

Resistance to Fracture of Lower Premolars with Abrasion and Abfraction Lesions

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Abstract:-

➤ Aim:

To compare the resistance to fracture of root canal treated mandibular premolars with abrasion and abfraction (non -cariou cervical) lesions involving the pulp, restored with different post systems.

➤ Materials And Methods:

Human mandibular premolars (n=20) with single root canal were divided randomly into four groups (n=5). Wedge-shaped lesions (NCCLs) were created in all teeth specimens on the buccal cervical area. After root canal treatment, the teeth were grouped into (i) NCCLs + prefabricated glass fibre-reinforced composite post + composite resin core (NCCL+PGFRC+CRC); (ii) NCCLs + prefabricated stainless steel post + composite resin core (NCCL+ PSSP+CRC) (iii)NCCLs + custom polyethylene fibre posts + composite resin core (NCCL+CRFP+CRC); (iv) NCCLs + composite resin core (NCCL+CRC). Axial compressive force was given to the occlusal surface with a universal testing machine until fracture. The crosshead speed was 0.5 mm/min. Pairwise comparisons of the load-to-fracture among the groups were analysed.

➤ Results:

Resistance to fracture was higher for NCCL+ PSSP+CRC than the other three groups, while NCCL+CRC showed the least value.

➤ Conclusion:

NCCL filled with prefabricated stainless steel post and composite resin core showed greater ability to withstand compressive load than the other groups.

Keywords:- Non Cariou- Cervical Lesion, Prefabricated Glass Fibre-Reinforced Composite Post, Prefabricated Stainless Steel Post, Custom Polyethylene Fibre Posts.

I. INTRODUCTION

Non-cariou cervical lesions can be in the form of shallow grooves, broad dish-out lesions or as large wedge-shaped defects and is seen on facial, lingual or interproximal surfaces.¹ This includes erosion, abrasion, and tooth flexure (abfraction). Excessive tooth brushing, increased intake of acidic foods, abrasive diet, abnormal occlusal forces are some of the aetiological factors. The prevalence of such lesions ranges between 5% and 85% and increases with age.^{2,3} In advanced cases, lesions affects the

structural integrity and vitality of the tooth by involving the pulp.⁴ Such situations necessitates the endodontic intervention and proper rehabilitation of the concerned tooth. Usually intra-radicular posts are indicated for their survival in the dental arch. This leads to further removal of radicular dentin and weakening of the tooth, thereby reducing their fracture resistance. More than 50% reduction in the fracture resistance of ETT have been noted in the presence of NCCLs. Fracture is a common reason for extraction of teeth after root canal therapy. Among this 13.4% is due to vertical root fracture.⁵

Various post systems like custom made cast post, prefabricated fibre posts and metallic posts, customised fibre posts, etc. are used presently. The physical and mechanical properties of each of these varies, hence their effects on the tooth.

Prefabricated posts are cemented with an adhesive technique.⁶ They have already designed taper, shape and diameter. So in wide canals, they have limited adaptation to the interior of the root canal.^{7,8} resulting in gap formation. This will increase cement thickness, micro leakage, low bonding strength, and decreased resistance to fracture when subjected to occlusal forces.^{9,10} Custom-made fibre posts requires minimal post space preparation, conserves more tooth structure, thereby improving the survival of teeth.⁸ Metallic posts are having higher fracture resistance than fibre posts.

Laboratory studies evaluating the survival of endodontically treated maxillary premolars with NCCLs shows favourable result with fibre post-retained composite resin.¹¹ Maxillary and mandibular premolars are usually subjected to non- cariou cervical lesions. Mandibular premolars, being the tooth under maximum flexure in the dental arch, is more prone for fracture in presence of a non-cariou cervical lesion. Hence, this study was intended to test the ability to withstand fracture by root canal treated mandibular premolars with non-cariou cervical lesion when it is rehabilitated with different post systems.

