EVALUATION OF THE FRACTURE RESISTANCE OF REMAINING THIN-WALLED ROOTS RESTORED WITH DIFFERENT POST SYSTEMS

ABSTRACT

The purpose of this work was evaluating the fracture strength of bovine roots weakened experimentally, restored with two different techniques: internal reinforcement of root canal walls with composite resin and a cast metal post and core or anatomic post (glass fiber post associated with composite resin). Thirty bovine lower central incisive were selected and transversally sectioned, remaining 14 mm of root in order to approximate to the human maxillary central incisive. A sequence of standardized wear was used to weak the root until the walls remaining achieved from 0.5 to 0.7 mm of thickness at the cervical edge. Two groups were separated randomly (n=15) in order to test the roots reinforced with composite resin associated with cast metal post and core (CMP), or roots restored with composite resin associated to the glass fiber post (GFP). The test were applied in a Universal Test Machine (EMIC) with tangential compressive loading focused on the lingual face of core in an angle of 135° with the long axis of the tooth at a crosshead speed of 0.5 mm/min until failure occurred. The results showed that the fracture strength of remaining roots with weakened walls was influenced by the restorative technique, and the higher values of strength fractures were observed in the group of roots reinforced by composite resin associated with CMP ($p<0.001$) when compared to the group of roots restored with anatomic post.

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KEYWORDS

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INTRODUCTION

Reconstruction of teeth where the root portion is weaken many times impose a dilemma to the clinical: how much of dental structure should be sacrificed in order to improve the retention and, added to this factor, there is also a lack of consensus about fundamental questions regarding the different techniques for post systems.[1]

The diversity of intra radicular posts and their particular techniques have been studied for decades in order to advance the strength of remaining roots against shear loadings caused by the post[2,3]. Differences about the kind of post, if prefabricated or a cast post and core4, ideal length and diameter[5,6], choice of cementation agent with resinous cements, zinc phosphate or even glass ionomer[7] and the quantity of dental structure remaining[8] are components responsible by the success of restoration, and thus clinical accompaniments[9] are investigated, as well as the laboratorial tests in order to achieve a standard able to offer strength and longevity for the rehabilitated element[7,10].

The features of metal posts evaluated by several studies have evidenced the optimum ability to resist compression strength, and optimum dimensional stability, on the other hand, they present negative aspects, like requirement of higher handicraft to confection them and higher time of work, they present rigidity superior to the dentin; require a non-conservative preparation and they are susceptible to corrosion[11].

Because of these aspects which challenge the modern dentistry, some alternatives for CMP have been evaluated in order to achieve materials with modulus of elasticity near to the dentin, with the view to achieve better distribution of tension[12]. Therefore, one of the requisites much evaluated in the comparison among techniques using prefabricated posts and cast metal posts is the fracture strength before loads applied on the restorations, where several works show that CMP presents a greater tendency to catastrophic failures compared to the prefabricated fiber reinforced posts[13,14].

Preserving as much as possible dental structures corroborates the idea that the indication of a post system should not aim to increase the strength of root, but it should be limited only when an additional retention is necessary. Results assert that roots with less structure remaining restored with post have less resistance, and it reinforces the importance of conservation of dentin [15,16]. Despite some authors list physiological changes of dentin, mainly its dehydration as factors that predispose the facture, the main responsible factor by radicular weakening is the loss of dentin structure inside the root, causing thin-walled roots[3,17,18]. In these situations, the root canal is flared excessively and the surrounding walls became very thin;

then there is the need to use a post in larger diameter, what can cause fractures and loss of element due to the shear strengths loads generated by the post. Therefore, a solution for these kinds of problem has been sought tirelessly, like the substitution of traditional cast metal post by glass fiber reinforced posts [4,5,11] or by decrease of light of root canal through reinforced material, previously of the use of a post system, with composite resin or glass ionomer[2,6,7,19].

When considering all these analyses carried out, there is no consensus about the superiority of determined material and technique for rehabilitation of weakened roots; therefore, this work had as aim evaluate strength fracture of radicular remaining by means of two different techniques: weakened roots reinforced internally with photopolymerizable composite resin and restored with CMP, and weakened roots restored with anatomic posts (glass fiber posts in association with composite resin).

