One Year Clinical Evaluation of Direct Posterior Composite Restorations With and Without Short Glass-Fiber Reinforcement in Endodontically Treated Teeth

Endodontik Tedavili Dişlerde Kısaltılmış Cam Fiber Destekli ve Desteksiz Direkt Posterior Kompozit Restorasyonların Bir Yıllık Klinik Değerlendirmesi

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ABSTRACT

Introduction: Laboratory studies were demonstrated promising performances of fiber-reinforced materials with respect to fracture resistance and polymerization shrinkage, especially for non-vital teeth restorations. However, few clinical trials on this topic had been published. The aim of the present study is to investigate the clinical performance of short glass-fiber reinforced composite restorations.

Methods: Thirty patients with root canal treated and temporarily filled molars include in this study. Half of them were restored with short glass-fiber reinforced composite restorations while the other half was restored with a nanohybrid resin composite only. Modified USPHS (US Public Health Service) criteria were used to evaluate restorations by two restorative dentistry specialist, at baseline, 6th month and 12th-month control sessions. Mc-Nemar test was used to compare baseline scores and control scores in the 6th and 12th months.

Results: Although the restorations performed showed slight changes according to the marginal integrity, marginal coloration and anatomical form criteria, these changes did not create a significant difference between the groups (p> 0.05).

Discussion and Conclusion: Within the limitations of this study, all restorations were provided adequate aesthetics and function during the 12-month follow-up regardless of fiber reinforcement.

Keywords: *Clinical trial, fiber, composite resin*

ÖZ

Giriş ve Amaç: Devital dişlerin restorasyonlarında fiber ile desteklenmiş malzemelerin özellikle kırılma direnci ve polimerizasyon büzülmesi üzerindeki umut verici performansları çeşitli in vitro çalışmalar ile göstermiştir. Bununla birlikte, bu konuyla ilgili yayınlanan klinik çalışma sayısı konunun önemine kıyasla oldukça azdır. Bu çalışmanın amacı, kısa cam fiberler ile desteklenmiş kompozit rezin restorasyonların klinik performansını araştırmaktır.

Yöntem ve Gereçler: Bu çalışmaya kanal tedavili ve geçici dolgulu azı dişlerine sahip 30 hasta dahil edilmiştir. Yarısı kısaltılmış cam fiber destekli kompozit restorasyonlarla restore edilirken, diğer yarısı ise sadece nanohibrit rezin kompozitler ile restore edilmiştir. Klinik performansı değerlendirmek amacıyla Modifiye USPHS (ABD Halk Sağlığı Servisi) kriterleri iki restoratif diş hekimliği uzmanı tarafından başlangıç, 6. ay ve 12. ay kontrol seanslarında olmak üzere 3 defa kullanıldı. Skorlar arasındaki farkın istatistiksel analizi için ise için Mc-Nemar testi kullanıldı.

Bulgular: Yapılan restorasyonlar marjinal bütünlük, marjinal renklenme ve anatomik form kriterlerine göre küçük değişiklikler gösterse de bu değişiklikler gruplar arasında anlamlı bir fark yaratmadı (p> 0.05).

Tartışma ve Sonuç: Bu çalışmanın sınırları dahilinde, fiber takviyesine bakılmaksızın tüm restorasyonlara 12 aylık takip süresince yeterli estetik ve fonksiyon sağlanmıştır.

Anahtar Kelimeler: *Klinik çalışma, fiber, rezin kompozit*

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INTRODUCTION

Studies have shown that endodontically treated teeth (ETT) have a higher risk of fractures than intact teeth.[1] This may be due to the loss of tooth substance or dehydration of the remaining dentine as a consequence of devitalization of the tooth.[2] The prognosis of root canal treatment (RCT) is influenced by several factors.[3] Completion of the RCT is followed by placement of a coronal restoration (CR), which should prevent bacterial leakage and restore aesthetics and function.[4] Some studies find the quality of the CR as the most important factor regarding the outcome of RCT, while other studies show no correlation between these factors.[5,6] Posterior resin composites have become preferred materials in coronal restorations because of their sufficient features such as applicable in a single session and having satisfactory aesthetic and mechanical properties. Fracture resistance of the teeth increases with the application of composite resins. However, in the presence of teeth with excessive substance loss, mechanical properties of coronal restorations should be strengthened.[7]

