Comparative Evaluation of the Compressive Strength of Endodontically Treated Teeth Using Bonded Amalgam & Bonded Composite Resin with and without Prefabricated Posts: An in Vitro Study

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Abstract

Aims: To compare the in vitro effect of bonded amalgam and bonded composite resin, with and without prefabricated posts, on compressive strength of endodontically treated teeth.

Methods and Material: One hundred maxillary and/or mandibular premolars were collected. After preparing access cavity, the teeth were biomechanically prepared and obturated. The samples were divided into five groups and two sub groups depending on the type of access cavity, restorative materials used and the use of posts. Teeth were embedded in acrylic resin and their strength was measured using Universal Triaxial Testing Machine. Data was tabulated and subjected to statistical analysis for comparison.

Results: Teeth restored with bonded composite resin were better than bonded amalgam when posts were involved in standard access preparation. The difference between this group and the intact teeth were statistically insignificant. Bonded amalgam corono-radicular restorations had significantly higher mean fracture loads than post retained amalgam cores.

Conclusions: Composite resin restorations with prefabricated post in standard access preparation showed compressive strength similar to intact teeth.

Key-words: Bonded restorations, Coronoradicular build up, prefabricated posts.

Introduction

The overwhelming success of endodontic therapy has allowed for the retention of more teeth than ever before, in the history of dentistry. Following endodontic therapy, the restorative dentist is faced with dilemma of deciding how to restore treated teeth, for use as an individual unit or as an abutment support for fixed or removable restoration in a predictable long term manner.

Often the tooth is badly destroyed by caries, and is further weakened by endodontic therapy. An endodontically treated tooth is more susceptible to fracture due to vertical and horizontal forces than a vital tooth. The fracture resistance of endodontically treated tooth is directly related to the amount of healthy dentin remaining. The quantity, intrinsic strength, configuration of restorative material, and the tooth structure determine the ability of restored endodontically treated teeth to resist the externally applied stresses.

Attempts to restore pulp less teeth using posts and crowns have been reported for more than 100 years. Until 1980, the cast metal post and core were considered the standard option to rebuild an endodontically treated and broken down tooth. However, prefabricated posts in conjunction with an amalgam or composite core performed at least as well as the conventional cast post and core [13].

Nayyar et al. in 1980 advocated the restoration of endodontically treated teeth with silver amalgam corono-radicular dowel and core technique. The primary purpose was to replace the lost architecture of the tooth. Silver amalgam lacked the adhesion property and retention, thus must be provided mechanically, with removal of additional tooth structure to develop undercuts. It is imperative for the restorative dentist to preserve as much tooth structure as possible.

Composites are fast encroaching on the territory, traditionally occupied by amalgam. Composite resin offers adequate strength, superior bonding and corrosion resistance therefore a better alternative to amalgam as a core build up material.

This study was carried out with the objective of comparing the compressive strength of endodontically treated teeth with bonded amalgam and composite resin, with prefabricated post and corono-radicular dowel and core technique.

Materials and methods

A total of 100 extracted maxillary and/or mandibular premolar were selected. They were stored in normal saline at room temperature. The teeth were randomly assigned into 5 experimental groups of 20 teeth each. All the experimental groups, except for group 1 were further subdivided according to their coronal tooth surface preparation as:

Sub group a: Standard endodontic access preparation.

Coronal access preparation was made with no 702 U taper fissure and regular length no. 4 round bur in high speed hand piece; root canals were instrumented to a size 40 file (Mani,Inc. Tochigi, Japan) and obturated with thermoplasticized injectable gutta percha, utilizing Obtura II heated gutta percha system and zinc oxide eugenol sealer (DPI)

Sub group b: Conservative mesio-occluso-distal (MOD) preparation with superimposed standard endodontic access.

MOD cavities were prepared using a no.245 bur to an occlusal width of 2mm of intercuspal distance; proximal box width: 3mm of the facio lingual distance at the gingival floor level; occlusal depth: 2mm at the central groove area; gingival depth: 4mm from the marginal ridge; and axial depth: 1mm at the gingival seat and 1.5 mm at the contact area.

The following groups and type of restorations were used

Group I Unaltered teeth (control group).

Group II Access preparation with obturation, restored with corono-radicular bonded amalgam restoration.

A radicular space, 3mm deep from the canal orifice was established for corono-radicular build up with peso reamer. The enamel-dentin surfaces were etched using

Unitech (32% h_3po_4) for 15 sec. The cavity was rinsed and excess water removed with a burst of air without desiccating the tooth. Primers A and B (ALL BOND-2 KIT) were mixed; 5 consecutive coats applied to enamel and dentin; surfaces dried gently for 5-6 sec; and were light cured for 20 sec each. Equal volumes of D/E resin and prebond resin were mixed and brushed onto the entire cavity surface. A tofflemire matrix band was positioned around the tooth, for MOD cavities. Tytin capsule was activated and transferred to amalgamator for trituration. Amalgam was condensed into corono-radicular space and the remaining cavity. It was burnished and tooth anatomy carved.

