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The fracture resistance of anterior teeth restored by three types of composite resins used in the core build-up

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Abstract

Background and objectives: The method of rebuilt of anterior teeth with the vast destruction of the crown plays an important role in the lifetime of these teeth. For obtaining the success in the treatment, a core material that replaces for the tooth tissue must have the same properties of the tooth structure. This study aimed to evaluate the fracture resistance of anterior teeth restored with three types of composite resins used in the core build-up. **Materials and methods**: forty healthy canine teeth were randomly divided into four groups. In the first group, there were healthy teeth that mounted in acrylic resin. The second, third and fourth groups were rebuilt by a core material of Nulite F, PhotoCore, and Brilliant, respectively. In all rebuilt samples, a 2-mm ferrule effect was created on healthy tooth tissue. By Universal Testing Machine under an angle of 45 degrees and a speed of 5.0 mm/min a 4- mm force lower than the tooth occlusal surface was applied to the samples up to the failure moment. Then, the obtained data were analyzed by ANOVA for the comparison between groups. **Results**: the average amount of force that caused the failure in the samples for groups 1, 2, 3, and 4 was 484 N, 480.7 N, 490.1 N and 450.4 N, respectively. **Conclusion:** In the strength of endodontically treated teeth, which have been rebuiltalong with a 2 mm Ferrule Effect and veneer, the type of core material is ineffective.

Keywords: Core; Composite core; Ferrule Effect.

Introduction

In endodontically treated teeth, the extents of the tooth crown destruction and the type of tooth determine the type of restoration. If a medium-sized anterior tooth, excepting the access hole created to treat the root, has a healthy crown tissue, composite resin restoration will be sufficient for it.

Putting a post in such a tooth will undermine the tooth rather than strengthen it (Shillinburg, Herbert T; 2012). Putting a post in such a tooth will undermine the tooth rather than strengthen it (Shillinburg, Herbert T; 2012). Lovdahl and Nicholls have found that healthy central incisors treated only endodontically, are three times more than the teeth restored with post and core, resistant versus the fractures (Lovdahl PE, Nicholls JI; 1977). However, the incision of the pivot levels for the establishment of the crown along with the creation of the access cavity for the Treatment of root often leads to the inadequate healthy dent into support a crown. If

there is a need for a crown due to the vast crown al destruction, then post and core must be used.

Use of the posts to distribute moment forces along the roots against the intraoral forces in the restoration of endodontically treated teeth has always been concerned (Dilmener FT, et al.,2006).The post length inside of the root should at least be equal to the crown length or post should be equivalent to two-thirds the length of the root in order to perform a desirably stress distribution, or, create a maximum retention (Fokkinga WA, et al.,2004).The chances of success with a post that its length is equal toor shorter than three-fourths of the crown length, is less than in when there is no post at all (Sorensen JA, et al.,1978).The restoration for teeth that have no crown building should be carefully selected. Being surrounded 1 to 2 mm of the vertical pivotal building of the tooth on the inside of the crown's walls creates a metal ring (Ferrule Effect) around the teeth and provides a protection for it against fracture (Elssman HF, et al.,1976).According to the findings by Engleman and Sorensen the presence of 1 mm of vertical walls of the tooth between the core edge and incision shoulder by creating a metal ring (Ferrule Effect) increases the resistance rate against fracture from 80% up to 139% (Sorensen JA, et al.,1990). If we fail to wear atleast 1mm of the vertical pivotal wall on the premolar tooth, which is intended as basic by the crown, the tooth must be extracted (Shillinburg, Herbert T; 2012). The ideal material that can be used for preparing the core, should be mechanically similar to the tooth structure. The use of materials that have a high strength and properties similar to the structure of the teeth is preferred in order to prevent the fracture and change the dimensions for building post and core(Hagge Mark S, et al.,2001).Thematerialsusedtobuildcoreincludecomposite, amalgam,theglassionomerandcastalloys (Raphael pilo, et al.,2002). Amalgam and cast gold are materials that have been successful in terms of longevity and clinically when used to build a core (Hagge Mark S, et al., 2001). Conversely, the composite has properties such as contraction due to polymerization shrinkage, water absorption and the relatively high thermal expansion (Hagge Mark S, et al.,2001). Despite such disadvantages, the use of composite cores by dentists is rapidly increasing, and this is more the result of saving time and the highest possible speed of setting of these materials. Composite resins are formed readily in large cavities, harden immediately; so, a crown incision can be done in the same session (Raphael pilo, et al., 2002). According to studies conducted by Lui (Lui JL,1994), Mezzomo (Mezzomo E, et al., 2004) and Fraga Fraga RC, et al, 2004), the usual reason of the fracture, during routine use of prefabricated posts and composite cores is the material fracture. This study was conducted due to the increasing reception of composites specifically forcore; saving time and the convenience of on the strength of the working with it; and the little studies conducted on the impact extent of the composite core on veneered anterior teeth.

