stresses rather than concentration at any point to prevent the possibility of fracture. Non-metallic posts have gained popularity in recent years for two reasons. Glass fiber posts blend in well if the restoration is either composite alone or if an all-ceramic crown is to be placed subsequently. Carbon fiber posts are stronger and are chosen if the restoration is to be a metal ceramic restoration.

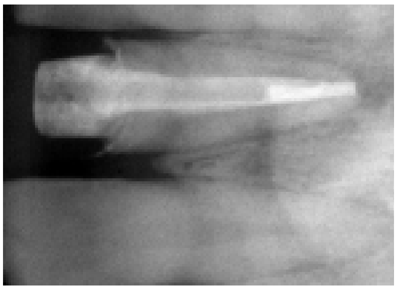
Described below is a clinical technique for restoring an incisor using Glassix posts (Harald Nordin SA, Switzerland).

1. Of prime importance is the first step of diagnosis & treatment planning. One must check for vitality of the tooth & periapical health. In the absence of secondary vertical fractures a decision for endodontic treatment is made in the absence of vitality or occasionally if the existing coronal portion of tooth is insufficient for restoration as in extremely worn out anteriors.
2. Any system of root canal treatment may be followed. Of the presently available engine driven instruments Light speed (Lightspeed technology Inc., Texas, U.S.A) lends itself well for the purpose of post techniques because the NiTi instruments have perfectly matched obturation tips

   (Simplifill) that allow a 5 mm long apical gutta percha «plug» to be placed as an apical obturation. In the Simplifill technique an Apical GP Plug that corresponds to the Master Apical Rotary Lightspeed instrument used for biomechanical preparation is chosen. Sealer is applied to the plug & it is inserted with firm apical pressure after which a counterclockwise twist disengages the stainless steel shaft of the carrier. On removal of the flexible stainless steel carrier shaft the remaining space is ready for post placement. In most other techniques obturation is carried out after which the required amount of gutta percha is either removed with a heated plugger or peeso reamers. Glassix posts come in 3 sizes (the most commonly required diameters of 1.2, 1.35 & 1.5 mm). Reamers are supplied by the manufacturer to aid in preparing the internal canal walls to receive the post.
3. Currently recommended sealers are either silicone or epoxy based. If eugenol based sealers are used care must be taken to clean up the canal to prevent the possibility of eugenol interfering with the setting of resin based luting agents.
4. The internal canal walls are prepared using the supplied reamer & the glass fiber post is trial fitted with gentle apical force after thorough irrigation to remove debris. Glassix posts are slightly longer than required to ensure ease of handling & to ensure that the post reinforces the core material right up to the coronal tip. Gross excess in lenght may be adjusted with a diamond disc after verification of post length space with a file in canal.
5. A resin based luting agent is preferred. An example is 3M s Relyx ARC. Etchant gel is applied to the insides of the canal with an interdental brusch (Oral B interdental set, U.S.A). After 15 seconds rinse & dry with paper points. 3M single bond adhesive is applied & excess removed with a paper point. After drying for 5 seconds, light cure for 10 seconds. The cement is now dispensed onto a pad & transferred to the canal with a periodontal probe or a lentulospiral. A little cement is applied to the surface of the post & the post is seated.







Excess cement that extrudes coronally is removed & then the cement is light cured for 40 seconds from an occlusal direction. Glass fiber posts transmit a certain amount of light apically but areas not exposed to light will set via the self-curing reaction of the cement.

