Original Research Paper

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Comparative Evaluation of Push out Bond Strength of Three Different Shapes of Fibre Posts: With and Without Silanisation : An in Vitro Study.

Abstract:

Aim: To evaluate and compare the push out bond strength of tapered, parallel tapered and double tapered epoxy resin fibre posts with two different surface treatments.

Methodology: A total of 48 samples were taken for the study. All the samples were decoronated. Biomechanical preparation was done and samples were obturated with 6% GP. The samples were stored for 48 hours thus allowing sealer to polymerise. These 48 samples were divided in 3 groups : tapered, parallel tapered, double tapered posts. Among these 8 samples treated with silane and 8 were without silanisation. Both post systems were cemented using Luxacore dual cure resin material. All specimens were stored for 24hrs in distilled water. Each specimen was cut horizontally into 5 sections each of 2mms and leaving a apical seal of 5mms. The first, third and fifth slices were used for the study. They were termed as coronal, middle and apical respectively. The push out bond strength was tested using the UTM (Instron). A push out test was applied at speed of 0.5mm/min with a 1mm diameter plunger from apical to coronal direction.

Results: The results of the present study showed that mean push out strength for double tapered postswere significantly greater than those for tapered post &parallel tapered post. The mean retention values of the double tapered post, tapered & parallel tapered post were statistically different. The Double tapered post had the highest mean push out strength and this value was significantly higher than those of parallel & tapered post.

Conclusions: This study showed double tapered posts to have better retention than tapered and parallel posts.

Keywords: Fiber post; parallel post; retention; tapered posts; double tapered fibre posts

Introduction:

"Oral cavity is the mirror of the body".

A healthy one is a great asset in one's life in which teeth play a pivotal role. Teeth are subjected to caries, fracture and pathological changes like attrition, abrasion and erosion. Damaged tooth has to be replaced by restorative material.

The choice of restoration is dependent on the strength and esthetic demand. There are two important factors that influence the choice of the technique: the type of tooth and the amount of remaining tooth structure. If the coronal structure is largely intact and loading is favourable, simple restoration is sufficient. But if large amount of tooth structure is missing, then the restoration of such teeth poses a problem. Most of the teeth require endodontic treatment. Some teeth don't have adequate amount of tooth structure and only way of gaining retention and resistance for the retainer is by posts with ideal core build up.

Use of fibre posts have become more popular as it possess adequate mechanical and aesthetic properties such as flexible strength similar to dentin, their translucency and similar elastic modulus to dentine, producing a stress field similar to that of natural teeth, whereas metal posts exhibit high stress concentrations at the post-dentine interface.[1]

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Some studies have shown that the major cause for failure of post and core is the loss of retention.[2] Retention can be affected by several factors such as the adhesive system, the resin cement and the post patterns, surface treatment of post. Good bonding between posts and luting agent as well as between luting agent and wall of canal is required for the proper dissipation of occlusal forces and clinical success.[3] Most cases of failure of post restoration occur at the post cement interface and to overcome this problem various surface treatments have been tested.

Various surface treatments include use of chemicals such as hydrogen peroxide, phosphoric acid and procedures that induce mechanical roughening of surface such as airborne particle abrasion and laser irradiation.[4] Silane coupling agents are used as the adhesion promoters in the epoxy resin fibre posts[5]. They provide a chemical bond between the fibre post and the polymer by increasing the wettability of the post.

Recently several types of fibre posts have been developed with various forms and surface roughness. Because, there is paucity of studies over the different forms and surface treatment of fibre posts this research was undertaken.

Materials and Methods:

An in vitro study was conducted to evaluate the pushout bond strength of three different posts i.e tapered, parallel tapered and double tapered fibre posts with and without silanisation.

Collection of teeth:

·Single rooted mandibular premolars extracted for periodontal and orthodontic reasons within 1 month were collected from the Department of Oral and Maxillofacial Surgery.

Preparation of samples:

• The freshly extracted teeth were washed under tap water after extraction.

• Teeth were cleaned using ultrasonic instruments and then disinfected by immersion in 2.5% sodium hypochlorite (parcan, septodont, India) for 2 hours and then stored in normal saline at room temperature till further use.

Root canal preparation:

• The teeth were decoronated with a diamond disk under constant water cooling thus leaving a root length of 15mm.