Materials and Methods

The study population, sampling and research design Forty healthy canine teeth, free from any corrosion and fractures, were collected. The samples were kept in normal saline for 72 hours before the start with the experiment, 30PCs of samples 2mm above the junction of the enamel, and cementum (CEJ) were cut off with the use of a turbine by Fissure and the flow of water Akkayan B ,2004). In order to treat the root, each of the above 70 samples was filed, and filled by lateral condensation method after washing and drying the canal by paper CONE with endodontic sealer AH26 (Detrey, Konstanz/Germany) and gutta- percha. Then gutta-percha was removed up to a depth of 10mm of canals prepared for putting posts by hot pellagra. There was atleast 4mm of gutta-percha in the end of the canal in all the samples. In order to simulate the elastic properties of the periodontal ligament an aluminum foil of a 2.0-mm thickness was used in place around the tooth root of for creating a space for elastic material. After hard eningacry licresin around the tooth root, aluminum foil was removed and replaced by elastic polyether material (Impergum/ESPE, 3M,USA). The teeth were randomly divided into four groups:

The first group: The first group or the control group without any that were mounted on the group of healthy teeth without any change in acrylic resin.

The second group: In this group, the core material of Nulite F (BTD;Australia) was used to reconstruct teeth.
The third group: In this group, the core material of Photo (kurarynoritake; Japan) was used to reconstruct teeth.

The fourth group: In this group, the core material of Brilliant (Colten; Switzerland) was used to reconstruct teeth in this group.

The characteristics of three types of core material used:

1) **Nulite F composite (BTD; Australia)** this product reinforced with fiber is made using a combination of materials such as Furfury Lmethacrilate, Tetrahydra Tripolymer, urethane BIS.

About 9% of its weight consists of Pyrogenic silica that causes the gel-like consistency. This causes the composite can easily penetrate the micron cracks, as well as it causes the strength and durability of the restoration by creating a chemical bond. This product is available in four colors: dark, light, natural, medium and due to the high strength, it can be vastly used for restoration of Mesial-occlusal-distal (MOD) and as well as in the posterior restorations under severe stress.

2) Photo core composite (Kuraray noritake; Japan):

Light- cured composite of Photo core is made from a combination of materials such as:

Silanated barium glass powder, Silanated glass powder, Bisphenol A *diglycidylmethacrylate*, *Triethylenglycol dimethacrylate*, and Dl-camphorquinone.After this composite was cured, the degree of its hardness was similar to dentin and acts similar to dentin when incision and making the core. Because of translucent such as composites, 20 seconds after to be cured, the polymerization depth of the composite reaches 5.5 mm and after 60 seconds, reaches 8 mm.

Major consumption of Photo core is for core build-up, and it is also contraindicated in patients who have a history of hypersensitivity to methacrylate monomer; in addition, due to the delay effect of aognol on polymerization stage should not be used with substances that contain aognol.

