

# Influence of the Fiber Post Material on the Reconstructed Tooth Crown Bending Resistance

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*Post and core build-ups provide resilience and retention for future tooth restorations. In this study we intend to assess the resistance to fracture of two types of aesthetic post, using a testing machine after the application of a paraxial force. The results show that no specific material from the ones used shows a better behavior. Fiber quartz posts AAA Fiber Post had the highest resistance and the fiberglass posts Matrix Plus 2 were rated with the lowest values. Further laboratory and clinical studies are necessary to the in which one type of post material is favorable for a specific type case.*

**Keywords:** fiber post material, crown reconstruction, bending resistance

In recent years many dental materials have appeared for post and core build-up to satisfy the esthetic demands of the patients [1]. These materials have been improved; they have predictable and long lasting results and provide an easy work protocol for the dentist.

In case of increased load on a tooth with major coronal loss, the risk of fracture rises and the retention is weak. Thus several methods have been suggested to solve these problems, one of them being the post and core build-up [2]. Researching in this field conducted to elaborate some post and core build-up systems that can be easily used by the dentist and used for prosthetic treatments like crowns, partial fixed dentures and other type of dentures [3].

Several products are available, but to obtain the best results, the post must have similar properties with the dentin to make a single body and to be biocompatible. [4] Initially, glass-ionomers or modified glass-ionomers were used for core build-up, but now, on a large scale the composite resins are used because of the increased resistance [5]. The chemical composition of the composites influences the mechanical properties [6]. The increase of the filler level of the composites enhances the resistance [7]. In order to obtain a good esthetic result, nonmetallic posts must be used, such as fiber glass, quartz, and zirconium [1]. Composite resins for core build-up are used with esthetic posts to restore the anterior endodontic treated teeth, thus offering an outstanding esthetic [8]. In recent years no universal recommendations of prefabricated esthetic posts have been established [9].

Endodontic posts fabricated from quartz fiber- or glass fiber-reinforced composite have elasticity characteristics similar to dentine that diminish the force concentration at

the apical part of the root, thus reducing the fracture risk. [10-12]

Based on all of these, an in vitro study has been performed to determine and compare the fracture resistance of teeth crowns at bending, after core reconstruction using different fiber post materials. We reconstruct the crowns of the studied teeth using a fiber post/build-up technique and an acrylic crown.

## Experimental part

Twenty eight single rooted teeth where used for this study, which weren't fractured and had similar dimensions. The teeth were scaled and cleaned and deposited in saline solution, [13] and their oral side was marked. The 28 teeth where split in 4 groups, with 7 teeth per group (table 1) for every post system used. One core build-up material was used for all the post systems.

## Core build-up material used

Composite resin fiberglass reinforced with dual polymerization (EasyCore – Spofa Dental Czech Republic) The pack contains a Catalyst Paste and a Base Paste. Catalyst Paste contains BIS-GMA, glass fibers, hexanediol dimethacrylate, BHT, UV-5411. Base Paste contains: DHEPT, BIS-GMA, glass fibers, hexanediol dimethacrylate, BHT, UV-5411, Darocure 4265

## Endodontic treatment, impression for Scutan crowns, preparing of teeth

The 28 teeth were endodontically treated following the procedure below. The access cavity (fig. 1) was made with a round diamond burr attached on a high speed handpiece

Group I	Fiberglass post (Matrix Plus 2 - Innotech Italy)
Group II	Fiberglass post (AAA Fiber Post China)
Group III	Quartz fiber post (Crystal 911 - Micro Medica Innovative Technology Italy)
Group IV	Quartz fiber post (AAA Fiber Post China)

**Table 1**  
FIBER POST USED IN OUR STUDY

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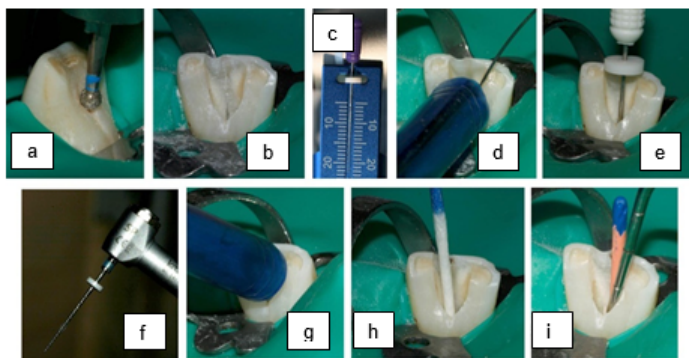


Fig. 1. Endodontic procedure: a) creating the access cavity; b) prepared access cavity; c) determine the working length; d) irrigation with sodium hypochlorite 5%; e) root canal preparation with file #15 to length; f) root canal length established on rotary file; g) final irrigation; h) drying of the root canal with paper points; i) root canal obturation with monocone technique.

