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Comparison of Shear Strength of Amalgam Cores With and Without Post in Endodontically Treated Posterior Teeth

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The purpose of this study was to evaluate the shear strength of amalgam cores with and without post. As many endodontically treated posterior teeth loose more coronal tooth structure they need post and core for retention of their restorations. The researches have shown different results when using various post and core materials. A total of 20 recently extracted mandibular premolars were used in this study. After endodontic treatment all canals and coronal portions of teeth were prepared for amalgam cores. The teeth were randomly divided in two groups. The teeth in group one were restored with amalgam core and post and group two with amalgam core without post. Each specimen was placed in a special jig and loaded with Zwick/Material testing machine with a crosshead of 0.5 mm min^{-1} until fractured. To compare the results t-test was used. Mean shear strength was 37.7 kgf for group 1 and 16.18 kgf for group 2. There was a statistically significant difference between two groups ($p<0.0001$). Based on present results it can be concluded that restoration of endodontically treated teeth with amalgam core and post had more shear strength resistance than amalgam core without post.

Key words: Post and core, endodontically treated tooth, core materials, posterior teeth, amalgam core

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INTRODUCTION

As the occlusal surface of posterior teeth is subject to greater occlusal forces than anterior teeth even caries free endodontically treated posterior teeth may fracture (Schwartz *et al*., 2004; Sedgley and Messer, 1992; Shillingburg *et al*., 1997). Many endodontically treated teeth have lost more coronal structure due to caries, previous restoration and access cavity that limit the use of remaining coronal portion for retention of restoration (Shillingburg *et al*., 1997; Stephen and Hargreaves, 2006). The studies have shown different results when using various post and core materials (Levartorsky *et al*., 1996; Fokkinga *et al*., 2005; Baldissara *et al*., 2006; Garoushi *et al*., 2007). The most common materials that have been used as a core material are cast post and core, amalgam, composite and glass ionomer which have more strength, respectively (Sedgley and Messer, 1992; Bonilla *et al*., 2002; Cohen *et al*., 1996). As the preparation of cast post and cores is more expensive and time consuming, the amalgam is used more as core material with and without post due to its greater strength than composite and glass ionomer. The aim of this study was to evaluate the shear strength of amalgam core with and without prefabricated post.

MATERIALS AND METHODS

This experimental study was performed in School of Dentistry, Kerman, Iran 2006. A total of 20 recently extracted single-rooted mandibular premolar were selected and placed in 5% buffered solution of formal for 2 h before experimental procedure (Baratieeri *et al*., 2002). Preoperative standardized radiographs were taken prior to instrumentation. Coronal access was achieved using diamond burs (Diatech, Swiss Dental Instruments, Switzerland). The working length for all groups was obtained by measuring the length of initial instrument (No. 10) at apical minus 1 mm. All root canals were cleaned and shaped with k- files (Dens Ply maillefer USA) using step back technique to file No. 45 (Stephen Hargreaves, 2006; Pilo and Tamse, 2000). Obturation was done following manufacturers technique protocols. Canals were filled with Gp (Dents Ply Tulsa USA) and AH 26 (Detry-Dents Ply, Konstansz, Germany) using lateral condensation technique. Specimens were stored at 37°C in 100% humidity until further use (Stephen and Hargreaves, 2006; Baratieeri *et al*., 2002; Pilo and Tames, 2000).

After root canal treatment the standard preparation for post and core begun by preparing the coronal tooth structure for the crown. The shoulder finish line of post was 2 mm above the finish line of crown (Shillingburg *et al*., 1997; Rosenstiel *et al*., 2006). The samples were randomly divided in two groups. Using a series of successively larger reamers, canals were enlarged to a diameter of 1.5 mm and length of 9 mm. At the end of instrumentation canals were irrigated with normal saline (Shillingburg *et al*., 1997; Cohen *et al*., 1996; Rosenstiel *et al*., 2006; Thorsteinsson *et al*., 1992). All procedures were performed by one operator (Fig. 1).

In group one (core with post), to confirm the fit of post before cementation, the post was tried in the canal. A thin mix of zinc phosphate cement was made and introduced to canal until the walls of canal were completely coated with cement. Then post was coated with cement and pushed slowly to the prepared canal allowing the excess cement to escape. The post was holed in place with finger pressure. When initial set occurred, the excess of cement was removed from around the post head. A correct diameter of matrix band was selected to fit the tooth and amalgam was condensed with amalgam condenser. After initial setting of amalgam, matrix band was removed. Samples were kept for final setting for 24 h. The cores were shaped with diamond bur (Diatech, Swiss Dental Instruments, Switzerland) to size of 5 mm height and 6 mm diameter in such a way that the gingival finish line crown was 2 mm below the finish line of post shoulder (Fig. 2).