• The canal patency was assessed with size 15 no.K file. Working length was established 1mm short of apical foramen. Cleaning and shaping of canals was done using rotary ProTaper (6%) (Dentsply Maillefer, Ballaigues, Switzerland) instruments upto F3 file with an intermittent irrigation with 5.25% sodium hypochlorite.

• After cleaning and shaping of canal, all specimens were flushed with 5ml of 5.25% NaOCl and 5 ml of 17%EDTA for 1 minute to remove the smear layer followed by final rinse with 5 ml of distilled water.

• After final irrigation with normal saline, canals were completely dried. And obturated using AH plus sealer (Dentsply Detrey, Konstanz, Germany) and corresponding F3 gutta percha.

• The specimens were stored at room temperature for 48 hours to allow the sealer to polymerise.

Post space preparation:

• Post space preparation was done upto a Peeso file no.3 (Mani, Japan) thus leaving a apical seal of 5mm of gutta percha in the canal.

• A final flushing of canal was done using saline and then dried with absorbent paper points. Presence of any remaining gutta percha pieces in the canals was evaluated by radiographs.

Sample distribution:

• After post space preparation all specimens were then randomly divided into three groups with the sample size of each

1. Tapered posts (A) GC fibre posts
2. Double tapered posts (B) (Medicept Dental India Pvt. Ltd)
3. Parallel tapered posts (C) (Hirem, Italy)

Surface treatment of posts:

• Each post was rinsed with water for 30 seconds followed by air drying.

• From each group the posts will be further divided into two groups :

I. Without surface treatment (1)

ii. Surface treatment with silane coupling agent (2)
Silane (Angelus, Dental Avenue India Pvt Ltd) was applied with microapplicator brush (2mm) waiting and then air dried for 60 seconds.

Cementation of posts:

• All the three post systems were cemented using the same dual cure resin material i.e Luxacore Z Dual.(Luxacore, DMG)
• Pretreatment of tooth surface was done initially by 37% phosphoric acid (Ivoclar – Vivadent, Schaan Liechtenstein) for 15 seconds. It was then rinsed and blot dried to keep it moist. Then bonding agent was applied to the prepared and dried post space for 20 seconds. It was then dried and light cured for 10 seconds.
• Cementation was done by placing cement in canals with the available tips and applying on the posts. Fibre posts were placed in canals and were seated with the application of finger pressure. Excess cement was removed. Then posts were held in place with moderate pressure and light cured for 20 seconds.

Fracture testing of samples:

• All the specimens were stored in distilled water for 24 hours. All the specimens were sectioned horizontally with the isomet cutting machine resulting in the specimens that are 2mm thick. The thickness of each specimen was measured with the digital vernier caliper.
• Five slices were obtained and each slice were 2mm thick. The first 2 slices were termed as coronal, third slice as middle and last 2 as apical third of fibre post .
• A push-out test was applied to slices 1st, 3rd and 5th slice at speed of 1mm/min with a 1mm diameter metallic plunger from apical to coronal direction until the post was dislodged.
The push-out test was performed using Universal Testing Machine(Instron). The maximum load required for failure was measured in Newtons(N).
• To express the bond strength in MPa the load at failure point was divided by area of the bonded interface, with the following formula:

$A=2\pi rh$

Where π is the constant 3.14, r is the radius of the post and h is the thickness of slice.
Thus groups are as follows :
A1 – Tapered posts without silanisation
A2 – Tapered posts with silanisation
B1 – Double tapered posts without silanisation
B2 – Double tapered posts with silanisation
C1 – Parallel tapered posts without silanisation
C2 – Parallel tapered posts without silanisation

Results and statistical analysis:

From the data collected in the study, the mean of push out bond strength for different posts were calculated and statistically analyzed. Descriptive statistics such as mean and standard deviation was used to present the data. Comparison between the groups was performed by using Mann– Whitney test. A p–value less than 0.05 were considered as significant. Data analysis was performed by using software SPSS v20.0. The results showed that there were highly significant differences in all forms of posts. There were highly significant differences in posts retention with and without silanisation.