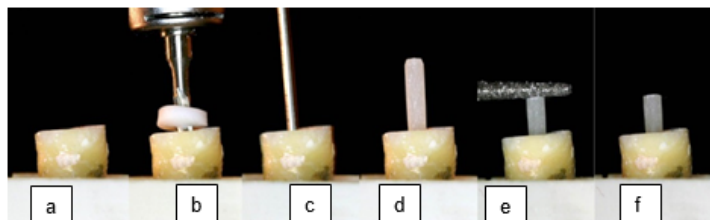


Fig. 2. Preparing the tooth for fiberpost socket: a) shortened tooth; b) removal of gutta-percha and preparation of fiberpost socket; c) irrigation; d) try-in of the fiberpost; e) shortening at length; f) final test.

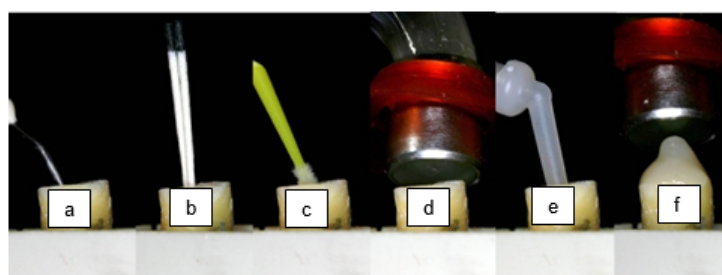


Fig. 3. Core build-up steps: a) acid etching of the tooth structure; b) drying with paper points; c) bonding application; d) light curing of the bonding; e) applying Easy-Core cement in the post space with automixing tips; f) light cure of material after fiberpost insertion

with water cooling. The tooth pulp was removed, and the working length was determined with a K-file #10. The irrigation was done with sodium hypochlorite 5%. The mechanical preparation of the root canal was done with K-file #15 then the crown down technique was used with the help of the rotary files Ni-Ti TEE (Poldent) and the endomotor Krafit (South Korea). The master file was #30 and 4% taper. In the end the root canal was irrigated with distilled water and the tooth was deposited in saline solution. The root canal was obturated with the monocone technique using a non-eugenol sealant and gutta-percha points. [14] A temporary filling was made and the teeth were deposited again in the saline solution. The teeth were then mounted in a stand and only the crowns were exposed. An impression of the crowns was made (this will be used later for manufacturing the provisional crowns using the Scutan technique) and then using a diamond disk attached to a straight handpiece, the crowns were sectioned at 2 mm from the enamel-cement junction, with a wheel-shaped diamond point on an air rotor with water spray (fig. 2.a). This stage of preparation was done according to the literature. [15]

#### Preparing the post space

The post space was prepared using the burs from the post system removing the gutta-percha until 4 mm from the apex. The root canal was irrigated with saline solution to remove debris. The post was tested for fitting and the excess was cut-off leaving 3 mm outside the root canal (fig. 2).

This stage of preparation was done according to literature. [15]

#### Adhesion and cement

The manufacturer indicated that silanisation wasn't necessary. The post space was cleaned with alcohol, then dried with paper points and etching acid - Xacid (37% phosphoric acid gel, Achulzer) was applied for 15 s (fig. 3)

and then irrigated with distilled water for 15s and then dried again. The bonding - Xbond (Schulzer) was then applied with a microbrush for 20 seconds on the post space walls and on the coronal surface, dried for 5 seconds., then light cured for 20s. Bonding was applied also on the post. The post was cemented with EasyCore (Spofa Dental) by placing the cement with an automixing tip in the post space and a thin layer of cement on the post. After the post was placed, light curing was done for 40s.