6. If the amount of tooth damage is minimal, for example the access opening plus a proximal lesion, composite build up to full tooth shape will sometimes suffice with the post reinforcing the coronal portion of the tooth. In most other instances a crown is preferred for protection. Prior to build up all unsupported enamel is removed & the outer edge or periphery of the remaining coronal portion of the tooth is sloped outwards. This feature called a contra bevel is placed with a flame shaped diamond for the purpose of providing a strengthening metal collar in the crown that is to be fabricated.
7. The tooth is now ready to receive the core buld up with composite. There are two ways of building up the core. One is to use the composite in increments to build up the tooth to its entire form & shape after which tooth reduction is carried out. The second is to directly build up the shape to that of a prepared tooth. The second approach minimizes time spent & wastage of material but requires patient planning & experience.
8. After the core has been built up judicious reduction is carried out such keeping in mind that preservation of remaining tooth structure greatly increases the treatment success. It is of paramount importance to ensure that the final finish margin of the tooth is carried apical to the core - tooth junction so that the metal of the crown encircles sound tooth thus providing strength to the final restoration. Invariably this will mean carrying the margin subgingivally. This also helps improve the final esthetic result but the patient must be instructed of the importance of maintenance of periodontal health.
9. The impression is made with non-aqueous elastomeric impression material. The putty - light body technique is either carried out in two steps by a single operator or both steps are carried out simultaneously by the doctor & assistant working in tandem. In the two-stage technique it is always advisable to make the putty impression prior to gingival retraction. Gingival retraction is then performed. Create escape grooves & necessary relief with a Bard parker blade in the putty. Light body material is mixed & loaded into the tray & also into a syringe. The material is injected around the preparation from the base upwards after removing the retraction cord & the tray is seated over the teeth with gentle pressure to prevent a rebound of the putty during the setting process. Excess pressure causes the putty to be compressed. When the putty relaxes after the setting of the light body the resultant cast will have smaller teeth and the crown fabricated will therefore have a tighter fit than required.
10. The steps required in the fabrication of the crown may now be carried out as with any other tooth. A temporary crown is fabricated using a polycarbonate crown. The polycarbonate crown is filled with self-curing tooth colored acrylic & the fit is adjusted on a cast of the prepared tooth obtained from an alginate impression. The finished temporary is cemented with an eugenol free temporary cement (e.g.: Freegenol Temporary Pack - eugenol free temporary cement, GC Corporation, Tokyo, Japan). Eugenol is said to cause a softening of the acrylic of the temporary crown.

Conclusion: With the advent of newer materials & improvements of age old techniques precision & quality are easier to achieve clinically. This essentially means that procedures earlier throught of as complex can now be performed with relative ease with predictable results improving the chances of saving many teeth from the ultimate fate of extraction.

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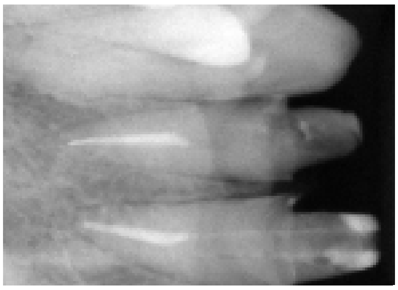

Extract from

Flexural properties of fiber reinforced root canal posts

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Introduction:

Crown restoration of an endodontically treated tooth often requires additional support from the root canal by means of a root canal preparation and the fabrication of a post and core restoration. Recent reports suggest that the rigidity of the post should be equal or close to that of the root of the tooth to distribute the occlusal forces evenly along the length of the root.

Prefabricated and cast metal posts are traditionally used. They are, as well as the novel all-ceramic posts, rigid in nature. The rigidity may pose a risk for root fracture. Recently, fiber reinforced composite (FRC) root canal posts have been introduced as an alternative to more conventional materials. The biomechanical properties of FRC posts have been reported to be close to those of dentin. Teeth restored with e.g. carbon/graphite fiber posts are found to resist fracture propagation better than teeth restored with prefabricated titanium posts or cast metal posts. Ongoing clinical trials are also suggesting good results. No post-associated failures during 3 year of follow-up were reported in a study where 236 endodontically treated teeth were restored using carbon/graphite fiber posts. The failure rate using prefabricated metal posts was reported to be 8%.

FRC posts contain a high volume percentage of continuous reinforcing fibers embedded in a polymer matrix, which keeps the fibers together. Matrix polymers are commonly epoxy polymers with high degree of conversion and a highly cross-linked structure. The first FRC-posts were made of carbon/graphite fibers due to their good mechanical properties. However, they are black in colour and thus lack cosmetic qualities. Instead posts made of glass or silica fibers are white or translucent and can be used in situations of higher cosmetic demand.

Many studies concerning the mechanical properties of FRC root canal posts have been done. Although the flexural strength of FRC posts have been shown to be relatively high, large variations in the reported flexural modulus of carbon/graphite fiber posts can be found. The flexural properties are found to decrease after moisture adsorption.

Glass fibers have a lower elastic modulus than carbon/graphite fibers. Glass fiber posts can be made of different types of glasses. Electrical glass (E-glass) is the most commonly used glass type in which the amorphous phase is a mixture of SiO_2, CaO_2, B_2O_3, Al_2O_3 and some other oxides of alkali metals. S-glass (high-strength glass) is also amorphous but differs in composition. Additionally, glass fiber posts can also be made of quartz-fibers. Quartz is pure silica in crystallized form. It is an inert material with a low coefficient of thermal expansion (CTE).

The stability of fiber/polymer matrix interface and the effect of possible mismatch of CTEs between fibers and matrix polymers must e considered when the clinical longevity of FRC posts is evaluated. To our knowledge, there remains a lack of studies concerning the stability of FRC posts after thermal cycling. The aim of this study was to investigate the flexural properties and fracture load values of different types of FRC posts and compare those values with a novel high strength FRC material for dental applications. Furthermore, the influence of thermal cycling in water on the flexural properties was determined.