Discussion:

An ideal post system should have modulus of elasticity, compressive strength, flexural strength and thermal expansion, similar to that of dentin, maximum retention in tooth and maximum retention of core material, protection of root from fracture, pleasing esthetics, biocompatibility, should bond efficiently to dentin.[6]

There are more than 100 different prefabricated posts available.[7] They are available in different forms: parallel–sided, tapered, double tapered, smooth and serrated forms, threaded posts.8 Tapered posts are less retentive as

compared to parallel posts. Tapered post conserves tooth structure and follows canal shape. Parallel post requires the extensive removal of tooth structure.[9] Tapered posts produce the greatest stress at coronal shoulder and parallel posts produce their greatest stress at apex of the preparation.[7] Parallel posts distribute the stress more uniformly along the entire length and also resist tensile, shear, and torquing forces better than tapered posts.[10] Although the retention of tapered posts is less than that of parallel posts it is satisfactory for clinical use. According to manufacturers double tapered posts have increased retention. The reason for this is the parallel shape of coronal portion of post.[9]

Cooney JP et al concluded that parallel-sided posts were more retentive than parallel posts with tapered ends.[11] Varun Pruthi et al stated that parallel posts provide better retention than tapered and double tapered posts. Double-tapered posts have greater fracture resistance than parallel and tapered posts[9]. Daniel Angerame et al concluded that single taper conical posts would be more preferable than double taper conical posts.[12]

In the present study three different posts were used: tapered, parallel tapered and double tapered. Double tapered posts showed higher push out bond strength than parallel tapered posts. This was not in accordance with the study by Varun Pruthi.[9]

The most common cause of failures in restored endodontically treated teeth was the loss of retention of post. Numerous studies have shown that the retention of the post is affected by post design, post length, post diameter and surface treatment[13], canal shape and preparation, luting medium, method of cementation, and location in the dental arch.[7]

The retention of posts depends on quality and durability of the bonding agent between the fibre posts and tooth structure. The bond strength tests provides information about the bond of the post to dentin.The most commonly used bond-strength tests to access the post retention in the root canal are the push out, microtensile and pull out tests. In the present study push out tests was applied to compare the effect of post shape and surface treatment on the retention of post. A universal testing machine is used to perform this mechanical test. In this method the load is applied through a plunger mounted in universal testing machine.

In this study bond strength at each section of the post was also assessed. As the post stabilises and retains the core, the determination of bond strength in different regions of root i.e coronal, middle, apical is crucial.[14] In the present study statistically significant differences were observed in all the three different regions of post. This was in accordance with the study Khaled A. Elbanna et al stated that irrespective of the post technique there was statistically signific ant difference in push out bond strength in different thirds.[15]

To improve the bonding between resin cement and fiber posts several surface treatments are suggested. Surface treatment increases the surface roughness of fiber posts thus enhancing the bond. These various surface treatments include silanisation, acid etching, sandblasting, adhesive application and alternative etching.[13] Surface treatments expose the fibers through removal of the matrix and thus improving the bond.

Silanization is a conventional surface conditioning used in dentistry. Treating the post surface with silane coupling agent is advisable to enhance the adhesion of resin cement for luting. Daneshkazemi A et al concluded that application of silane coupling agent to fiber post enhanced the bonding between fiber post and composite resin.[3] The results of this study are thus in accordance with that of Daneshkazemi A et al. Perdigão J et al stated that the use of a silane coupling agent may not provide increased bond strength between the fiber posts and the resin cement.[16]

In the present study three different types of posts with and without silanisation were used. Irrespective of the form of fibre post and region of fibre post, the posts treated with silane showed higher push out strength as compared to those withoutsilane. As this is an in vitro study it has certain limitations. There are wide variety of factors that influence the survival of posts in oral environment. More parameters should be added for further studies. More clinical trials should be conducted along with continued search for more better material.

Conclusion:

Within the limitations of this in vitro study following conclusions were drawn:

1. There are significant differences in push out bond strength between tapered fibre posts and parallel tapered

and double tapered fibre posts and surface treatment with and without silanisation.

2. The push out bond strength of double tapered fibre post was highest followed by parallel tapered followed by tapered irrespective of the type of surface treatment.
3. The push out bond strength of fibre post treated with silanisation was higher than that of without silanisation irrespective of the type of posts.
4. The double tapered fibre posts surface treated with silanisation had the highest push out bond strength.
5. The tapered fibre posts surface without silane had the lowest push out bond strength.

However further studies should be done to evaluate influence of different surface treatments and the type of posts.

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