MATERIAL AND METHODS

Sample

Thirty bovine lower central incisive free of caries or fractures were selected. Their roots were sectioned with a Diamond disc (KG Sorensen, Brazil) in low rotation, remaining standardized 14 mm length measured by digital caliper (Figure 1).

The sectioned roots were submitted to endodontic treatment with instrumentation until K-file 80 (Dentsply Maillefer, Brazil), irrigation with 1.0% Sodium hypochlorite (Asfer, Brazil), drying the canal with absorbent paper points (Tanari, Brazil) and obturation with gutta-percha using the lateral condensation technique (Tanari, Brazil) 1 mm short the radicular apex, all of them carried out by the same professional.

The samples were stored in distilled water with a 3 mm plug made of glass ionomer cement Maxxion R (FGM, Brazil). After 14 days in distilled water, the plug was removed and the obturations of root canal were also partially removed.

Removal of gutta-percha was performed until 9 mm depth (maintained 4mm of apical sealing) with Largo Bur n° 4 (Injecta, Brazil), maintained between 2.0 and 2.5mm of thickness in radicular wall on cervical edge evaluated with digital caliper.

Figure 1: Root sectioned in 14,, length.

Intraradicular preparation to simulate weakened roots

The 30 teeth suffered an additional wear on the walls, in order to simulate thin-walled roots. A drill Largo #5 (Injecta, Brazil) was introduced in the root canal in low rotation, until 9mm depth,

established by the stop positioned in the drill rod. Following, a spherical Diamond bur #1016 (KG Sorensen, Brazil, 1.8mm diameter) was used in high speed, under constant water cooling until 8 mm depth.

Next, a Diamond bur #3017 HL (KG Sorensen, Brazil) 2.5 mm diameter carried out the wear on the middle third until achieve 5 mm deep. Finally, a Diamond bur n #3018 (KG Sorensen, Brazil) carried out the wear until 3 mm depth to prepare the cervical third. The remaining on the radicular wall, at the end of preparation, presented a thickness between 0.50 and 0.70mm, in a simulation of a root weakened by the excess of structural loss (Figures 2 and 3).

Figure 2: Sequence of wear to weaken root.

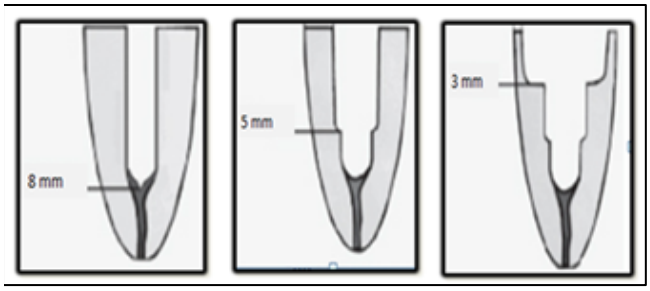
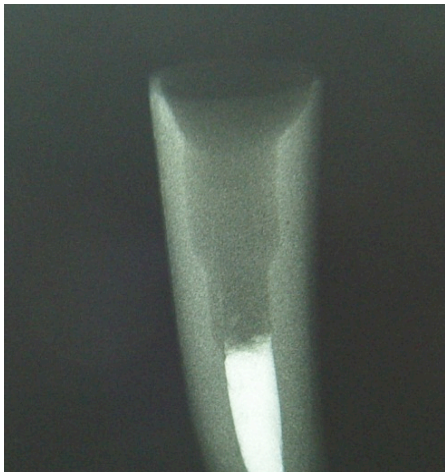


Figure 3: Radiograph demonstrating radicular weaken.

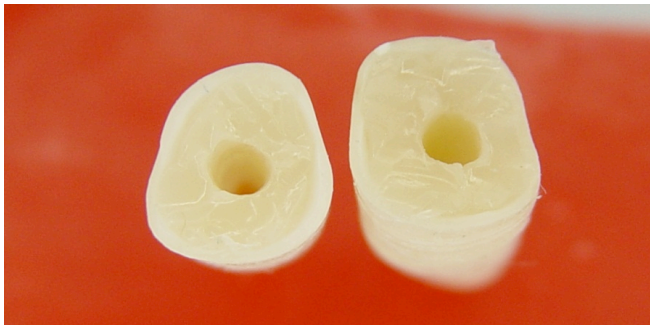


Groups with weakened roots

CMP-CR

Flared roots had the light of root canal decreased by the increase of photopolymerizable composite resin (Z350-3M ESPE, Brazil) inside them (Figure 4), and posterior cementation of Co-Cr cast metal post and core with zinc phosphate (Sswhite).