#### Core build-up

EasyCore was then applied around the coronal part of the post and light cured for 40 s. Then the abutment was prepared with a cylindrical burr attached to a high speed handpiece (fig. 4), obtaining a chamfer of 1 mm and a ferrule of 2 mm. The teeth were then deposited in saline solution. All the teeth were prepared to have a wall thickness of minimum 1 mm, according to Jotkowitz A and Samet N [9]

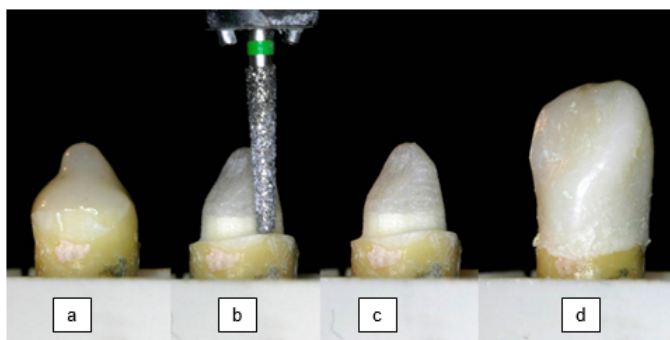


Fig. 4. Tooth crown preparation and reconstruction: a) build-up reconstructed tooth; b) tooth preparation with high speed; c) final abutment preparation; d) reconstructed tooth with temporary crown cemented

## Crowns

The crowns were prepared using the Scutan technique and a temporary crown material – Duracryl (Spofa). The temporary crown material was applied in the impression and then the impression was applied on to the prepared tooth. After the setting time passed, the crowns were adjusted. Then the crowns were permanently cemented with zinc-phosphate cement (Adhesor) (fig. 4).

## Fracture resistance of post and core build-up testing

The teeth were mounted in a metallic stand filled with self-curing acrylate. They were mounted perpendicularly to the base of the stand and introduced in the acrylate – Duracryl (Spofa) until 1mm above the cervical part of the crown. Each tooth had its own body of acrylate.

The teeth were placed on the universal testing machine Quasar 25 – Galdabini. The metallic stand was placed on a metallic custom made holder which guided the force applied on the tooth to the oral surface through a metallic rod at an angle of 45 degrees to the long axis of the tooth, in agreement with Shukri and co. [16] Every tooth was tested under a load that increased with 5 Newton per minute [17] until acoustic and visual signs of failure of the post and core build-up were observed.

## Results and discussions

The fractures resulted at the adhesion junction, in the dentin and in the core material. After the fracture resistance

For determining the average bending moment and the normal stresses (table 5), formulas based on figure 5 and explained in table 4 were used.

The literature explores many aspects of the longevity and the success of the endodontically treated teeth. There are factors which depend on the quality and quantity of the teeth structure [18-20], factors that depend on the procedure of preparation, and factors of reconstruction like the type of post and the type of core materials [9]. In our study we respect the ferrule effect conditions such as thickness and depth of the dentin walls also the total surrounding effect of the tooth, placing us in the no anticipated risk situation. What we vary in our study is the esthetic post material.

Anterior teeth are generally exposed to paraxial forces, and this increase in certain clinical situations such as deep bite situations. Anterior teeth are exposed to horizontal and vertical fractures [9, 21, 22]. In our study, the force applications are also paraxial.

The addition of a crown would enhance the fracture resistance of the tooth and it would be able to resist to greater forces [23].

Mikako Hayashi et al. [24] compared the fracture resistance of the extracted teeth restored with metallic and fiber glass posts on which vertical and oblique forces were applied. The results showed that teeth restored with fiber glass were much more resistant to fracture than those

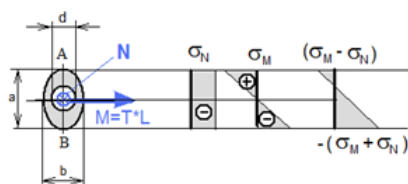
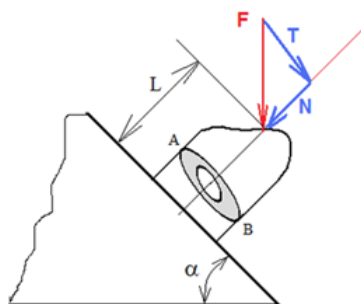
**Table 2**  
AVERAGE VALUES OF THE  
COMPRESSION FORCES  
NEEDED TO FRACTURE THE  
TESTED TEETH