Group III Corono-radicular preparation similar to group II was done. Scotch bond etchant was applied to enamel and dentin for 15 sec; cavities rinsed for 10 sec. and blotted leaving tooth moist. Two consecutive coats of single bond adhesive was applied to etched enamel-dentin; dried for 2-5 sec. and light cured for 10 sec., the corono-radicular space was built with 3M fitek P-60 composite resin. An incremental curing of 2mm for 20 sec each was done. A tofflemire matrix band was positioned around the MOD cavity preparation. The band was removed and each surface of the restoration was cured for an additional 20 sec.

Group IV Teeth from group IV had post space prepared, leaving 4-5mm of gutta percha in the apical third of the root. Peso reamers no.1, no.2, no.3, was used for post space preparation. The final canal preparation was done with a matched parapost twist drill. Parapost no.4 equivalent was then luted, with HY- bond glass ionomer LX cement within the canal. 3mm of post length was maintained in the coronal portion of the access preparation. The remaining cavity was restored with bonded amalgam as in group II.

Group V Post space preparation similar to group IV was done. The remaining cavity was then restored with P-60 composite resin following similar steps as in group III.

Throughout the preparation the teeth were held in wet gauze to prevent dehydration. All samples were mounted in auto polymerizing acrylic resin to a level of 1mm apical to the cemento-enamel junction. The prepared samples were stored in normal saline for 24 hrs, before they were tested.

To test the compressive strength of the prepared teeth, the specimens were placed on the lower platen of a Universal Tri-axial Testing machine. The upper platen of the machine housed a 5mm steel sphere which was placed in contact with the occlusal surface of the tooth such that it contacted the inclined planes of the buccal and lingual cusps rather than the restorative margins. A constant rate of 0.75mm/min was applied to the specimens until fracture occurred. The force required to fracture each tooth was recorded in Newton's. The readings were obtained, tabulated, and subjected to statistical analysis using unpaired t-test for comparison.

Results

The mean force at fracture and standard deviations for each group are presented in table 1.

		Group II	Group III	Group IV	Group V
Subgroup "a" (Standard endodontic access preparation)	Mean	1202.5	1156	1089	1344
	S.D.	51.59	86.85	70.33	47.54
Sub group "b" (MOD with standard endodontic access preparation)	Mean	1091	1035	1065	1369
	S.D.	57.36	60.99	60.32	60.32
	Control group (group I)		Mean	1374	
			S.D.	59.68	

According to Unpaired t-test results, there were no significant difference between intact teeth and bonded composite resin with prefabricated post in standard endodontic access preparation (group I and group Va, P<0.05). Bonded amalgam and bonded composite resin showed comparatively similar results in standard endodontic access preparation, which were statistically insignificant (group IIa and group IIIa, P<0.05). There was significant difference between composite and amalgam restored standard access preparation with prefabricated post (Group IVa and Group Va, P<0.001)

There was significant difference between intact teeth and teeth with MOD cavity, with corono-radicular build up, restored either with bonded amalgam or with composite resin (P<0.001).There was no significant increase in resistance to fracture, in teeth restored with post and bonded amalgam or bonded composite resin (group IVb, group Vb, p<0.05).

Discussion

Contemporary endodontics has enabled retention of severely damaged teeth. Their restoration has been the subject of much discussion and controversy in the past decade. With advent of newer technologies and new materials, there has been considerable debate on the appropriate techniques for retention, reinforcement, and restoration of root filled teeth.

Endodontically treated teeth are widely considered to be more susceptible to fracture than vital teeth [9]. Dentin provides solid base required for restoration of tooth, and the structural strength of tooth depends on the quality and the inherent strength of dentin and the integrity of its anatomic form[1]. After endodontic therapy, there is usually an appreciable loss of dentin, including vital anatomic structures such as transverse ridges, marginal ridges, and the arched roof of pulp chamber. As more tooth structure is lost, the resistance to occlusal forces is diminished and the possibility of fracture increases.

Most of the literature concerning restoration of endodontically treated teeth has focused on the post and core unit. The traditional objective for a post was to strengthen and reinforce the weakened tooth, against intra-oral forces by equally distributing them with in the radicular dentin to supporting tissues, thus dispersing the forces along the root[1]. Also it provides the retention for the core that replaces the lost coronal tooth structure. However, excessive preparation of the canal weakened the tooth, decreased its ability to withstand forces before insertion of metal post, and the post further increased the risk of fracture [15].