Figure 4: Internal enhance with composite resin.



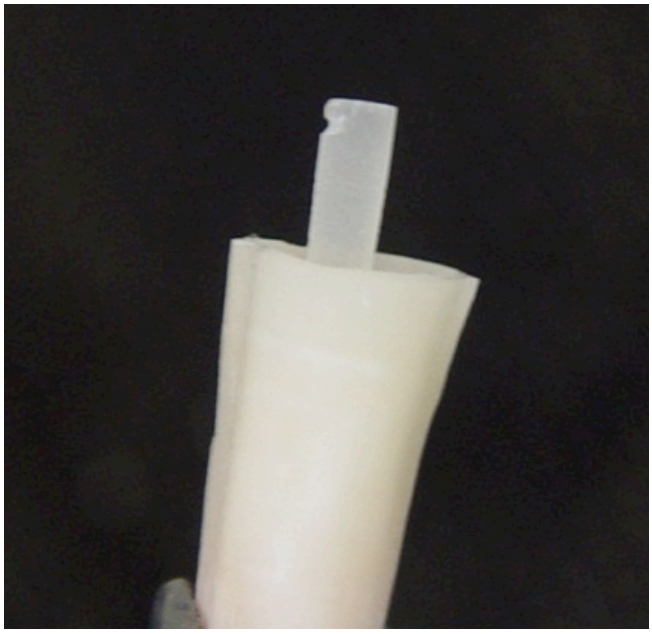
To standardize the confection of coronal portion of CMP, a matrix in Co-Cr (Fitcast cobalto, Talmax, Brazil) with five metallic patterns obtained from duplication in self polymerizable resin Duralay (Reliance Dental, EUA) of a model of a superior central incisor prepared to receive a total crown was used. From this metallic pattern, matrixes in EVA – Ethylene copolymer/vinyl acetate (FGM, Brazil) were confectioned in a vacuum laminator machine, which was used as guides in the modeling of coronal portion of CMP.

GFP-Cr

Weakened roots were restored with glass fiber post (Figure 5) #2 Whitepost DC (FGM, Brazil)

in association with photopolymerizable composite resin Z350 (3M ESPE). The post covered by composite resin was introduced inside the canal, modeling it and next it was removed and photopolymerized, in order to create an anatomic post. The coronal portion of the post was obtained by photopolymerization of the resin with the matrix in EVA positioned, in order to standardize the samples. Lastly, they were cemented with resin dual cement Rely-X Arc (3M ESPE).

Figure 5: Glass fiber post used for anatomic post confection.



Samples assembly

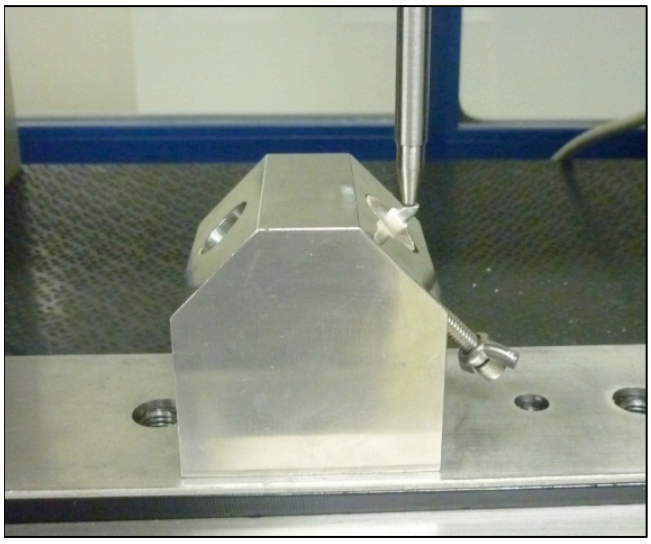
All the remaining roots were covered with two layers of Universal Tray Adesive (Zhermack, Itália) in order to simulate the periodontal ligament. Self polymerizable colorless acrylic resin (JET, Clássico, Brazil) was poured inside the half inch cylinders PVC (Tigre do Brasil) with 20 mm height, keeping 3 mm of root off the resin in order to simulate the biological distance. After the polymerization of resin, the samples were identified and stored in distilled water. During the three days before the test the samples were stored in humid environment, in controlled temperature at 37°C.