Today, fiber reinforcement has become an effective material of choice within restorative dentistry. In 2013, short fiber-reinforced composite (SFRC) (EverX Posterior; GC, Tokyo, Japan) was introduced to the market with the goal to mimic the stress absorbing properties of dentine. The SFRC material is intended to be used as bulk base in high stress-bearing areas for restoring vital and non-vital teeth.[8] It consists of a combination of a resin matrix, randomly-orientated E-glass fibers, and inorganic particulate fillers. The resin matrix contains bisphenol-A-diglycidyl-dimethacrylate (bis-GMA), triethylene glycol dimethacrylate, and polymethylmethacrylate, forming a matrix called semi-interpenetrating polymer network (semi-IPN), which provides enhanced bonding properties for repairs and improves the toughness of the polymer matrix.[8,9]

Laboratory studies demonstrated good performance of fiber-reinforced materials with respect to fracture resistance and polymerization shrinkage.[10,11] To date, only limited data from clinical trials on this topic have been published.[12,13] The information from laboratory tests does not always correlate with clinical performance. Therefore, the aim of the present study was to further investigate the clinical performance of nanohybrid and fiber-reinforced restorative resins in class II cavities over 12 months. The null hypothesis was that the fiber-reinforced resin composite restorations would not differ from nanohybrid resin composite restorations in terms of clinical performance.

MATERIALS AND METHODS

Ethics committee approval was obtained before the study (Ethics committee number:14-10/15). Endodontically treated and temporarily restored molars were included in the study. In this in vivo study SFRC was used due to its high fracture and flexure resistance as a test group while direct posterior composite restoration, which is widely used technique for ETT in clinical practice, was preferred as the control group. The lot method was applied to determine the patient groups. The groups were identified by instructing the patients to draw one of the envelopes containing one and two group numbers. In this study in which 30 patients were included, 15 restorations were performed for each group.

Oral hygiene motivation was given to the patients included in the study and patients informed that the restorations would be checked in certain periods. Digital photos were recorded from the teeth to be restored.

Root canal treated, temporary restored permanent molar teeth with MOD cavities were included in the study. Teeth with a residual wall thickness of less than 2 mm, crack formation on the remaining walls on visual and radiographic examination were excluded.

Firstly, the appropriate color selection was made for the tooth to be restored. Then, temporary filling and unsupported enamel were removed using a water-cooled high speed air turbine. All cavities were shaped in accordance with minimally invasive principles. After providing isolation and ensure the cavity disinfection with 2% chlorhexidine gluconate solution was done.

Total 30 cavities were prepared for restorations. A flowable resin composite (G-ænial Universal Flo, GC Corp. Tokyo, Japan) and a nanohybrid resin composite (G-aenial Posterior, GC Corp. Tokyo, Japan) were used in all cavities. A shortened glass fiber reinforced composite (Everx Posterior, GC Corp. Tokyo, Japan) was used only in 15 cavities.

A sectional matrix system (Garrison Dental Solutions, USA) was applied and the interdental wedge (Polydentia SA, Mezzovico, Switzerland) was placed. After an universal adhesive G-Premio BOND, GC Corp, Tokyo, Japan) applied with the selective etcing methode, an aproximal wall was created using the nanohybrid resin composite (G-aenial posterior, GC Corp. Tokyo, Japan). A flowable resin composite (G-ænial Universal Flo, GC Corp. Tokyo, Japan) was placed in the cavity base.

In the bulk-fill group, shortened fiber-reinforced resin composite (Everx Posterior, GC Corp. Tokyo, Japan) was applied at once with 4mm thickness and light cured for 20 seconds with a LED curing device (Elipar Freelight 2, 3M ESPE). The remaining space in the occlusal part of the cavity was filled with a nanohybrid resin composite (G-aenial Posterior, GC Corp. Tokyo, Japan).

In the control group, following formation of the aproximal walls, cavities were restored with the same nanohybrid resin composite with incremental technique (1.5-2 mm layers). Finishing and polishing procedures were done with composite finishing burs (Acurata,

Thurmansbang, Germany) aluminum oxide polishing tires Onegloss (Shofu Inc. Kyoto, Japan) and a polishing paste (Diapolisher Paste, GC Corp. Tokyo, Japan) respectively.