II. MATERIALS AND METHODS

➤ Sample Selection

Twenty intact human lower premolars with solitary root canal, extracted as part of orthodontic treatment and without caries or cracks, were kept in 0.9% normal saline solution at room temperature. Soft and hard debris were removed using 3% sodium hypochlorite (for 30 minutes) and by scaling respectively. Teeth with (i) multiple canals;

(ii) cracks; (iii) immature apex; (iv) resorption; (v) blocked canals were excluded.

➤ Artificial NCCLs Preparation

Wedge-shaped NCCLs were created for the specimens, on the cervical area of the buccal surface. The dimensions of the lesions were;

- Occluso- cervical height of 3 mm
- Depth upto the pulp space
- The mesio-distal width extending between the line angles.

➤ Root Canal Preparation

Access cavities were prepared and the working length was determined. A manual glide path was established using a #10 K-file. Cleaning and shaping was performed with crown down technique, up to ProTaper gold F2 with 17% EDTA gel, copious irrigation using 3% sodium hypochlorite and 0.9% physiologic saline. After drying, the canals were obturated with a Gutta-Percha Point for #F2 and AH Plus sealer. Wait for 24 hours to ensure complete setting of the sealer. Specimens were grouped into the following groups with five teeth in each. The groups are;

- NCCLs + prefabricated glass fibre post + composite resin core (NCCL+PGFP+CRC)
- NCCLs +prefabricated stainless steel post + composite resin core (NCCL+PSSP +CRC)
- NCCLs + custom polyethylene fibre posts + composite resin core (NCCL+CPEFP+CRC).
- NCCLs + composite resin core (NCCL+CRC);

A post space preparation was done in each specimen of the first three groups using peeso reamer size 2. 5 to 6 mm of apical root filling was left behind.

➤ Restoration of root canal system

The root canals of the first three groups were etched with 37% phosphoric acid (Eazetch, Anabond) for 15 seconds and was washed with copious water. After drying, dentin bonding agent (Te-Econom, Ivoclar, Vivadent) was applied in the root canals and light cured for 20 seconds.

For NCCL+PGFP+CRC group, Angelus reforpost fibre glass, size 2 (Angelus) was used to restore the root canal system. The post surfaces were cleaned using alcohol and dried. On it two layers of Silane coupling agent (Silane-X, Prevest, Denpro) was coated and air dried. Later, the posts were bonded with a dual cured resin cement (Fusion Ultra D/C, Prevest, Denpro) and were cured for 40 seconds.

For NCCL+PSSP +CRC group, the resin cement was applied and the Angelus reforpost metallic, size 2 (Angelus) were placed carefully into the canal. Then it was rotated a quarter to engage the serrations on the post surface with the cement and was cured for 40 seconds.

The NCCL+CPEFP+CRC group was restored with Ammdent infibra fibre splint, a polyethylene fibre splint material. Adequate length of the material was cut and wetted using a dentin bonding agent, with gloved hands. Then it was adapted into the canal and luted using the resin cement.

The access cavity and the buccal non carious cervical lesions of all samples were restored using hybrid composite (Te-Econom plus, Ivoclar, Vivadent).

III. MECHANICAL COMPRESSIVE LOADING TEST

Each specimen were mounted in individual acrylic blocks of 4cm x 1.2cm x 1.2cm size up to 2 mm apical to the CEJ. Resistance to fracture was determined by a universal testing machine (Instron 2710) using a 5 mm diameter stainless steel rod crosshead. A compressive load recorded in Newton (N) was applied along the long axis of the tooth at a constant speed of 0.5 mm/ min until fracture. (figure1).



Fig 1 Stationary Compressive Load Applied using Universal Testing Machine on the Occlusal Surface.

IV. STATISTICAL ANALYSIS

Kolmogorov-Smirnov test was used to assess the normality of fracture resistance and was found to be normally distributed. For inter group comparison, Kruskal – Wallis non-parametric test was used. P value was set at $p \leq 0.001$. Post hoc analysis was done.