Fracture strength test

The specimens were positioned in a metal bracket inclined at 45° related to the base in order to allow the application of load with 135° angle related to the long axis of the tooth. Following, they were hold in a Universal Test Machine (EMIC), where the compression tangential force was applied at a crosshead speed of 0.5 mm/min, until the occurrence of the sample fracture (Figure 6).

Fracture strength data were analyzed by the Students T Test after vacuumerify the normal distribution of both groups. The significant level adopted was 5%, and statistical calculus carried out in the Program SPSS 20 (SPSS Inc., Chicago, IL, EUA).

FIgure 6: Specimen submitted to the compression test at universal test machine.



RESULTS

Table 1 shows the descriptive data analysis about strength fracture of remaining roots with weakened walls of groups CMP and GFP, and the comparison result between the groups analyzed through the Student T test. There was a statistical significant difference that shows that strength fracture of flared roots with thin walls reinforced by composite resin and restored with CMP was superior to the group that received GFP with composite resin (P< 0.001).

Table 1: Fracture strength values (Kgf) in radicular remaining with weakened walls restored with different techniques.

Technique	Mean	Standard deviation	Minimum	Maximum	P
CMP	52.9	18.8	25.7	90.0	<0.001
GFP	30.2	10.7	16.4	43.5	

P value obtained by Student T test with 5% significance. MMC-RC: Molten metallic cores enhanced with composite resin; FBP-CR: Fiberglass posts enhanced with composite resin.

DISCUSSION

Several authors have demonstrated the effectiveness of reinforce internal walls of root canal before the post installation. Mostly, the materials for this objective are composite resin or glass ionomer[2,6,13,19].

This research evaluated the behavior of weakened roots regards to the fracture strength, when they are restored following two different techniques to reinforce the root, in one of the groups was used internal enhance of walls in association with cast metal post and core (CMP), and in another group, with anatomic post. According to the tests applied in these samples, the results presented discard the null hypothesis that there is no difference related to the compression between the groups, because when mean values obtained are compared with the use of CMP (52.9 kgf), relative to the mean values obtained with the use of anatomic post (30.2 kgf), the results are similar to those obtained by Giovani et al. (2009) and Kivanç et al. (2009), that demonstrated higher values of strength fracture for cast metal post than for glass fiber posts (FGP), both associated with internal enhance with composite resin. With respect to this work, the lowest value obtained by anatomic posts may be related to the absence of coronal remaining structure, the core is formed only by composite resin and glass fiber post, leading the specimens to the fracture in coronal portion. In this way, it is common associate the fracture with the failure of union between the resin and the post surface, with the radicular portion intact. Perhaps the explanation for this fact can be associated with the occurrence of compression load only in one point of core palatal surface, what can favor the adhesive failure of composite resin with the resinous matrix of the post. New studies using different methodologies, or with addition of a crown could elucidate this question.

There is a consensus among several authors that instrumentation of root canal weak significantly the roots, and there are three important factors to reduce the fracture risks: quantity of remaining dental structure, strength of post and core, and cementation interface between the post and tooth[17,18].

However, situations where the root presents deficiency of dental remaining and the enhance material chosen is the composite resin some authors highlight the fact that photo-transmitter posts should be used to ensure the complete polymerization of the material 6. Based on this hypothesis, would be necessary compare the results with samples of weakened roots reinforced with other material. In this case, the glass ionomer could be indicated to carry out comparative tests about compression loads.

However, the result observed in this work corroborates with found by Fukui et al. (2009), and validate the results from specific literature, that have demonstrated after with similar methodology the group CMP and composite resin enhancing the canal presented better mechanical properties in rehabilitation of roots committed than the group GFP after the compression test.

Meanwhile, it is important highlight that data found in this study should be interpreted carefully, taking into account the natural limitations presented by a laboratorial test. In this way, more laboratorial studies are necessary, and in another moment similar tests adding a prosthetic crown could complement the results obtained.

CONCLUSION

From the analysis of results obtained in this study, within the limitation of an in vitro methodology is possible conclude that:

a. The fracture strength of weakened roots is influenced by the restorative technique chosen.

b. The groups with weakened roots reinforced with composite resin and restored with cast metal post and core presented higher strength values than the group with weakened roots restored through the association between fiberglass post and composite resin.

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