ORIGINAL RESEARCH PAPER
Volume-8 | Issue-3 | March-2019 | PRINT ISSN No 2277 - 8179
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

EVALUATION OF FRACTURE RESISTANCE AND SITE OF FRACTURE OF ENDODONTICALLY TREATED TEETH RESTORED WITH VARIOUS TYPES OF POSTS- AN IN-VITRO STUDY.

Prosthodontics

Dr Sumit Singh* Senior Resident AIIMS Patna *Corresponding Author

ABSTRACT

INTRODUCTION- Final restoration of endodontically treated teeth often requires a post and core. Space for the post is obtained by removing a predetermined amount of root canal filling material and then preparing the canal with reamers or drills to the desired form and shape.
AIM & OBJECTIVE- 1. To compare the fracture resistance of endodontically treated teeth restored with glass fiber post, prefabricated metallic post, cast metallic post core and prepared teeth.2. To compare the site of fracture of endodontically treated teeth restored with glass fiber post, prefabricated metallic post, cast metallic post core and prepared teeth
METHODOLOGY- A total of 40 samples were prepared to evaluate the fracture resistance and site of fracture of endodontically treated teeth restored with glass fiber post, prefabricated metallic post, cast metallic post core and prepared teeth. A total of 40 extracted human mandibular 1st premolar teeth were used within 3 months following extraction.
RESULT- SIMULATION 1- On the basis of above observations the following order of fracture load in different groups was observed:
Group III > Group IV > Group I ~ Group II
SIMULATION 2- On the basis of above observations the following order of fracture load in different groups was observed:
Group IV > Group III > Group I > Group II
CONCLUSION- 1.So, from the result of this study, it was concluded that under conditions of vertical loading, the fracture load of teeth restored with the cast metallic post-cores was greatest among the groups and under the condition of oblique loading, the fracture load of teeth restored with pre-fabricated metallic posts was significantly smaller than that in other groups.2.The combination of a fiber post and composite resin core with a full cast crown is the most protective method for maintaining tooth structure.3.All the fractures in the specimen samples, irrespective of the nature/presence of post took place at cervical region.

KEYWORDS

INTRODUCTIO

Restorative methods for pulp less teeth with post core systems have been widely investigated with the aim of achieving long-term prognosis. Despite the various attempts that have been made, vertical root fractures of pulp less teeth are still encountered in everyday clinical practice[1]. Although it is acknowledged that minimal tooth cutting in endodontic and restorative procedures is the most effective measure for preventing vertical root fractures in pulp less teeth, it is often necessary to restore teeth with extensive loss of structure such as those without coronal portions. In such cases, the best restorative methods for effectively reinforcing pulp less teeth need to be identified.

In recent years, various types of fiber posts have been introduced and excellent long-term clinical performances of pulp less teeth restored with a combination of fiber posts and resin cores in conjunction with dentin bonding systems have been reported. In particular, very few root fractures have been detected in these clinical findings. Furthermore, in vitro studies on the mechanical strengths of pulp less incisors, restored with fiber posts, have shown reduced incidences of root fractures during fracture tests.[2]

On the basis of these encouraging in vivo and in vitro findings, restoration using fiber posts might have potential in reinforcing pulp less teeth. However, little is known about the effectiveness of fiber posts with adhesive materials in reinforcing extensively damaged pulp less molar teeth against occlusal force. Recent finite element analyses presented the different stress distributions in pulp less teeth restored with different post-core systems.

It needs to be confirmed, whether the stress distribution with vertical or oblique loading, significantly affects the fracture resistance of teeth restored with different types of restoration.

Therefore, this study was undertaken to evaluate the fracture resistance and site of fracture of endodontically treated teeth restored with various post and core systems.

AIM AND OBJECTIVE

This in vitro study, to evaluate the fracture resistance and site of fracture of endodontically treated teeth restored with various types of posts was carried out in AIIMS Patna and Central Institute of Plastic Engineering and Technology (CIPET), Lucknow with the following aims and objectives:-

1. To compare the fracture resistance of endodontically treated teeth restored with glass fiber post, prefabricated metallic post, cast metallic post core and prepared teeth.
2. To compare the site of fracture of endodontically treated teeth restored with glass fiber post, prefabricated metallic post, cast metallic post core and prepared teeth.