3) **Composite Brilliant (Colten; Switzerland):**

This type is a hybrid composite, which is supplied in three types of Enamel, Incisal, and Dentine. Its ingredients include: EMAB is, BisGMA, Amorphous silica, Barium glass, and TEGDMA. Average particle size in the composite is 5.0µm and the volume of inorganic filers in the types of Enamel and incisal is %5.58, and in Dentinis % 59. This composite is used for reconstruction and restoration of parts of the translucent teeth, core build-up, paste the bridge, splints and veneer. Cement Zincoxide eugenol (ZOE) should not be used due to its effect on polymerization of composite.
For the preparation of a canal to put a titanium post (Parapost XPColtone Vivadent Shaan/ Liechtenstein) respectively the reamers 2, 1, and 3 were used. The post was cemented by cement zinc phosphate on the inside of the canal in such away that the 10mm of it was on the inside of the canal, and 2mm was out of the canal. Then, canal thickness up to 10mm on the outside of the teeth was measured by using a Vernier caliper (MahrCo; Germany), and it was found that in all cases, there is atleast 1 mm dentine around the post (Shillinburg, Herbert T; 2012). Tooth prepared with phosphoric acid was etched or 15 seconds, and are sin bonding layer was put on the samples and cured. To unify the composite cores, the core–forming matrix (TDV Dental, Ltd, PomerodS C, Brazil) was used.

After the reconstruction of the teeth, with the use of turbine by Torpedo diamond dental bures and along with the water flow, the incision with a Chamfer incisal edge of a depth of 4.0mm to an amount of 2mm lower than the junction of the core and tooth tissue was done for placement of full cast metal veneer until to be created Ferrule Effect of 2mm.

Above –mentioned silicon casting materials (Zhermac; Italy), including Putty (Very heavy consistency) and Wash (light consistency) were moulded with the use of prefabricated Terry, and full cast metal veneers were made with a base metal alloy (WERABOND, Albadent; USA) for all the samples.

After completing the lab steps to build veneer, veneers were placed by Zinc phosphate cement on samples. Simultaneously with putting the veneer on the samples, Veneers were pressed by the finger for 1minute and then for10 minutes with a force 3 to 5kg. All the teeth were mounted on the cylindrical-like acrylic resin so that the long axis of the tooth was placed in parallel with the cylindrical acrylic wall, and each tooth has been placed within a distance of 2mm lower than CE Jin acrylic.

Then force was exerted on the lingual surface under 45 degrees angle with the longitudinal axis of the tooth by Universal Testing Machine with a speed of 5.0mm per minute. The device was connected to a drawing of the curve. With the first pressure loss in the diagram, the machine was stopped and the fracture – causing force was recorded.

The information recorded was examined by ANOVA for comparison groups. As well as then, in terms of being a significant difference in the results achieved the groups (two versus two) were compared using the TUKEY test.

Results

In this study, three different types of composite resin (Nulite F, Photocore, and Brilliant) were used for making the core in prepared samples. The four groups, which each group contains 10 samples, were ready. The control group were healthy teeth that were mounted in acrylic resin.

Unlike the control group, the identical posts along with core and full metal composite veneer were used in the other three groups. In this research, the force was applied to the core through the veneer and with regard to the existence of two mm Ferrule Effect, in all cases the forces on the teeth caused the fracture in the area of the tooth root.

The average of the forces that caused the fracture in the groups of 3, 2, 1, and 4, was respectively 484 N, 480.7N, 490.1N and 450.4N (Table No.1and Figure No.1).

The greatest average force was related to the third group, i.e. the group composite photocore; and the lowest average force was in the fourth group or the group in which the composite brilliant has been used. The results obtained in groups 1to4 were analyzed by ANOV Aanalysis.

The P-value among groups was 0.882 ($p>0.05$) that this shows there is no significant difference between forces leading to fracture.

TUKEY test did not show a significant difference between the groups.

