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One-Year Clinical Comparison of Survival of Endodontically Treated Premolar Restored with Different Direct Restoration Technique: A Prospective Cohort Study

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Abstract

Background: Endodontically treated teeth need to be restored in a manner to provide protection for the remaining tooth structure but would also allow the restoration of esthetic and functional demands.
Objectives: This study evaluates the clinical success rate of endodontically treated premolars restored with different techniques.
Methods: In this study, 96 participants were included with indication of endodontic treatment of one maxillary or mandibular premolar. Only cases with premolars along with MOD Class II carious lesions and preserved cusp structure were recruited. After endodontic treatment subjects were randomly assigned to one of the following restoration methods: (1) composite restoration without any cusp reduction (2) Composite associated with a fiber reinforced composite (FRC) post (3) capping the buccal and lingual cusp and composite restoration. Subjects were recalled for the clinical and radiographical evaluations with modified USPHS criteria after three, six and 12 months.
Results: During the evaluation period, all the three methods of restoration, achieved the Alpha degree in term of modified USPHS criteria.
Conclusions: The clinical success rates of endodontically treated premolars restored with fiber posts and direct composite restorations, direct composite restorations with cusp capping and simple direct composite restoration were perfect after one year of follow-up evaluation.

Keywords: Cusp Capping, Direct Composite Restoration, Endodontically Treated Premolar, FRC Post

1. Background

Restoration of endodontically treated teeth (ETT) with extensive loss of coronal structure may be problematic because of a significant reduction in their capacity to resist functional forces. Due to the fact of inherent weakness, the structure is considered as the most important aspect in improving the survival rate of ETT (1). Previous retrospective clinical reports (2, 3) showed that premolars were the most frequently fractured teeth, therefore, different restorative methods for these teeth have been suggested (4, 5).

The intracoronal restoration with adhesive techniques allowed maximum preservation of the intact tooth structure; therefore, direct composite resin restoration of premolars can be more predictable than molars (6). This concept was anticipated because the smaller amount of composite needed for the restoration resulted in the lower polymerization shrinkage stress and also the interproximal margins of premolars are more accessible for finishing and inspection procedures than molars. Hansen showed that ETT with MO/DO or an MOD cavity restored only with composite without cuspal overlay, survived many years (7).

In another reinforcement method, Fiber-reinforced composite (FRC) posts were used. The elastic modulus of these posts were the same as dentin (8, 9). As a result, when an ETT is restored with FRC post, the post can redistribute the stress, so it could recover the fracture resistance of teeth (10, 11) and also may reduce the incidence of unfavorable fracture modes (12, 13). Previous studies have shown that the resistance of endodontically treated premolars were improved by fiber posts (14-16). Although laboratory studies showed favourable mechanical and physical properties of fibre posts, clinically, there has been a wide range of failures mechanisms are reported in the literature. Adhesive failure was reported in 16 of the 19 trials, making it the most frequent cause of failure (17).

However, according to Mackenzie (18), cuspal coverage was using as the traditional method of providing reinforcement for ETT. This was because the access cavities result in morecuspal flexure and increase the probability of cuspal fracture. In a retrospective study, 400 teeth during a 9-year evaluated and showed that ETT with cuspal coverage were six times more likely to survive than those with intra-coronal restorations (19). Although this method was ideal; in some situation has many disadvantages such as poor esthetics, more cost and the removal of large amounts of tooth structure (5).

However, no previous prospective clinical study has compared the failure rate of endodontically treated premolars restored with composite or with those of teeth restored by the same technique but with FRC post or cusp coverage.

2. Objectives

This study evaluate the one-year clinical success rate of endodontically treated premolars restored with simple direct composite with FRC post or cusp coverage in term of modified USPHS criteria.

3. Methods

3.1. Study Population and Tooth Selection

In this study, 96 individuals attending the department of operative dentistry of Mashhad dental school whose required aesthetic restoration of endodontically treated premolar were included. All participants were given a brief explanation about the investigation and all were consented to participate in the study. All signed consent forms were approved by the ethics committee of research in Mashhad University of Medical Sciences (MUMS).

Only premolar teeth with Class II MOD carious lesions and preserved cusp structure were included, therefore the buccolingual widths of each cavity should be less than two third of intercuspal widths after cavity preparation. The root of the selected teeth should have one canal with appropriate length and without severe curve that was evaluated by radiography. The participants should have a canine rise occlusion and the selected teeth were in occlusal function.

Exclusion criteria were teeth with failed endodontic therapy, extensive caries under the margins of the free gingiva. Moreover, teeth with deep periodontal pockets, no adequate periodontal support and poor oral hygiene or high caries rates were not included in this trial. Patients with open or deep bite, with severe parafunction and shortened dental arches and patients wearing removable partial dentures were also excluded. All subjects received oral hygiene instruction. Individuals had to be healthy and willing to return at regular intervals for follow-up evaluation.