Materials and methods:

Seventeen different FRC posts of various brands and diameters, and continuous unidirectional glass fiber composite shaped into the form of a post, were tested. Five posts of each type were tested as dry (stored in room humidity) and five were tested after thermocycling in water (12.000 x, 5°C/55°C, dwelling time of 30 s). Subsequent to thermocycling the posts were stored in water for 2 weeks before mechanical testing.

The three-point bending test according to the ISO 10477 standard (span 10.0mm, crosshead speed 1.0mm/min, cross-sectional diameter of loading tip 2 mm) was used to measure the flexural strength and modulus of FRC post specimens. All posts were tested with a material testing machine (model LRX, Lloyd Instruments, Fareham, England).

Fracture load of post was measured. Flexural strength (δf) and flexural modulus (Ef) were calculated from the formula:

$$\delta f = 8F \max l/\pi d^3$$

$$Ef = S4l^3 / (3\pi d4)$$

Where Fmax is the applied load (N) at the highest point of load-deflection curve, l is the span length (10.0mm), d is the diameter of the specimens. S=F/D, the stiffness (N/m) and D is the deflection corresponding to load F at a point in the straight line portion of the trace. In order to eliminate the influence of the conical end of some of the posts, a short span length was used to get support for the post within the cylindrical part of the post. The parallel-sided cylindrical part of the post was considered to be the specimen. The specimens were polymerized in a light curing oven (LicuLite, Dentsply De Trey GmbH, Dreieich, Germany) for 40 min.

In addition 2 posts of each group were embedded in PMMA and wet-ground with 40 (FEPA). After that, specimens were sputtered (SCD 050, BAL-TEC AG, Balzers, Liechtenstein) with gold and transverse sections of posts were visually examined with a SEM (JSM-5500, JEOL Ltd, Tokyo, Japan) to determine the differences in posts.

Flexural properties were analysed with three way ANOVA (SPSS, SPSS Inc., Ill, USA) to evaluate the effect of thermocycling, brand of material and diameter of specimen. To determine statistically significant differences the tukey post hoc test was used.

Results:

The flexural strength, flexural modulus and maximum fracture load of tested specimens are presented in Figs 1-2. The analysis of AOVA revealed that thermocycling, brand of material and diameter of specimen had a significant effect ($P \leq 0.001$) on the fracture load and flexural strength. In general, thermocycling decreased the flexural modulus of the tested specimens by approximately 10% (Fig. 2). Strength and fracture load decreased by approximately 18% as a result of thermocycling. The average reduction percentage in fracture load after thermocycling of the tested post specimen is presented in Fig. 4. visual analysis of SEM-micrographs revealed that a certain amount of porosity in competitor A was easily recognized whereas Glassix® had a tight solid matrix without porosity.

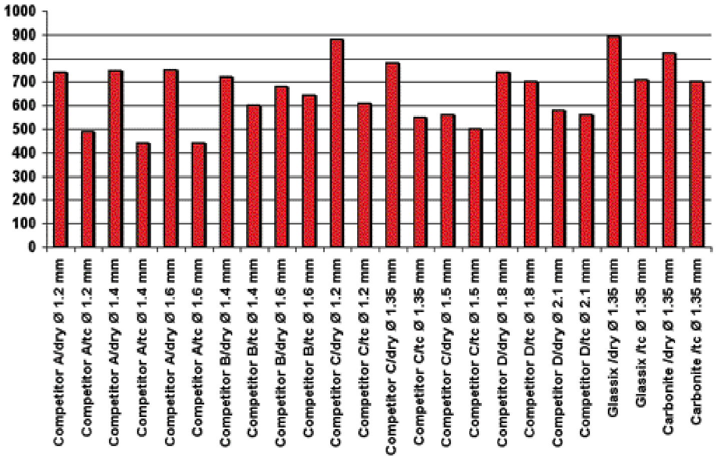

Fig. 1: Flexural strength of FRC posts (Mpa)