METHODOLOGY

A total of 40 samples were prepared to evaluate the fracture resistance and site of fracture of endodontically treated teeth restored with glass fiber post, prefabricated metallic post, cast metallic post core and prepared teeth. A total of 40 extracted human mandibular 1st premolar teeth were used within 3 months following extraction. Premolars were selected for use in this study only if they were free from caries and tooth fractures on visual inspection.

PREPARATION OF SAMPLE

The following steps were involved in the preparation of the sample:-

1. Bucco-lingual, mesio-distal dimensions and root lengths of all teeth selected were measured using digital calipers.
2. Then teeth were divided into eight groups (n=5 teeth each) so that there were no significant differences among groups in terms of bucco-lingual and mesio-distal dimensions.
3. Coronal sections of teeth to be restored with post-cores were removed with a low speed disc at the level of the cemento–enamel junction.
4. The teeth were then endodontically instrumented to a size 40 file and the root canals were obturated with gutta percha.
5. After the root canal treatments, the teeth underwent post space preparation to 2/3 of the root length by means of a preparation drill.

The specimens were then divided into four groups of 10 specimens each, depending on the type of post used:

Group I: Fiber Post Group

1. First, the light cured dentin adhesive (Smartcem2, Dentsply) was applied to the dentin surface of the post space followed by drying with a paper point to remove moist spots was applied and light-cured for 10 s.
2. The surface of the fiber post (Reforpost, angelus, 1.3 mm)was also coated with dentin adhesive. Then, the dual-cured resin cement(Smartcem2, Dentsply) and fiber post were inserted into

the post space.

3. After removal of excessive cement, the resin cement was cured by irradiation for 40 s.
4. Core build-up procedures were performed in a silicone (Silflex, Dentsply) mold using core build- up material (Flourocore2, Dentsply)

Group II: Prefabricated Metallic Post Group

1. A prefabricated stainless steel post (AD Post #4, Kuraray Medical Inc., Tokyo, Japan) was adhered to the post space using dual-cured resin cement in conjunction with a metal primer (Alloy Primer, Kuraray Medical, Inc.)
2. Other restorative procedures were identical to those in the fiber post group.

Group III: Cast Metallic Post-Core Group

1. A cast metallic post-core was fabricated from a wax pattern, the core portion shape of which was copied from the silicone mold to obtain a shape identical to that of the resin core.
2. The pattern was then invested and cast with Ni-Cr alloy (Dentsply).
3. The cast metallic post-core coated with metal primer (Alloy Primer, Kuraray Medical, Inc.) was luted into a post space using the dual-cured resin cement.

Group IV: Crown Preparation Group

1. The teeth in two groups received crown preparation instead of post-core preparation.
2. The crown preparations were performed to reproduce a shape identical to that of the core.

Steps in metallic crown fabrication:-

1. A wax pattern was fabricated using a silicone (Silflex, Dentsply) mold to shape standardized full crowns with a chamfer margin designed to locate 1 mm below the core-root interface, and subsequently cast in (Ni-Cr alloy, Dentsply).
2. Metallic crown was luted to a tooth with dual-cured resin cement and a metal primer.

RESULT

A total of 40 samples were divided in to 4 groups of 10 each (25%each)(TABLE 1 and FIGURE 1). Group I had 10 samples of fiber post, in Group II, there were 10 samples of prefabricated metallic post, in Group III, there were 10 samples of cast metallic post-core and in Group IV and there were 10 prepared teeth.

The fracture load in different groups was evaluated under two simulations:

Simulation 1-90° vertical loading
Simulation 2-45° oblique loading

SIMULATION 1

In Group I, the fracture load ranged from 288 to 308 kgF with a mean value of 297.20 kgF and a standard deviation of 8.32 kgF. The median value was 298 kF. On checking the normality of the distribution using Shapiro-Wilk test it was found to be normal (p=0.715).

In group II, the fracture load ranged from 289.00 to 300.00 kgF with a mean value of 284.8 and a standard deviation of 8.79 kgF. The maximum value was observed to be an outlying value. Assessment for normality of distribution using Shapiro Wilk test revealed it to be normal (p=0.064).

