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Clinical Evaluation of Posterior Composite Restorations in Endodontically Treated Teeth

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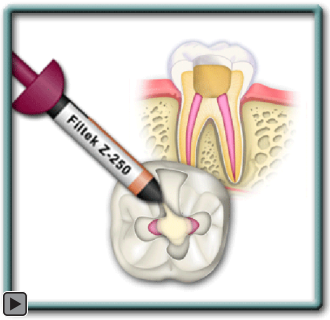

Abstract

Objective: The purpose of this study was to evaluate the two year clinical performance of posterior composite restorations in endodontically treated premolars and molars using a hybrid composite (Filtek Z-250, 3M ESPE) and a total etch bonding system (Single Bond, 3M ESPE).

Method and Materials: Thirty-nine class II restorations in endodontically treated premolars (n=11) and molars (n=28) of 27 patients (14 female, 13 male, mean age 36.51) in 16 maxillar and 23 mandibular teeth were placed by one operator. Restorations were evaluated by two experienced investigators at baseline, 12 months, and 24 months according to the modified United States Public Health Service (USPHS) criteria that included retention, color match, marginal discoloration, secondary caries, anatomic form, marginal adaptation, and surface texture. All restorations were able to be evaluated at baseline, 12 months, and 24 months.

Results: Paired samples t-test showed only marginal discoloration showed a statistically significant difference ($p<0.05$) at the end of 24 months, and no other significant differences were observed for the other variables examined over the duration of the study. None of the restored teeth showed periapical pathology at the end of 24 months.

Conclusion: At two years, limited deterioration in marginal discoloration was detected. The clinical performance of posterior composite restorations in endodontically treated teeth using Filtek Z250 was found clinically acceptable after two years.

Keywords: Endodontically treated teeth, USPHS criteria, clinical evaluation, Filtek Z250

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Introduction

The strength of an endodontically treated tooth is directly related to the amount of the remaining tooth structure.[1] Endodontic procedures had only a small effect on tooth strength.[2] Rather, caries, trauma, iatrogenic factors, location, and shape of the endodontic access and post space preparation causes reduction in the relative stiffness and weakens endodontically treated teeth.[3] Cuspal deflection increased with the extension of cavity preparations and was greatest when endodontic access was incorporated into the preparation.[4] Teeth with mesioocclusodistal (MOD) preparations accounted for the lowest compressive strength, whereas endodontically treated teeth with canal access only showed similar fracture resistance as compared to unaltered natural teeth.[5]

The restorative techniques used for an endodontically treated tooth is often described in prosthetic terms such as prefabricated or custom-made post and cores and full crowns and in restorative terms such as amalgam, reinforced glass-ionomer cements or composite restorations, supported by pre-shaped posts cemented in the endodontic space.[6] The choice of restoration to be used is determined by the volume of tissue loss and form of the endodontic access.[1] However, post and core restorations are the recommended treatment option[7,8] based on the view all endodontically treated teeth should be crowned.[7,8,9] Posterior teeth function mainly in compression, therefore, the benefit of a post is limited.[1] Furthermore, post placement was often found to be the primary cause of root fracture[10], and the preparation of the post space markedly weakened the endodontically treated tooth.[11] Trends towards less invasive forms of restorative dentistry, together with ongoing progress in adhesive dentistry, created new opportunities for the restoration of endodontically treated teeth.[1] Documentation regarding the use of various direct restorative materials and techniques in compromised teeth showed good prognosis *in vitro*.[12,13,14] In these studies, adhesive composite restorations were found to be superior to amalgam.[2,13] Composite resin restorations have been suggested for the restoration of a non-vital tooth by only replacing the missing tooth tissue as the adhesive system can reinforce the remaining tooth structure.[13]