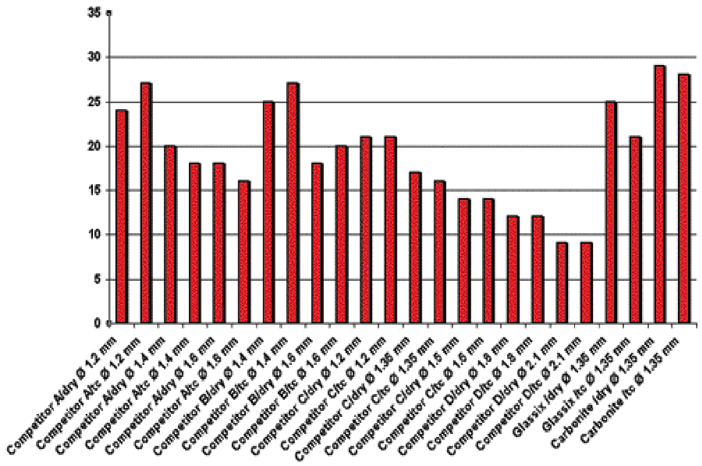

Fig. 2: Flexural modulus of FRC posts (Gpa)

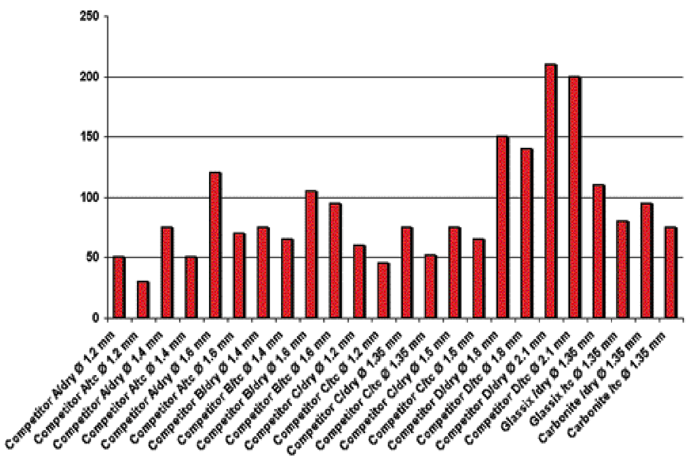

Fig. 3: Maximum fracture load of FRC posts (N)

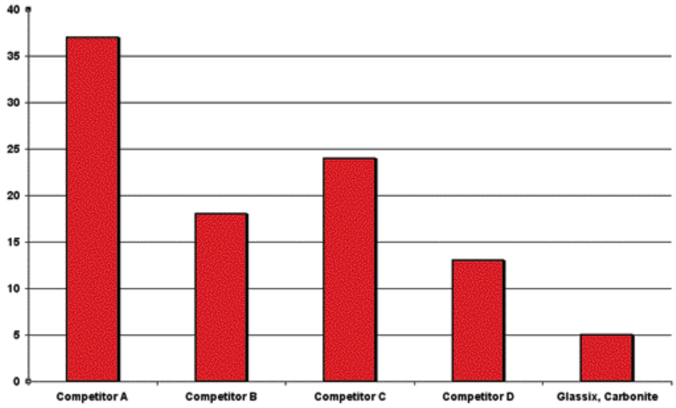

Fig. 4: Reduction of fracture load of dry and thermocycled specimens

Discussion:

Many studies concerning the mechanical properties of FRC posts have recently been published. Lack of standardization of the testing conditions and methods has resulted in large variations in the mechanical properties reported. In the present study, thick posts showed lower flexural strength values (MPa) than thin posts although the fracture load values (N) behaved oppositely. The results show that when a three-point bending test is used to measure flexural properties of FRC-posts, the results are related to the ratio of span length and diameter of the test set-up.

As seen in this study all FRC post specimens showed a linearly increasing resistance against loading force along with an increase in diameter. Both carbon/graphite and glass fibre reinforced posts behaved similarly. However, if interfacial bonding between fiber an matrix is not adequate, no better mechanical properties are acquired.

Differences in the mechanical stability after thermocycling were found between the post specimens tested. Competitor A specimens showed approximately 40% in flexural strength after thermocycling, whereas flexural strength of the other post brands tested and the Glasix®, Carbonite® posts decreased by approximately 5% as a result of thermocycling. On the other hand, a study by Torbjörner et al. reported a 65% decrease in the mechanical properties of the Competitor D carbon /graphite fiber posts after thermocycling. However they compared posts with different diameters with each other and the results are thus affected by the influence of the L/D ratio.