In group III, the fracture load ranged from 398 to 412 kgF with a mean value of 404 and a standard deviation of 5.83 kgF. The distribution was normal (p=0.585).
In group IV, the fracture load ranged from 296 to 310 kgF with a mean value of 302.8 and a standard deviation of 6.10 kgF. None of the values were outliers. The distribution was normal (p=0.549).

It was observed that Group III had maximum fracture load (404±5.83 kgF) followed by Group IV (302.80±6.10 kgF), Group I (297.20±8.342 kgF) and Group II (284.80±8.79 kgF) respectively. The minimum fracture load was observed as 278 kgF in a specimen of Group II while the maximum fracture load was observed as 412 kgF in a specimen of Group III.(FIGURE 2)

Between groups comparisons showed a statistically significant difference for all the comparisons except between Group I and Group II and Group I and Group IV. Maximum difference was observed between Group II and Group IV while minimum difference was observed between Group I and Group IV.

On the basis of above observations the following order of fracture load in different groups was observed:

Group III > Group IV ≥ Group I ~ Group II
All the fractures took place at cervical location

SIMULATION 2

In Group I, the fracture load ranged from 198 to 220 kgF with a mean value of 210.8 kgF and a standard deviation of 8.79 kgF. The median value was 210 kF. On checking the normality of the distribution using Shapiro-Wilk test it was found to be normal (p=0.665).

In group II, the fracture load ranged from 135 to 158 kgF with a mean value of 147.8 and a standard deviation of 9.28 kgF. Assessment for normality of distribution using Shapiro Wilk test revealed it to be normal (p=0.800).

In group III, the fracture load ranged from 230 to 248 kgF with a mean value of 239.6 and a standard deviation of 6.54 kgF. The distribution was normal (p=0.914).

In group IV, the fracture load ranged from 248 to 268 kgF with a mean value of 256.4 and a standard deviation of 8.05 kgF. None of the values were outliers. The distribution was normal (p=0.750).

It was observed that Group IV had maximum fracture load (256.40±8.05 kgF) followed by Group III (239.60±6.54 kgF), Group I (210.80±8.79 kgF) and Group II (147.80±9.20 kgF) respectively. The minimum fracture load was observed as 135 kgF in a specimen of Group II while the maximum fracture load was observed as 268 kgF in a specimen of Group IV.(FIGURE 3)

Between groups comparisons showed a statistically significant difference for all the comparisons. Maximum difference was observed between Group II and Group IV while minimum difference was observed between Group III and Group IV.

On the basis of above observations the following order of fracture load in different groups was observed:

Group IV > Group III > Group I ≥ Group II
All the fractures in the specimen samples, irrespective of the nature/ presence of post took place at cervical region

DISCUSSION

Despite the various attempts that have been made, vertical root fractures of pulpless teeth are still encountered in everyday clinical practice[3]. Although it is acknowledged that minimal tooth cutting in endodontic and restorative procedures is the most effective measure for preventing vertical root fractures in pulp less teeth, it is often necessary to restore teeth with extensive loss of structure such as those without coronal portions[4]. In such cases, the best restorative methods for effectively reinforcing pulp less teeth need to be identified[5]. The purpose of this study to establish effective restorative methods for reinforcing pulp less teeth with extensive loss of tooth structure and to study the difference in the fracture strengths of pulpless premolars restored with different types of post-core systems and full coverage crowns under vertical or oblique loading.

Under the condition of vertical loading, the fracture loads of teeth restored with cast metallic post-core systems were significantly greater than those with crown preparation without posts. It was observed that Group III had maximum fracture load (404±5.83 kgF) followed by Group IV (302.80±6.10 kgF), Group I (297.20±8.342 kgF) and Group II (284.80±8.79 kgF) respectively. The minimum fracture load was observed as 278 kgF in a specimen of Group II while the maximum fracture load was observed as 412 kgF in a specimen of Group III. Analysis of variance (ANOVA) revealed a statistically significant intergroup difference ($F=278.53$; $p<0.001$).

These results were in concurrence with other authors (Hayashi Mikako et al)[5] who used 48 maxillary premolars which were restored with fiber post, prefabricated metallic post, cast metallic post core and prepared teeth as control group. Under the condition of vertical loading, the fracture load of teeth restored with the cast metallic post-cores was greatest among the groups (two-factor factorial ANOVA and Scheffe'sF test, P>0.05).