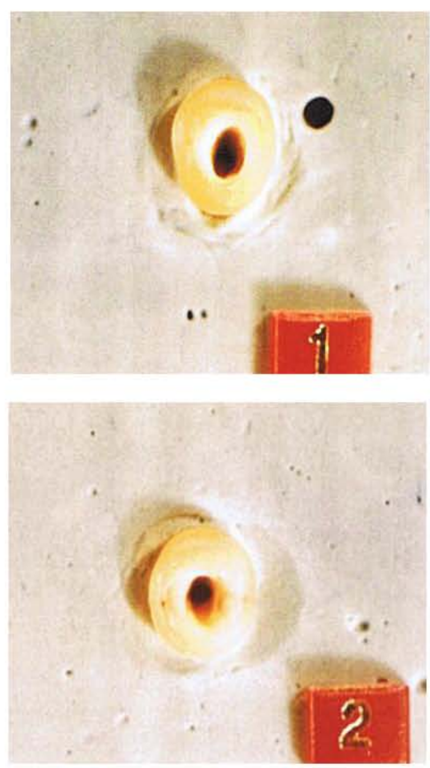

Fig. 1: Teeth after standard preparation for post and core

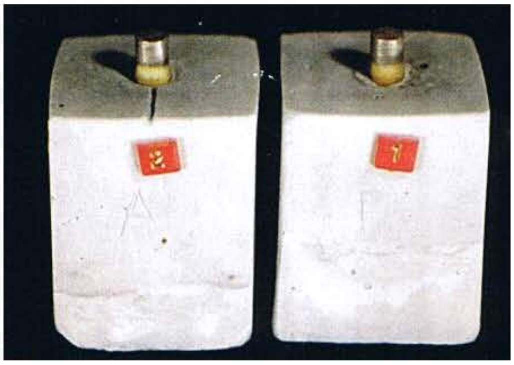

Fig. 2: Amalgam cores with and without post

In second group the cores were made without post that is amalgam was condensed in canal and core space and all the other procedures were same as the first group.

Each specimen was tested for shearing strength with Zwick/Material testing machine at a cross head speed of 0.5 mm min^{-1} until failure occurred.

Statistical analysis: To compare the mean of shear strength for two groups t-test (pooled) was used.

RESULTS AND DISCUSSION

The maximum and minimum shear strength was 58 and 21 kgf, respectively in group one. For group two the maximum shear strength was 30 kgf and minimum was 10 kgf. The mean shear bond strength for group 1 and 2 was 37.7 and 16.8, respectively (Table 1). There was a significant difference between the two groups ($p<0.0001$) (Table 2). The mode of failure was also different for the two groups. For group 1 the fractures were mostly adhesive that is at post and core interface but in group 2 most of fractures were cohesive that is at junction of core and orifice of canal.

Endodontically treated teeth are structurally different from unrestored vital teeth and required specialized restorative treatment. The major changes are loss of tooth structure, altered physical characteristics and esthetic change in tooth structure. Restorations for endodontically treated teeth are designed to compensate for these changes. These changes that accompany root canal therapy influence the selection of restorative materials and procedures. An endodontically treated tooth should have a good prognosis. It can resume full function and serve satisfactorily as an abutment. Two factors influence the choice of technique: the type of tooth and the amount of remaining coronal tooth structure (Stephen and Hargreaves, 2006; Rosenstiel *et al*., 2006). As most endodontically treated teeth have lost more than half of

Table 1: Minimum, maximum and mean (kgf) of groups

Group	Minimum	Maximum	Mean
1	21	58	37.7
2	10	30	16.8

1: Amalgam core with post, 2: Amalgam core without post

Table 2: Statistical results for shear strength of groups

Group	SD	Variance
1	10.49	110.0401
2	6.37	40.5769

t- test: $t = 5.38$, $df = 18$, $a = 0.05$, $p<0.0001$

tooth structure, the use of post and cores is necessary to get retention for their restorations (Shillingburg *et al*., 1997). Due to more expensive and time consuming nature of cast post and core the use of pre fabricated post has become more popular (Cohen *et al*., 1996). Many materials have been used as core material but in posterior teeth amalgam is mostly used as core material due to better strength of amalgam as compared to composite and glass ionomer (Al-Ansari, 2007; Coltak *et al*., 2007). As there is no difference between core materials when 2 mm of tooth structure remained as ferrule for crown (Cohen *et al*., 1996; Kovarik *et al*., 1992; Levartorsky *et al*., 1996; Barjau-Escribano *et al*., 2006), in this study the crown was not used to eliminate the ferrule effect. The result of this study indicated that the maximum shear bond strength in group one was more as compared with group two. The mean of shear bond strength for group 1 and 2 was 31.1 and 16.8, respectively. Amalgam core with post showed more strength than core without post, which was the same as studies of Cohen *et al*. (1996), Levartorsky *et al*. (1996), Chen *et al*. (2006) and was different from the results of Fokkinga *et al*. (2005), Baldissara *et al*. (2006) and Garoushi *et al*. (2007). The mode of fracture was different in both groups. In group one it was mostly adhesive that is from junction of post and core amalgam. This may be due to mechanical bond between the post and amalgam core which acts as a void in restorative material and interference of post and core materials with different modulus of elasticity (Kao, 1991). But fracture in group two was cohesive. This may be due to more strength of amalgam when it is in bulk (Cohen *et al*., 1996). Although amalgam core with post has lower fracture force resistance than cast post, but the technique using prefabricated post and amalgam may be appropriate because there are no root fractures. Hence, the direct method appeared to protect the tooth structure. The limitation of this investigation include: the use of finger pressure to hold the posts in position during post cementation which did not provide a standardized loading force and the use of single load-to-fracture test to test the fracture resistance of specimens. For more accuracy of the results, future studies considering thermal cycling of specimens and fatigue loading is recommended.

CONCLUSION

According to the result of present study there was a significantly higher fracture strength in core amalgam with post and the type of fracture was mostly adhesive in amalgam core with post and cohesive in amalgam core without post.

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