V. RESULTS

Descriptive statistics on the fracture resistance were expressed in mean, median, interquartile range and minimum – maximum values. Group (ii) (NCCL+PSSP +CRC) showed the maximum mean and median, $1228.8 \pm 53.3N$ and $1236N$, respectively. The mean and median for group (iv) (NCCL+CRC), showed the least values ($498.6 \pm 37.4N$ and $493N$ respectively). The data were normally distributed. Groups i and iii had comparable values of load required to fracture ($850.2 \pm 20.1N$ and $810.6 \pm 21N$ respectively).

Table 1 Descriptive Statistics on the Fracture Resistance (N) Expressed in Mean, Median, IQR and Minimum – Maximum Values.

Group	n	Load to fracture			
		Mean± Standard Deviation (N)	Median (N)	IQR (N)	Max-Min (N)
Glass fibre post	5	850.2 ± 20.1	854	867.5 - 831	878-826
Stainless steel post	5	1228.8 ± 53.3	1236	1278 - 1176	1282-1155
Polyethylene fibre post	5	810.6±21	817	829-789	836-786
Composite core	5	498.6±37.4	493	532.5-467.5	558-463

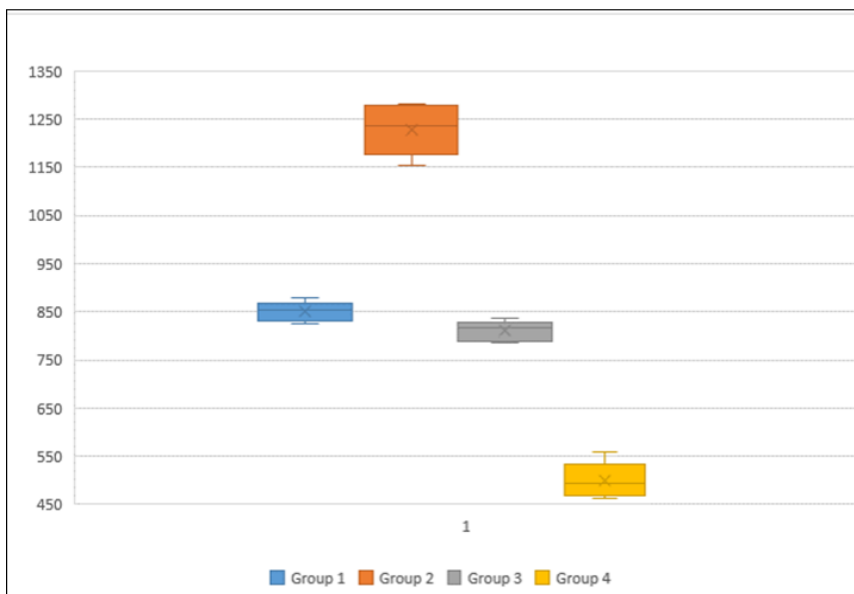


Fig 2 Box whisker plot showing the fracture load values of different experimental groups presented as median and interquartile range (IQR) and minimum and maximum values. Group 1 - Glass fibre post, Group 2 - Stainless steel post, Group 3 - Polyethylene fibre post, Group 4 - Composite core.

Table 2 Normality Test of Fracture Resistance (N) Performed using Kolmogorov-Smirnov Test.

		Fracture resistance
n		20
Normal Parameters ^{a,b}	Mean(N)	847.05
	Std. Deviation	267.820
Test Statistic		.204
Asymp. Sig. (2-tailed)		.029
a. Test distribution is Normal.		
b. Calculated from data.		

VI. DISCUSSION

Non-carious cervical lesions (NCCLs) are featured by loss of tooth substance from the crown and root at the level of cemento-enamel junction, without any caries.¹³ The prevalence of NCCLs accounts for nearly 53 to 72%.^{14,15} Deep cervical lesions approximating the pulp, needs endodontic treatment for their survival. It occurs commonly in aged population and the causative factors include the development and functioning of chewing muscles, trauma caused by excessive biting forces, faulty tooth brushing, chemical erosion, and inferior quality of cervical enamel. Whatever be the cause, it leads to weakening of tooth due to reduction in the thickness of peri-cervical dentin.¹⁶ NCCLs are commonly found in first premolars.¹⁷