When specimens are exposed to thermocycling the differences between coefficients of thermal expansion (CTE) of the individual material may affect the long term stability of the FRC-post-tooth combination. Large variations in CTE exist between reinforcing fibers and the matrix polymer used in FRC posts (polymer matrix: 40-80x10-6/°C, E-glass: 8x10-6/°C, quartz: 0.2x10-6/°C, carbon/-graphite-fiber: 0.4x10-6/°C). I should be emphasized that the thermomechanical behaviour of anisotropic/orthopaedic/isotropic dental FRCs is not fully understood at the moment. The reduction in flexural properties of Competitor A specimens after thermocycling could be related to the discrepancy in the CTE between the materials of Competitor A composite. The difference in CTE between silicazirconium fibers and the polymer matrix is bigger than that of E-glass, S-glass and carbon/graphite fibers and matrix polymer. Also the porosity, which is seen in the SEM-micrographs of Competitor A might be one explanation for the reduction of mechanical properties after thermocycling.

The present study has to be considered as a short-term water exposure study. Our results are in accordance with several other studies showing that a decrease in mechanical properties is taking place during 30 days of water storage and is caused by plasticization of the polymer by water. In long-term water exposures, hydrolyzation of the silane coupling agent which is used to promote adhesion between the fibers and the polymer matrix, might play a major role.

Interestingly, it was found that the Glassix® glass fibre composite post and the Carbonite® carbon fibre composite post have the lowest reduction of fracture load of dry and thermocycled specimens. This unexpected finding could be explained by the optimization of the polymer matrix and fiber properties to function as a composite material.

Clinically, it is well established that the longevity of root-post-core-crown systems used to restore an endodontically treated tooth is affected by many factors e.g. the design, length and thickness of the post, the ferrule effect, cementation and the quantity of remaining tooth substance. Many in vitro studies have shown that FRC posts due to their modulus of elasticity being closer to that of dentin. This phenomenon of modulus compensation of stress induced root fractures could have an impact on the post-core-crown restorations in the future.

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Replacement of an old bridge and reinforcement of cores using Lamel® composite resin cement and Glassix®, glass fibre reinforced composite post.

By Dr. Björn Oscarsson. Information provided by Nordin S.A.

The patient, a middle-aged woman presents an old bridge (gold and ceramic) on 23,24,25,26. The bridge is anchored on 23 and 25. It is dislodged and discoloured. The old bridge is sectioned and removed. Cores on 23 and 25 are exposed and are endodontically treated but have no post reinforcement. 25 is badly discoloured (black) probably by a previous amalgam restoration. (Fig. 1)

1. Both canals in 23 and 25 are opened using a standard Gates reamer N° 3. (Fig. 2)

2. The root canals are adapted using a **Glassix**® reamer calibrated to fit the shape, size and diameter of the selected **Glassix**® glass fibre post. (Fig. 3)

3. The root canal is cleaned and can be etched with a 37% phosphoric acid gel (this is optional as the cement (Lamel® composite resin cement) to be used has good retention to canal wall by itself).

4. Selected **Glassix**® glass fibre posts are tried in root canal to check that fit is correct. (Fig. 4)

5. It is decided to shorten **Glassix**® posts only after cementation as the longer posts are easier to insert into root canal.

6. **Lamel**® composite resin cement is inserted directly into canal using its disposable auto mix tip (**Lamel**® requires no mixing on slab nor does it require any bonding or any other accessories as it has a perfect bond by itself). (Fig. 5)

7. Some **Lamel**® is also applied to post which is then inserted.

8. **Glassix**® posts are inserted in root canal with **Lamel**® resin cement let to set (setting time 3-5 minutes). (Fig. 6)

9. When **Lamel**® is fully set the posts are shortened to desired length with a diamond bur.

10. If posts are already in the desired length core build up material can be applied without waiting for **Lamel**® to be fully set (the two composite materials will bond together).

11. Excess **Lamel**® cement is removed and some etchant (37% phosphoric acid in gel) is applied to dentine next to post to allow core build up to bond to the tooth.

12. Core build up composite is placed in a core form which is placed over 23 and core build up material is light activated. (Fig. 7)

13. Core 25 has sufficient tooth substance and some **Lamel**® left and therefore requires no special core build up material.

14. When cores are set the core form is removed and adjusting preparations are made on cores with a diamond burr.

15. Cores are now ready for impression and a new bridge in porcelain fused to gold will be made and fitted. (Fig. 8)


Fig. 1. Old bridge 23,24,25,26 is removed


Fig. 2. Standard Gates reamer N° 3 is used to open up canal.


Fig. 3. Calibrated Glassix® reamer is used to adapt shape and size of canal to selected Glassix® post.


Fig. 4. Glassix® post is tested to fit in prepared canal.


Fig. 5. Lamel® composite resin cement is injected with disposable auto mix tip directly into the root canal.


Fig. 6. Glassix® post placed in root canal and cemented.


Fig. 7. Core build up composite in a core form placed over shortened Glassix® post.


Fig. 8. Cores ready for impression and new bridge.