Control periods were determined as 1 month, 6 months and 12 months after the restoration. Modified USPHS (US Public Health Service) criteria were used in the controls. The controls were performed by 2 physicians who are experts in the field of restorative dentistry. If there was a difference in scoring among the physicians, consensus was achieved. At the same time, the teeth were evaluated clinically and radiographically for the presence of coronary and radicular fractures, the presence of periapical lesions and the presence of dental caries. Statistical analysis of this study was done with SPSS 25.0 (IBM SPSS Statistics., Illinois USA) package program. Mc-Nemar test was used to compare baseline scores and control scores in the 6^{th} and 12^{th} months. The significance value was accepted as $p = 0.05$.

RESULTS

Retention and Recall Rates

Two patients from each group were excluded from the study because periodic controls of these patients could not be performed for various reasons. Thus, the number of restorations included in the assessment was determined as 13 per group (n = 13) with a recall rate of 86.6% and a retention rate of 100%. Distribution of modified USPHS criteria scores of groups was given in Table 1.

Table 1. Distribution of modified USPHS criteria scores of groups. B: Baseline, 6: 6^{th} month results, 12: 12^{th} month results

		EverX Posterior		Gaenial Posterior	
Variables (Modified USPHS Criteria	**Scores**	**A**	**B**	**A**	**B**
Marginal Adaptation	**B**	13	0	13	0
	6	13	0	13	0
	12	12	1	12	1
Marginal Discoloration	**B**	13	0	13	0
	6	13	0	13	0
	12	12	1	13	0
Anatomic Form	**B**	13	0	13	0
	6	13	0	12	1
	12	13	0	11	2
Recurrent Caries	**B**	13	0	13	0
	6	13	0	13	0
	12	13	0	13	0
Surface Texture	**B**	13	0	13	0
	6	13	0	13	0
	12	13	0	13	0

Marginal Adaptation

In the first six months, all restorations in both groups achieved an alpha score and showed excellent marginal adaptation, while in the first year follow-up, bravo score was obtained by one restoration in both groups.

Marginal Discoloration

Similar to the results in the marginal adaptation criterion, a total of 26 alpha scores were determined in both groups during the first six months. In the first year follow-up, all restorations in the Gaenial Posterior group maintained alpha scores, while one restoration in the EverX Posterior group showed mild marginal discoloration (Figure 1).

Figure 1.

Anatomic Form

EverX Posterior group exhibited higher scores in the follow up periods according to anatomic form criterion. At the end of the first year 13 alpha scores obtained by EverX Posterior group while two restorations show a slight level of deformation was detected according to the anatomical form criteria so 11 alpha and 2 bravo scores obtained by Gaenial Posterior group.

Reccurent Caries and Surface Texture

According to the results of statistical evaluation, there was no difference between the groups in terms of marginal caries and surface roughness from the beginning to the end of 12 months.

Although the restorations performed showed slight changes according to the marginal integrity, marginal coloration and anatomical form criteria, these changes did not create a significant difference between the groups ($p > 0.05$).

DISCUSSION

Standardization of evaluation criteria is very important for comparing clinical studies. Cvar and Ryge determined the criteria to be used in the clinical evaluation of dental restorative materials in 1971.[14] This criteria is called Ryge criteria or USPHS criteria. This system evaluates color, anatomical form and marginal features (adaptation, coloration and caries). According to

the Ryge criteria, the restorations with Alpha score are clinically perfect. The restorations with Bravo score show clinically acceptable changes but do not need to be renewed. Restorations with a Charlie score are considered to have undergone a change that would require the restoration to be renewed.[15]

The World Dental Federation (FDI) also published another clinical research guide in 2007 to standardize clinical evaluation criteria and guide researchers.[16] This guide, which allows very detailed evaluation, is also called "FDI" criteria. Restorations evaluated in 3 different sections as aesthetic, functional and biological and in 5 different scores in FDI criteria. It is claimed that FDI measurement criteria provide more precise and detailed evaluation in the clinical follow-up of the restorations compared to Ryge criteria.[16] However, due to the low number of FDI criteria used today, it is an important disadvantage that the number of studies that can be compared is low. Apart from that, a very detailed learning curve is needed to calibrate the clinicians who will perform the evaluation by using this system.

In this study, modified USPHS criteria were preferred due to its widespread and simple use in the clinical evaluation of composite resin restorations. The restorations were evaluated in terms of marginal adaptation, marginal discoloration, anatomic form, surface texture and secondary caries.