The fibre post used in this study is Angelus reforpost glass fibre size 2 by Angelus. It is a parallel shaped prefabricated fibre post with conical tip and grooves for

retention. The conical tip helps to conserve radicular dentin in the apical portion of the root. Its elastic modulus is similar to dentin. This helps in reducing the stress concentration and provides stress distribution similar to that of an intact tooth. It contains 80% glass fibre, 19% pigmented resin and 1% stainless steel filament for radiopacity. Hence it can be distinguished on a radiograph unlike other common fibre posts. For bonding the post in the intraradicular space, the manufacturer recommends silanisation of the post surface. This improves the bond strength.

Angelus reforpost metallic by Angelus is the prefabricated stainless steel post used in the study. It has a sandblasted surface to increase retention and is not threaded. So it is not screw-retained, which avoids stress generation into dentin. It can be fixed into the canal with any luting cement, but resin cement provides the maximum bond strength.

Infibra fibre splint by Ammdent is made of highly crystallized polyethylene fibre which is white in colour and with special interlacing pattern of arrangement. This provides superior mechanical characteristics. The unique interlacing enables a net like pattern and enables the complete entangling with all low viscosity dental resins. It is commonly indicated for periodontal splinting, temporary replacement of missing teeth and for stabilisation of dentition after orthodontic treatment. But it can also be used for customised endodontic posts, as it can be adapted well to the canal space after wetting with a dentin bonding agent. It was carried into the canals using a hand plugger by Dentsply. It provides adequate strength when luted with a resin cement.

Te-Econom Plus by Ivoclar, Vivadent, is a light-curing, radiopaque hybrid composite with better physical properties and polishability. The manufacturer supplies a single-component total-etch adhesive, Te-Econom Bond along with it. It has high radiopacity making it visible on a radiograph and medium translucency giving better aesthetic results. Since it is light curable, provides adequate working time. At the same time, it is fast curing (10 seconds with high power lights > 1000mW/cm², for all shades) so that conserves procedural time.

Under abnormal occlusal forces, the tooth undergoes compression at the side of application of force and tension on the other side. The structure of teeth is in such a manner that it can resist compressive stresses well, but fails in the presence of tensile stresses. So loss of tooth structure occurs in those areas. The mechanical compressive loading test was used in this study which can produce more flexure towards the cervical area of the tooth.

An invitro study in which the ability to withstand fracture of ETT maxillary front teeth with loss of tooth structure in the cervical area was evaluated and the results proved the superiority of fibre post over the other modes of restorations.^{18,19} But when the resistance to fracture of endodontically treated intact teeth restored with stainless steel post, cast metal post and fibre posts were compared, stainless steel post showed better result.^{20,21} Makade et al. found that teeth reinforced with glass fibre posts demonstrated only core fracture whereas metal post and core found to have root fracture in the upper and middle thirds.²⁰

The poly ethylene fibre reinforced restorations have shown better result in improving the survival of teeth. Teeth reinforced with polyethylene fibre posts showed similar efficacy as zirconia-rich glass fibre post in retaining composite resin restorations.²² Sirimai et al reported that the ribbon made of ultra high molecular weight polyethylene fibres was effective in reducing the incidence of root fractures in the axial direction and the failure thresholds were much below than that of conventional cast posts.²³

In a study by Li. et. al. on teeth with open apex, the group restored with fibre post was found to be superior to the cast metal post group in terms of fracture resistance.²⁴

In the current study, the maximum resistance to fracture was shown by teeth samples restored with stainless steel post. The least value was shown by the teeth in which no endodontic posts were used. This shows that the fracture resistance of ETT with NCCL was improved when an endodontic post was used for their rehabilitation.

VII. CONCLUSION

The ability to withstand fracture by endodontically treated lower premolars with NCCL can be improved if properly restored. Among the different post systems used, prefabricated stainless steel posts showed maximum resistance to fracture, while samples without a post showed least resistance to fracture.

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