Extensive composite restorations in endodontically treated teeth are frequently placed in routine practice in some dental schools.[15] However, there is only limited information in the literature regarding the clinical performance and survival rate of direct composite restorations in endodontically treated teeth without posts and crown coverage. Endodontically treated posterior teeth restored with amalgam[16] or self-cured and light-cured resin composite[17] without crown coverage or post placement have been studied, retrospectively. It has been reported no statistically significant difference was found between teeth restored with mesioocclusal/distoocclusal amalgam (MO/DO) teeth and pooled MO/DO plus mesioocclusodistal (MOD) resin restored teeth, whereas teeth with MOD amalgam restorations had a higher failure rate than was found for resin restored teeth. If a fracture occurred, the teeth restored with resin composite failed less catastrophically and was more easily re-restored than teeth restored with amalgam.[16,17] Newer composite resins have increased strength owing to a higher filler content, an improved filler technology, modifications in the organic matrices, and a greater degree of polymerization which improves their mechanical and physical properties.[18] These developments in filler technology and formulation in the resin matrixes resulted in changes in the reasons for restoration replacement, as well as the increasing trend to insert composite restorations in stress-bearing areas of posterior teeth.[19] Short-term laboratory studies provide some information about the physical properties of new materials. However, long-term clinical studies provide further information regarding the performance of these

materials over an acceptable time period and their cost-effectiveness.[20] Therefore, the purpose of this study was to evaluate the two year clinical performance of posterior composite restorations in endodontically treated premolars and molars using a hybrid composite (Filtek Z250, 3M ESPE) and a total etch adhesive system (Single Bond, 3M ESPE).

Method and Materials

Thirty-nine class II restorations in endodontically treated premolars (n=11) and molars (n=28) of 27 patients (14 female, 13 male, mean age 36.51) in 16 maxillar and 23 mandibular teeth without the presence of preoperative periapical infection were placed by one operator. After performing local anesthesia, the root canals were shaped using the crown-down technique under copious irrigation of 5.25% sodium hypochlorite (NaOCl). Final irrigation was accomplished with saline. The root canals were obturated using the cold lateral condensation technique. AH-Plus (Dentsply De Trey, Konstanz, Germany) was used as a sealer. After endodontic therapy, all of the teeth were temporarily restored with zinc phosphate cement (Kulzer, Germany) for one week. Enamel margins of the cavities were not beveled, and placement of the restorations were done using the incremental filling technique using metal matrices under cotton role isolation.

Table 1. Modified USPHS criteria.

Category	Scores	Criteria
Retention	Alpha	No loss of restorative material
	Charlie	Any loss of restorative material
Color Match	Alpha	Matches tooth
	Bravo	Acceptable mismatch
	Charlie	Unacceptable mismatch
Marginal Discoloration	Alpha	No discoloration
	Bravo	Discoloration without axial penetration
	Charlie	Discoloration with axial penetration
Secondary Caries	Alpha	No caries present
	Charlie	Caries present
Anatomic Form	Alpha	Continuous
	Bravo	Slight discontinuity, clinically acceptable
	Charlie	Discontinous, failure
Marginal Adaptation	Alpha	Closely adapted, no detectable margin
	Bravo	Detectable margin, clinically acceptable
	Charlie	Marginal crevice, clinical failure
Surface Texture	Alpha	Enamel-like surface
	Bravo	Surface rougher than enamel, clinically acceptable
	Charlie	Surface unacceptable rough

Table 2. Results for USPHS criteria (%) for composite restorations at baseline and each recall.

	<	n	Baseline	12 months	24 months
Retention	Alpha	39	100	100	100
	Charlie	39	0	0	0
Color Match	Alpha	39	95	95	92
	Bravo	39	5	5	8
Marginal Discoloration	Alpha	39	100	90	87
	Bravo	39	0	10	13
Secondary Caries	Alpha	39	100	100	100
	Charlie	39	0	0	0
Anatomic Form	Alpha	39	100	100	92
	Bravo	39	0	0	8
Marginal Adaptation	Alpha	39	100	97	95
	Bravo	39	0	3	5
Surface Texture	Alpha	39	100	100	95
	Bravo	39	0	0	5