Table 1. The results of statistical calculation of data of fracture-resistance of the samples

Group	Mean	SD	Max	Min
Group1	484.000	139.6862	636	258
Group2	480.7000	114.6299	673	283
Group3	490.1000	114.6299	616	304
Group4	450.4000	115.1407	647	287

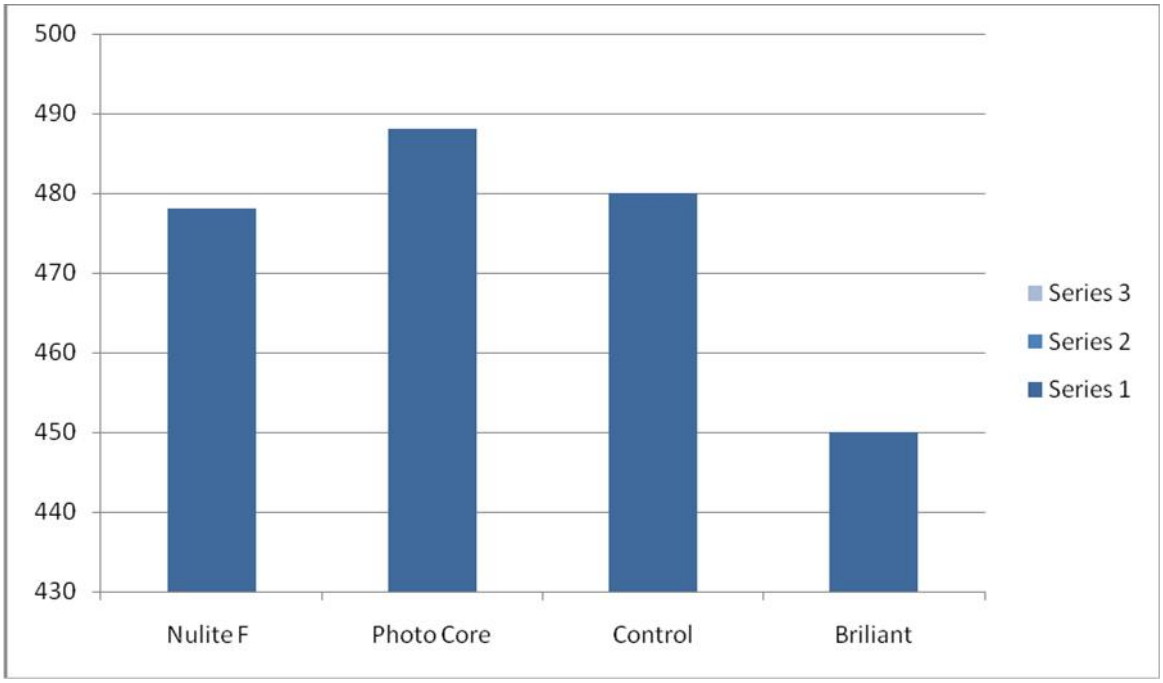

Figure 1. The average amount of forces causing a fracture in different groups according to Newton

Discussion

Mechanically, the core should be tolerant versus the forces that will be transmitted to the teeth. Clearly, core material that substitutes the natural tooth tissue did not have mechanical properties of tooth, but in terms of the mechanical properties, it should be as possible as close to the tooth tissue. In this research the force applied through the veneer on the core, and with regard to the existence of two mm Ferrule Effect in all the samples was considered a type of core matter force resistant factor assessment. In fact, two mm of Ferrule Effect moved forces on tooth tissue so that in all the samples the fracture was observed in the root. In none of the samples, the fracture was not seen in the core or in its connection area of the teeth. Unlike the control group, none of the groups show significant difference in the amount of resistance to the fracture. There were reports previously on the effect of the type of the core in the resistance to fracture in endodontically treated teeth by direct force applied in the non-veneered core material versus the forces exerted upon the teeth. In a study of the maxillary incisor teeth with undermined roots using the composite core material of photo core and the prefabricated D.T. lightpost along with different resin cements and sub-posts in the tooth root, Moosavi *et al.* concluded that there is no significant difference between the fracture- resistance rates among the studied groups (Moosavi H, et al., 2002). As well as the more fractures happen to the Crown of the tooth and above the CEJ that is confirming comments by Mezzomo(Lui JL,1994), Lui (Mezzomo E, et al.,2004) and Fraga(Fraga RC, et al, 2004). They believed that the usual reason for the fracture when using prefabricated posts and composite resin is the composite core material fracture. Unlike the current study, in the above studies, veneers along with Ferrule Effect have not been used that this could justify a higher rate of fractures in the Crown of the tooth compared with the root because the presence of Ferrule Effect prevents concentrating forces on the Crown of the tooth. In a study on the core material of amalgam, composite, post, and casting core without the use of veneer, Lovdahl and Nichols showed that Amalgam and composite materials have a lower mechanical property compared to post and casting core, and by applying lower force, they undergo a fracture compared to post and casing core (Lovdahl PE, Nicholls JI; 1977).