3.2. Clinical Procedures

After anesthesia, selected teeth were isolated in each patient using rubber dams (Derma Dam, Ultradent, USA). Standard Mesio-occluso-distal (MOD) cavity was prepared by a diamond bur (# 878/d2, Teeskavan, Iran) with a water-cooled high speed handpiece. Deep dentin caries were removed using a #2 round carbide bur (SS White HP Series, Lakewood, NJ, USA) with a low-speed handpiece (NSK EX-203, Japan) if needed. Burs were changed after every four cavity preparations.

No enamel bevel was prepared. The cavo-surface margins of the gingival floors were located in the enamel.

In each patient, the endodontically treated tooth was restored accordingly into one of the following groups.

In the first group, the whole prepared teeth were etched with 35% phosphoric acid (Scotch Bond Etchant; 3 M ESPE, St Paul, MN) for 15 seconds. After rinsing the teeth for five seconds and removing the excess water, bonding agent was applied according to the manufacturer's instructions (Adper Single Bond; 3 M ESPE) and cured for 10 seconds by using a light-curing unit (Astralis 7; Ivoclar Vivadent AG, FL-9494, Schaan, Liechtenstein). After placement of matrix band with a retainer, resin composite (Filtek P60; 3 M ESPE, St Paul, MN) was placed incrementally in 2-mm layers. Each layer was light-cured for 40 seconds. Post-curing was carried out on buccal and lingual aspects of the boxes for 40 seconds on each side, after removal of matrix band and retainer.

In the second group both buccal and lingual cusps were reduced up to 2 mm then a similar procedure was employed as in the first group. However, the reduced cusps were covered by 2-mm thicknesses of composite resin on each cusp.

In the third group, the appropriate size of FRC post was selected and the root canal space was prepared with calibrated drills provided by the manufacturer, to a length of 8 - 9 mm; at least 4 - 5 mm of apical seal was maintained. The posts were tried in and if necessary shortened with a diamond separating disc. To bond the post, the canals were preconditioned with the ED Primer self-etching primer (Kuraray Medical Inc, Okayama, Japan) for 60 seconds. Any remaining primer in the apical part of the canal was removed with a paper cone. For post preparation, the same bonding agent was applied on the post surface. Panavia F 2.0 cement (Kuraray Medical Inc, Okayama, Japan) was mixed and applied to the post surface then placed in the canal. Subsequently, the post was seated in place, and excess cement was removed with a brush. The cement was light-cured for 40 seconds from the occlusal direction via the post. After post cementation, a similar procedure was used as in the group 1.

3.3. Clinical Evaluation

Each restoration was assessed clinically and radiographically by two investigators who were not involved with the restoration placement procedure, at 3, 6 and 12 months interval periods. Examiners were trained and calibrated prior to the scoring of the restorations. If any difference was recorded between the two examiners, they called to examine again to reach an agreement.

The modified USPHS criteria that were used for evaluating the failure of restoration were categorized as fracture, marginal adaptation, marginal discoloration and evidence of secondary caries related with the margins of the restoration. Each of these criteria was scored to Alpha, bravo, Charlie (

Clinical evaluation included visual inspection conducted with loops under the light of unit at original magnification and examination of the integrity of the margins of the restoration with the tooth structure was evaluated by an explorer (EXS6; Hu Friedy, Leiman, Germany).

Radiographs of all restorations were taken with the standardized long-cone technique just at 6 and 12 months interval periods for carries diagnosis.

4. Results

All 96 original composite restorations at the baseline were available for clinical evaluation at the 12 month visit. The participants were between 20 to 50 years of age including 41 males and 55 females. Teeth included in the study were 19 maxillary first premolars, 37 maxillary second premolars, 14 first and 26 mandibular second premolars.

The results of the modified USPHS criteria for each interval time are summarized in Table 2. During the evaluation period, the clinical performance of all the treated teeth was ideal as evaluated by the modified USPHS criteria.

5. Discussion

In the present study it was shown that the aforementioned three methods have had successful performance according to the modified USPHS criteria and no problem was observed during the one year follow-up evaluation.

Although it is not sufficient time to evaluate the clinical durability, many studies have shown that imperfect extensive restoration of ETT demonstrated some degree of failure within the first year (15, 20). Criteria such as recurrent caries may not be common in the first year; however some degree of marginal discoloration or cusp fractures can be observed.

It was found that the clinical survival of the restoration of endodontically treated premolars without a fiber post were similar to those with a post. This finding is in agreement with a number of other studies (21-23). During post placement, because of removal of tooth structure, the resistance to occlusal forces is reduced, and so the possibility of fracture increased (24). In addition, endodontic treatment and preparing post space may lead to cracks and defects that can concentrate stresses and increase the possibility of tooth fracture (25). It has been noted that adhesive restorations transmit and distribute functional stresses across the bonding interface to the tooth more accurately, which has the potential to reinforce weakened tooth structure (26). Therefore, it is possible to redistribute occlusal forces in a wide surface even without fiber post placement, as a result of micromechanical adhesion, rendering the tooth more resistant against forces.