The dentin and enamel of the teeth were treated with 35% phosphoric acid for 15 seconds and rinsed thoroughly with water. Excess water was removed with an air syringe and then dentin was blotted with a cotton pellet to keep it slightly moist. Single Bond (3M ESPE) adhesive was applied in two coats to the moist dentin and dried enamel surfaces then polymerized for 10 seconds using a light-curing unit (PolyLUX II, KaVo, Germany) with the intensity at 600 mW/cm^2. The cavity filling started with the proximal segment of the preparation, and each of the resin composite (Filtek Z250, 3MESPE, St. Paul, MN, 55144, USA) increments (2 mm thick or less) was light cured for 20 seconds. Finishing of the restorations was done with 40 and 15 µm diamond burs, polishing disks, and strips (Sof-Lex, 3M ESPE, St. Paul, MN, USA). At the one year and two year recalls, the restorations were initially examined to determine clinical acceptability and were then assessed using the codes and the United States Public Health Service (USPHS) criteria[21] that included retention, color match, marginal discoloration, secondary caries, anatomic form, marginal adaptation, and surface texture (Table 1). Two experienced investigators undertook the recall evaluations, seeing each patient independently; any discrepancy between examiners was resolved before the patient was dismissed. In addition an occlusal view photographic record was made for each restoration. Periapical radiographs were taken at baseline and recall periods.

Results

Paired samples t-test indicated only marginal discoloration showed a statistically significant difference ($p<0.05$) at the end of 24 months (Table 2), and no other significant differences were observed for the other variables examined over the duration of the study (Figures 1 and 2).

None of the restored teeth showed either secondary caries or periapical pathology at the end of 24 months (Figures 3 and 4).

Figure 1. Clinical appearance of the composite restorations in mandibular first and second molars at baseline (a) and 24 months (b). The restoration in the first molar was clinically rated "Bravo" for the criteria marginal discoloration, color match and "Alpha" for the other examined variables.

Figure 2. Clinical appearance of the composite restoration in mandibular first at baseline (a) and 24 months (b). The restoration in the first molar was clinically rated "Bravo" for the color match at baseline and 24 months and "Alpha" for the other examined variables.

Figure 3. Periapical radiograph of the composite restoration in mandibular first and second molars (Figure 1b) at 24 months.

Figure 4. Periapical radiograph of the composite restoration in mandibular first molar (Figure 2b) at 24 months.

Discussion

Restorative materials can be clinically tested by various methods, such as cross-sectional studies, longitudinal studies, or clinically controlled experiments. Cross-sectional studies are most frequently found in the literature because they are relatively simple to carry out and provide fast results. However, long-term longitudinal studies under controlled standardized conditions are considered more reliable.[22] They follow the same individuals over time and offer the best opportunity for analyzing reasons for change. In this study, to achieve the demands for medium-term longitudinal studies, a two year observation period with a 12 month intermediate examination was chosen.[23] The modified USPHS rating system[21] is designed to reflect absolute differences (acceptable/unacceptable) and, therefore, the

scores have direct clinical implications.[24] It should be mentioned restorations rated Alpha and Bravo were clinically acceptable. Differences between Alpha and Bravo scores were only in degrees, whereas those restorations rated Charlie had undergone an essential change. Patients included in the study had good oral hygiene and no clear indication of any parafunctions. Antagonistic contacts of the teeth were with either enamel or composite restorations. All restorations were placed by one operator to prevent the variations in preparation designs, finishing, and polishing procedures among clinicians.

Insufficient wear resistance resulting in loss of anatomic form and interproximal contacts with general degradation were the main problems of direct composite restorations in the 1970's and early 1980's.[25] For the achievement of optimum physical and mechanical properties of composite resins, manufacturers changed the composition of the resins by increasing the volume of filler particles, varying the size and type of particles, altering the chemistry of resin matrix, and increasing the molecular weight.[26,27]

The test material Filtek Z250 (3M ESPE, St. Paul, MN, 55144, USA) used in this study is a hybrid composite that has been modified to exhibit lower polymerization shrinkage, higher fracture toughness, and superior curing characteristics when compared to its predecessor, Z100 (3M ESPE). The resin system in Filtek Z250 has been modified by eliminating the Bis-GMA content and reducing the amount of TEGDMA; the new resin consists of UDMA and Bis-EMA(6) plus a small amount of TEGDMA.