Clinical procedures should minimize weakening of teeth, and when an adequate amount of intact tooth structure is present to retain a core, conservative restorative technique using amalgam and composite as a corono-radicular dowel[11] and core technique may be a viable alternative to the conventional post core technique.

Observations demonstrated that when the tooth structure was not significantly weakened, corono-radicular build up using either bonded composite or bonded amalgam showed comparatively similar results, which were statistically not significant (group IIa and group IIIa). This finding is in agreement with work by authors like Ulsoy Nuran et al [16]

Composite resin was significantly better than bonded amalgam as a choice of core build up material when post were involved, in conjunction with standard access (group IVa and group Va). Cohen I brett et al.[5] carried out a study and had a similar results.

The type of restoration in teeth with small preparation contributes minimally in decreasing the compressive strength of the cusps. If reasonable amount of sound dentin remains, tooth can be restored with or without reinforcement with a prefabricated post. Composite may be a better choice of material with a post as it has higher strength, better bonding with both the post and the tooth structure and less corrosive influence on the metal post [8].

It is significant to note that the ultimate compressive strength of teeth restored with prefabricated post and bonded composite resin in standard access preparation was very close to that of intact teeth, in fact the difference was statistically insignificant (group I and group Va). Clinically this may be of great significance, in that with minimally invasive endodontic access preparation, the use of prefabricated post with bonded composite may suffice as a final restoration.

Amalgam is strong in bulk, and the post itself reduces the bulk of amalgam restoration and tends to concentrate the stresses at specific points or line angles, of post-amalgam interface. This could weaken the material and account for lower results. The use of forth generation adhesive materials are advocated to bond amalgam to dentin[3].Though, the mechanism of amalgam bonding has been suggested to be one of the mechanical interlocking of freshly condensed amalgam into the unpolymerised resin as opposed to chemical adhesion of the composite resin.

In our study we found that bonded amalgam corono-radicular restoration had significantly higher mean fracture loads than post retained amalgam cores used as final restoration (group IIa and group IVa). It is conceivable that the use of the post could have resulted into reduction of bulk of amalgam restoration [10].

The strength of an endodontically treated tooth is directly related to the bulk of remaining tooth structure. Mesio-occluso-distal cavity preparation reduced the stiffness of the teeth by 63 % [12] indicating that the loss of tooth structure and destruction of marginal ridges and/ or transverse ridges are the key determinants in weakening the tooth.

When more dentin was removed to simulate a more extensive preparation, there was a significant drop in strength of the teeth restored with either bonded amalgam or bonded composite corono-radicular build up as compared to intact tooth. Neither of the two restorative materials led to a significant increase in the stiffness of the treated teeth.

The primary function of a post is to aid in retaining a core, to restore lost tooth structure and not to provide strength or resistance to fracture[17]. Their use should be avoided when they are not required to provide retention for a core[14]. In this study it was found that there was no significant increase in resistance to fracture, in teeth restored with post and bonded amalgam or bonded composite resin (group IVb and group Vb).These observations are in agreement with work done by authors like Sorenson A. John and Martinoff J. James[13].

It is interesting to note that irrespective of method of restoration or reinforcement used, none of the groups excepting composite with post in standard access preparation showed an ultimate compressive strength, comparable to intact teeth. The method of post and core technique may not be as significant as the placement of full coverage cast crown restoration with sound dentin as a base and placement of margins beyond the build-up restoration[6] . A cast restoration protects the weakened tooth from horizontal and vertical forces. However, the duration of this study was short, long term evaluation of these restorative materials in a clinical environment is necessary to judge their actual performance.

Additionally, the forces generated intra-orally during function vary in magnitude and direction. In the present study forces were applied in a single direction and at a constant speed until the tooth fractured.

It should be further evaluated whether sand blasted post or carbon fiber post luted with resin luting cement could impact adequate strength to the tooth to withstand forces of mastication in the clinical environment.

Conclusion

(i) Corono-radicular build up using either bonded amalgam or bonded composite resin as a core material in standard endodontic access preparation showed similar compressive strength.

(ii) The ultimate compressive strength of teeth restored with post and bonded composite resin as core build up material in standard access preparation, was substantially superior to bonded amalgam and post group.

(iii) Endodontically treated teeth with mesio-occluso-distal cavity preparation restored with bonded composite resin corono-radicular build up, had similar fracture resistance to teeth restored with bonded amalgam corono-radicular restoration build up.

(iv) With extensive loss of tooth structure, the use of post with either bonded composite resin or bonded amalgam showed similar compressive strength.

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