It was also similar to the study conducted by authors (Newman Marcela P.et al)[6] who used 90 maxillary central incisors which were divided into 8 experimental groups and 1 stainless steel (ParaPost) control group of 10 specimens each. Eighty teeth were assigned to 2 main experimental groups called "narrow" and "flared" canals. Prefabricated posts (FibreKor and Luscentanchors) for narrow and flared canals were cemented with an autopolymerized resin cement and a flowable composite, respectively, whereas customized Ribbond posts were luted with a light-polymerized flowable composite for both canal types. Results from the study show that the load to failure of the stainless steel posts were significantly stronger than all the composite posts studied.

Under the condition of oblique loading, It was observed that Group IV had maximum fracture load (256.40±8.05 kgF) followed by Group III (239.60±6.54 kgF), Group I (210.80±8.79 kgF) and Group II (147.80±9.20 kgF) respectively. The minimum fracture load was observed as 135 kgF in a specimen of Group II while the maximum fracture load was observed as 268 kgF in a specimen of Group IV. Analysis of variance (ANOVA) revealed a statistically significant intergroup difference (F=168.40; p<0.001).

It was similar to the study performed by (Martinez-Insua Arturo et al)[7] who used 44 recently extracted sound premolars which were randomly distributed into2 equal groups: group I, restored with prefabricated carbon-fiber post and a composite core; and group II, with custom-cast type III gold alloy post and cores .All teeth were fully covered with a nonprecious cast crown. Fracture resistance was measured by applying a point force at 45 degrees to the long angle of the tooth. Significantly higher fracture thresholds were recorded for the cast post and core group (differences significant with *P*=.003).

Under the condition of vertical loading, most of the cracks propagated in the cervical portions of teeth restored with posts were found. It can, therefore be considered that the posts significantly contributed to the reinforcement and strengthening of pulp less teeth by supporting remaining tooth structure against vertical compressive force.

When a 45-degree oblique load was applied to teeth restored with a cast metallic post core, the stress distributed inside the post, all over the interface between the post and root dentin, and in the apex of the post. Reflecting this stress distribution, fractures propagated along the metallic post over the cervical portion of the root were seen in the present study. This indicates that most of the fractured teeth restored with cast metallic post-cores were not reparable.

In contrast, the majority of fractures in the fiber post group were limited to the cervical portion of the root including the core-dentin interface, since the stress was concentrated in the cervical area and the outer root surface. This type of fracture is most easy for repeated repair. This was similar to the study conducted by (Darabi Farideh et al)[8] in which 40 maxillary canine with similar size were chosen and divided into 2 groups: fiber post and composite core and cast metal post core. Fiber post were luted with dual core resin cement and cast post was luted using zinc phosphate cement. Load was applied to the long axis of tooth and was observed that all of the fractures in this group were repairable.

When a post with a similar modulus of elasticity to that of radicular dentin, such as a fiber post, is used for restoration, less stress is transferred from the post to the dentin. These phenomena can be exaggerated by applying an oblique load, which induces bending stress in the restored roots. This might be the reason for the significant reduction in fracture resistance of teeth restored with metallic posts in the present study, and the lowered clinical incidence of root fractures in pulpless teeth restored with a fiber post compared to those restored with a conventional metallic post system.

Under the condition of oblique loading, all teeth restored with post-core systems fractured at the interface between the post-core and root dentin accompanied by dislodgement of the posts. These fractures could have originated from the adhesive interface between the cores and root dentin. Therefore, successful adhesion between the restoratives and root dentin might be critical for the durability of pulp less teeth restorations.

These results were different from other authors (Hayashi Mikako et al)[4] who used 48 maxillary premolars which were restored with fiber post, prefabricated metallic post, cast metallic post core and prepared teeth as control group. Under the condition of vertical loading, most of the cracks propagated in the middle and apical portions of teeth restored with posts were found as vertical splits, due to buckling of root dentin.