The manufacturer claimed with the new resin system of higher molecular weight and filler content (zirconia/silica particles 60% of volume with a mean particle size of 0.6 µm), Filtek Z250 yielded fewer double bonds to cross-link so the resin is cured more efficiently.[28] In this study all of the restorations were scored Alpha for anatomic form at one year recall; only three restorations (8%) were scored Bravo at two year recall, whereas surface texture showed a high number of Alpha scores (95%). This result is consistent with the study of Wilson et al.[29], which showed a high number of Alpha scores for anatomic form and surface roughness for posterior composite restorations with Filtek Z250 at one-year.

This result may be explained by the high microhardness and lower polymerization shrinkage of Filtek Z250 when compared with various types of composite resins.[30] Composites wear more rapidly than enamel[31], however, the favorable antagonist for composite restorations is still intact enamel.[32] Therefore, patient selection was performed under strict criteria that antagonistic contacts of the restorations should be with either enamel or composite restorations. The size of the restoration as well as the location of the restored tooth affects clinical wear of the composites. As the surface area and length of cavosurface margins increase and the more posteriorly a tooth is located, the more wear on the composite resins.[33,34] In clinical studies, the most wear occurred in the first five years.[35] Therefore, two years observation time may not be long enough to assess the wear characteristics of a composite as a posterior restorative material[36], especially in such cases where the size of the restoration is large. Further evaluation of the restorations is needed to justify whether they will maintain their success.

Two year findings revealed a similar incidence of limited deterioration in marginal adaptation. Only five restorations (13% rated Bravo) showed slight marginal discoloration (Figures 1a, 1b) and only two of them (5%) were assessed as Bravo for marginal adaptation (Table 1). Incremental filling technique[37] as well as low configuration factor[38] may optimize the damaging polymerization shrinkage stresses and maintain a satisfactory restoration adaptation. Color match of the

restorations were excellent, only two restorations were rated Bravo at the baseline (Figures 3a, 3b) and three restorations at the 24 months recall (Figures 1b, 3b).

In general early failures of dental restorations encountered after weeks or months need to be distinguished from late failures after several years of clinical service. The early failures are a result of severe treatment faults, selecting an incorrect indication for the restorative material, or postoperative symptoms.[19] On the other hand, late failures are mostly caused by the fractures of the restorations or the teeth, marginal discoloration and deterioration, the occurance of secondary caries, and wear.[33,39,40,41,42,43,44] Microfilled composites exhibited more fracture-related failures, especially in high-stress class II cavities, compared with hybrid composites, because of their inferior mechanical properties. In this study none of the restored teeth as well as none of the restorations were fractured during 24 the month observation period. This may be due to the high flexural strength of Filtek Z250.[30] Higher flexural strength composite resins are less prone to bulk fracture of the filling as well as fracture of the margins.[45,46] Another reason may be that none of the patients had parafunctional habits which may lead to improper stressing on the fillings.

Composite restorations were found less effective in preventing secondary caries compared to amalgam restorations in endodontically treated posterior teeth especially after three years.[47] In the recent study none of the restorations showed secondary caries during the 24 month recall period. It is possible the limited observation period of two years was insufficient for the development of secondary caries. Also, the strict respect of the patients to the usual rules of oral health maintenance may further represent the favorable conditions of the restorations.

In recent years indications for the use of direct composite systems expanded enormously.[48] Tooth structure saving restorations in teeth including larger defects can also be restored with direct composite restorations. These restorations may be considered an alternative to indirect restorations, including onlays and partial crowns.[48] A 39-restoration sample size can be considered small, however, it may suggest the anticipated deterioration in composite restorations in terms of failure rate and marginal adaptation. The critical importance of this is the practitioner decision-making process to place these restorations. Two year findings revealed only a similar incidence of limited marginal discoloration and suggested Filtek Z250 can be used for restoring large cavites in endodontically treated posterior teeth when the patient selection was performed adequately.

Conclusion

At two years, limited deterioration in marginal discoloration was detected. The clinical performance of posterior composite restorations in endodontically treated teeth using Filtek Z250 was found clinically acceptable after two years.

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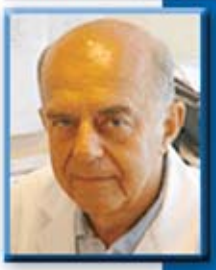

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