In the samples in which composite and amalgam had been used, the fracture was seen more in the core material, but in the samples in which the post and casting core had been used, the root fracture was dominant (Lovdahl PE, Nicholls JI; 1977).

In 2 other separate research (KantorME, Pines MS ,1977) and (Sirimai S, et al.,1999) in the same field carried out on three of the above articles, the results were similar to the results of the testing by Nicholls and Lovdahl. In all the studies that reviewed the force was applied directly on the core, and in these studies, the veneer was not used. Due to the use of veneer in our study, the results cannot be compared with the results of research that did not use the veneer. Considering the use of veneer on the post and core in the clinic, the above studies did not have the high clinical application.

If the edges of the veneer be placed on the healthy teeth tissue the forces applied to the teeth will be accumulated around the teeth and at the junction point at the veneer edge with the tooth (Raphaelpilo et al., 2002). Aquaviva suggested that if we want the laboratory studies can be applied in clinics; they should be as possible as close to the clinical conditions(Aquaviva SF,Gauri SD, 2001). Since the inside of the core mouth is always covered by the veneer, in the present study, the teeth were rebuilt by aveneer as possible, the conditions inside the mouth can be simulated. In the preparation of veneers, maximum attempts took place to be the same stages of construction and preparation of them to come up in the results; no conflict occurred in terms of the type and the size and hardness of veneer. In 2012, Raphaelpiloetal. Concluded that in endodontically treated teeth with veneer and three different types of core material (composite, amalgam, post, and cast core) if the edge of the veneer be placed on the healthy tissue of teeth and 2mm lower than the junction of the core and the teeth, the core material type will not have much impact in results (Raphael pilo et al., 2002). Similarly, in this study, 2mm of Ferrule Effect was considered that the results confirmed the lack of impact of mechanical properties of core matter against the force to the teeth. In a separate investigation (Gelfand M, et al.,1984; Assif D, et al.,1993; Robbins JW, et al., 1933), the results showed that if the edge of the veneer is located on the healthy tooth tissue, if the appropriate Ferrule Effect can be applied, the average of the difference between the forces that cause fracture in the teeth, will not show significant differences. They concluded that the type of core material and shape of the post did not have a role in increasing the tooth resistance. In our study, a type of post with the same size and the same diameter was used for all the samples, and only our variable was core material that force was applied to it indirectly and from the veneer. We concluded the existence of the post in the endodontically treated teeth renovated with veneer and with 2mm Ferrule Effect cannot undermine the tooth; so, the lack of significant differences between the control group in which there were healthy teeth and three other groups that all they were rebuilt by the identical posts, confirms our claim.

Conclusion

Despite the restrictions that there was in this study, type of core matter is without impact in resistance to fracture among the endodontically treated teeth that have been veneered along with 2mm Ferrule Effect.

Furthermore, a post in endodontically treated teeth, which plus 2 mm full - Effect Ferrule, rebuilt by the full–crown, will not undermine the tooth.

Conflict of Interest statement

The authors declare that there is no conflict of Interest.

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