It has been reported that the ordinary chewing force of adult's ranges from 7 to 15 kg, and the maximum bite force is up to 90 kg. The fracture loads in all groups were found to be sufficiently greater than the ordinary chewing force, and even greater than the maximum bite force. Further studies are currently underway to investigate the fatigue resistance of pulp less teeth restored with different types of post-core systems. The mechanical strength of pulp less teeth restored with post-core systems needs to be evaluated by both initial fracture and fatigue resistance, since pulpless teeth have to endure both types of load in the oral environment and both types of loading can induce critical fracture of pulp less teeth.

CONCLUSION

1. So, from the result of this study, it was concluded that under conditions of vertical loading, the fracture load of teeth restored with the cast metallic post-cores was greatest among the groups and under the condition of oblique loading, the fracture load of teeth restored with pre-fabricated metallic posts was significantly smaller than that in other groups.
2. The combination of a fiber post and composite resin core with a full cast crown is the most protective method for maintaining tooth structure.
3. All the fractures in the specimen samples, irrespective of the nature/ presence of post took place at cervical region.

TABLE 1

S. No.	Group	No. of samples	Percentage
1.	I	10	25
2.	II	10	25
3.	III	10	25
4.	IV	10	25

FIGURE 1

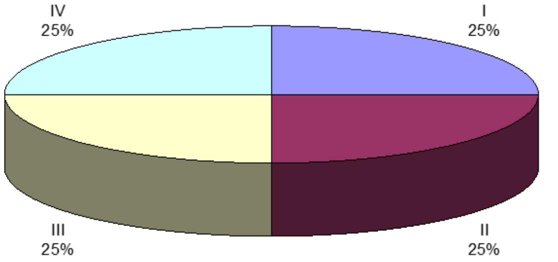


FIGURE 2

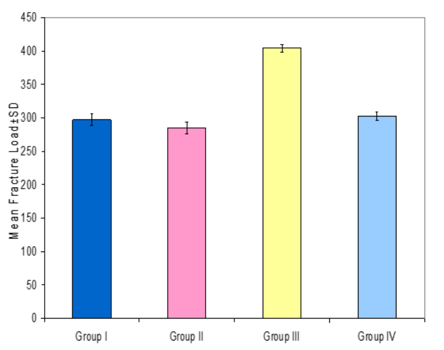
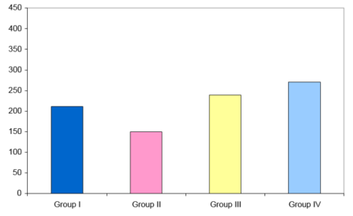


FIGURE 3



REFERENCES

1. Ali Balbosh, Matthias Kern, Christian-Albrechts. Effect of surface treatment on retention of glass-fiber endodontic posts. J Prosthet Dent 2006;95:218-23.
2. Arturo Martinez-Insua, Luis Da Silva, Benito Rilo, Urbano Santana. Comparison of the fracture resistances of pulpless teeth restored with a cast post and core or carbon-fiber post with a composite core. J Prosthet Dent 1998;80:527-32
3. Baraban D.J**.** A simplified method for making posts and cores, J. Prosthet. Dent., 24: 287, 1970.
4. Mikako Hayashi, Yutaka Takahashi, Satoshi Imazato, Shigeyuki Ebisu. Fracture resistance of pulpless teeth restored with post-cores and crowns. Dental Materials 2006; 22: 477–485.
5. Begum Akkayan. An invitro study evaluating the effect of ferrule length on fracture resistance of endodontically treated teeth restored with fiber-reinforced and zirconia dowel systems. J Prosthet Dent 2004;92:155-62.
6. Marcela P. Newman, Peter Yaman, Joseph Dennison, Mary Rafter, Edward Billy. Fracture resistance of endodontically treated teeth restored with composite posts. J Prosthet Dent 2003;89:360-7.
7. Arturo Martinez-Insua, Luis Da Silva, Benito Rilo, Urbano Santana. Comparison of the fracture resistances of pulpless teeth restored with a cast post and core or carbon-fiber post with a composite core. J Prosthet Dent 1998;80:527-32
8. Farideh Darabi, Laleh Namazi. Comparison of the Fracture Resistance of Endodontically Treated Teeth Using Two Different Restoration Systems. August 2008 Dent Res J 2008; 5(2):65-69