Indicators	Group 1	Group 2	Group 3	Group 4
Pieces	7	7	7	7
Average $F$ [N]	126	257	265	269
Interval $F$ [N]	35-300	30-520	45-370	115-480

**Table 3**

STATISTICAL ANALYSIS RESULTS AT PAIRED T TEST BETWEEN GROUPS (\*SIGNIFICANT  $P < 0.05$ )

Group1 Group 2	Group 1 Group 3	Group 1 Group 4	Group 2 Group 3	Group 2 Group 4	Group 3 Group 4
0.07	0.01*	0.02*	0.47	0.45	0.48
Not significant	significant	significant	Not significant	Not significant	Not significant



**Fig. 5.** Graphic representation of bending moment and stresses components:  $F$  is the applied force,  $T$  is the shear force component of applied force,  $N$  is the axial force component of applied force,  $\alpha$  is the angle between the direction of the force and the axis of the tooth,  $A$  and  $B$  are the points where it was determined the extreme stresses,  $L$  is the length between the point where the bending force is applied on tooth surface and the surface plane of the tooth supporting material where the tooth is rigidly fixed.

testing, maximum values of the compression force were obtained and their average appear in table 2.

Student paired  $t$  test was used to analyze and compare every group with the other groups to observe if they are statistically significant (table 3). The resulted values can be interpreted as follow: group 1 doesn't differ from group 2 but differs significantly from group 3 and group 4, group 2 doesn't differ from group 3 and 4, group 3 doesn't differ from group 4 ( $P < 0.05$ ).

restored with metallic posts. In other studies that approached the same subjects such as [25] Frank Seefeld, et al, the results of the maximum fracture resistance forces were between 60 and 96N, and the bending moment was between 565 and 898MPa.

Bahman Seraj, et al [26] tested the fracture resistance of three post systems mounted on extracted teeth such as composite resin posts, fiber quartz and fiber glass posts. The results showed that fiber quartz had the biggest



**Table 4**  
FORMULA USED TO COMPUTE BENDING MOMENT AND NORMAL STRESSES

Explanation	Formula
T, the shear force component of applied force F	$T = F \cdot \sin \alpha$
N, the axial normal component of applied force F	$N = F \cdot \cos \alpha$
Bending moment	$M_i = L \cdot T = L \cdot F \cdot \cos(\alpha)$
Normal stresses	$\sigma_A = \sigma_N + \sigma_M$ where $\sigma_N = \frac{N}{A}$ , $\sigma_M = \frac{M}{W}$
Sectional area	$A = \pi \left[ \frac{a}{2} \cdot \frac{b}{2} - \left( \frac{a-d}{2} \right) \cdot \left( \frac{b-d}{2} \right) \right]$
Bending modulus	$W = \frac{\pi}{4} \cdot \frac{a}{2} \left[ \left( \frac{a}{2} \right)^3 \cdot \frac{b}{2} - \left( \frac{a-d}{2} \right)^3 \cdot \left( \frac{b-d}{2} \right) \right]$

Indicators	Group 1	Group 2	Group 3	Group 4
Average BM [MPa]	580	1111	1372	1011
Average $\sigma_A$ [MPa]	23	57	58	48

**Table 5**  
AVERAGE BENDING MOMENT AND THE  
STRETCHING TENSION FOR THE TESTING  
GROUPS

fracture resistance but it didn't differ significantly from the other posts used.

In our study too we can't point out a specific fiber post material. One of the commercial glass fiber posts used in our study shows significant lower values for fracture forces compared to the quartz fiber posts but the other glass fiber post have a similar pattern to the quartz fiber posts. Further, there are no significant differences between the two types of glass fiber posts. We presume that the fact of fiber post being fabricate to have similar properties to the dentine can bias the results by the fact that it limits the maximal resistance at bending force. It is possible that the differences identified in our study may be related to structural failure of reconstructed tooth (adhesion of build-up materials to dentin, fiber post, etc). In clinical practice, fatigue resistance of fiber posts and core build-up may have a greater importance than the maximal value for fracture force.

## Conclusions

Within the limits of our study, a fiber post material couldn't be evidenced from those studied which can modify significantly the bending resistance of the dental crowns. Further laboratory and clinical studies are necessary to identify the situation in which one type of post material is favorable to a specific type case.

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