Qualtrough and Mannocci (12) have demonstrated that although bonding agents had strengthened weakened cusps, the fracture resistance of teeth restored with composite resin was not completely recovered. However, other studies reported (27-29) no significant difference in fracture resistance between sound teeth and teeth restored with composite resin.

In the present study, coverage of the cusps with composite had an Alpha degree in modified USPHS criteria like the other treatment methods. In this regard, our results are in agreement with the results of other studies (22, 30). The reason for the tendency of onlay restoration to achieve the higher load may be due to dispersion of compressive stresses in onlays, whereas it tends to concentrate in the inlays. In addition, composite has a low modulus of elasticity and transmits less of the applied load to the underlying tooth structure (31). However, it seems that in the current study, considering the splinting of cusps by composite restoration, the possibility of cuspal fracture as a result of cuspal deflection, decreased even without cusp coverage. In contrast to our study, Soares et al. (13) showed that, reduction of cusps and coverage by composite resin reduced fracture resistances in lower premolars. However, the amount of reduction in that study was more than in our study.

In the current study, restoration of endodontically treated premolars with FRC post and composite was perfect in survival rate like simple composite restoration or restoration with cusp coverage. Many studies challenged the use of posts for support and reinforcement of remaining tooth structure and even considered post placement as a risk factor that weakened the remaining tooth structure and predisposed tooth fracture. This was greatly attributed to the stress concentration within the radicular dentine during post placement and, consequently, the al-

Table 1. Modified USPHS Criteria That Was Used for Clinical Evaluation of Restorations

Marginal adaptation	Alpha (A): No visible evidence of crevice along margin can be detected by the explorer
	Bravo (B): Crevice detected by the explorer, but without
	exposure of the dentin or base
	Charlie (C): Dentin or base exposed
Marginal discoloration	Alpha (A): No discoloration
	Bravo (B): Discoloration without axial penetration
	Charlie (C): Discoloration with axial penetration
Secondary caries	Alpha (A): No evidence of caries at the margin
	Charlie (C): Evidence of caries at the margin
Fracture	Alpha (A): Restoration continuous with tooth
	Bravo (B): Restorations discontinuous with tooth, but without exposure of the dentin or base
	Charlie (C): The restoration is mobile or fractured

Table 2. Modified USPHS Criteria Results in Each Interval Time for Each Group

Group	3 month			6 month			12 Month		
	A	B	C	A	B	C	A	B	C
Group 1	96	0	0	96	0	0	96	0	0
Group2 FRC post									
Marginal adaptation	96	0	0	96	0	0	96	0	0
Group 3 Cusp cap	96	0	0	96	0	0	96	0	0
Group 1	96	0	0	96	0	0	96	0	0
Group2 FRC post									
Fracture	96	0	0	96	0	0	96	0	0
Group 3 Cusp cap	96	0	0	96	0	0	96	0	0
Group 1	96	0	0	96	0	0	96	0	0
Group2 FRC post									
Secondary caries	96	0	0	96	0	0	96	0	0
Group 3 Cusp cap	96	0	0	96	0	0	96	0	0
Group 1	96	0	0	96	0	0	96	0	0
Group2 FRC post									
Marginal discoloration	96	0	0	96	0	0	96	0	0
Group 3 Cusp cap	96	0	0	96	0	0	96	0	0

tered pattern of stress distribution upon loading (32, 33).

Fokkinga et al. (21) reported that the presence or absence of metal/fiber posts did not affect the fracture resistance and failure modes of endodontically treated premolar teeth with resin composite crowns. Moreover, another in vitro study found no difference in the fracture resistance of premolars restored with direct resin composite in the presence or absence of fiber post and cusp coverage (34).

Based on the present study, it was believed that the results of this study may be explained by the determinant role played by remaining tooth structure: a growing body of data from clinical and laboratory investigations shows that the more residual coronal dentin there is, the better the survival rate (15, 20, 35). In addition, the study population was pre-selected, since tooth loss due endodontic or periodontal failures was excluded; thus, the data only represent restorative failure. Furthermore it would be favorable to reduce bias if the study could have been designed to include three teeth in one participant. Unfortunately, it is practically impossible to collect a minimum number of 32 individuals with three premolars with Class II carious lesions that also need endodontic treatment. However, it will be necessary to continue to monitor for future studies that have longer follow-up periods.

5.1. Conclusion

Within the limitations of this clinical study, we recognized that simple composite restoration had a successful performance similar to other methods. FRC post and cusp coverage did not enhance the clinical performance of endodontically treated premolar when compared with the placement of a direct composite restoration during a one-year follow up.

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