It is generally accepted that the 6-month retention rate for a restorative material must be at least 95% in order to be considered as clinically successful. In this study, we evaluated the strengthening effect of EverX Posterior, which is a glass fiber reinforced resin composite for the restorations of ETT, there was no loss and retention rates were 100% in glass fiber reinforced and also in unsupported composite resin groups at the end of 12 months follow-up. G-aenial Posterior, a nanohybrid composite resin, has been clinically successful in retention, both in glass fiber reinforced and unsupported use. Clinical studies designed to measure the clinical success of restorative materials, usually take place during short follow-up periods, both from the patient and from the physician. However, it is known that a minimum follow-up period of at least 5 years is needed to obtain reliable evidence.[17,18] One of the limitations of our study results might be the relatively short follow-up period.

The marginal integrity (marginal adaptation) criterion is a clinical parameter that expresses the integrity between restoration and tooth. This criterion one of the important factors that determine the survival of a restoration. Insufficient marginal adaptation can cause leakage of oral fluids between the restorative material and dental tissue, postoperative sensitivity, marginal coloration and recurrent caries formation.[19] Statistical evaluation of this study conducted at the end of 12 months the rate of the restorations with an alpha score related to the marginal integrity criterion was found to be 92.3% in both restorations with nanohybrid composite resin and SFRC supported restorations. We think that the high adhesion strength of the adhesive agent used in this study and the superior physical properties of the nanohybrid composite are effective in obtaining high scores in both groups in terms of marginal adaptation. Similar to this study, Sadeghi *et al.* [20] evaluated the 18-month clinical performances of a microhybrid, a condensable and a nanofill resin composite in molar teeth by using the Ryge criteria and stated that there was no significant difference between the materials in terms of marginal adaptation and all materials are clinically successful.

The marginal integrity criterion is also closely related to the marginal coloration criterion. It is claimed that the most important cause of marginal coloration in composites is the gap between restoration and tooth as a result of polymerization shrinkage and marginal coloration is caused by marginal leakage.[21] In this study, although there was no statistically significant difference between the groups, marginal coloration was observed in one of 13 restorations of sfrc group. We think that the edge coloration detected in the sfrc group, which is claimed to have a reducing polymerization shrinkage effect, is not due to polymerization shrinkage, but to patient habits or cavity design.

Nicheva *et al.* [22] evaluate the clinical performance of direct and indirect composite restorations in ETT. The surface gloss disappeared in two of the direct restorations according to the surface roughness criterion and a change to Bravo score was observed. The coloration seen in the border of enamel with composite resin in two of the direct restorations indicates the microleakage in the restoration border. However, the change from Alpha to Bravo score is considered superficial and is not considered sufficient for microleakage. Shrinkage stress that can cause microfractures in enamel in large restorations may be the reason for this. Problems in finishing and polishing processes, which are likely to impair the marginal integrity of the restoration, are also considered as other factors. Clinical performances of both direct and indirect composite resins were found to be successful at the end of the study at 6 months.,

Microleakage is one of the most important problems especially in posterior restorations extending to the gingival border. Sharafeddin *et al.* [23] reported that polyethylene fiber reinforcement to Class II resin composite restorations did not cause a significant reduction in microleakage after 6 months. In this study, no difference in terms of marginal coloration was detected in research groups. According to these results, we can also state that fiber reinforcement does not contribute to reducing microleakage in the short term.

Secondary caries formation is also an important criterion in the clinical evaluation of resin based restorative materials. Although composite resins are

accepted as an alternative to amalgams, studies show that secondary caries are more common in composite resin restorations. In studies with a short clinical follow-up, it was reported that secondary caries were rare, but in long-term clinical studies, the rate of secondary caries increased. [24] In this study, secondary caries were not observed in any restoration at the end of 12 months follow-up period.

Surface roughness is another important factor in the clinical evaluation of resin-based restorative materials. In this study, a single step polishing system containing aluminum oxide particles and polishing paste containing diamond particles were used in the polishing of the restorations. The effectiveness of single step polishing tires is claimed to depend on the composite resin used.[25] We think that the nanohybrid composite resin and polishing system used in this study contributes in obtaining the alpha score at the beginning and at the end of twelve months according to the surface roughness criteria.

CONCLUSIONS

According to the Modified USPHS (US Public Health Service) criteria in the 12-month control, there was no statistical difference between composite restorations supported by short fiber reinforced resin composite and without fiber support. All teeth included in this study were provided adequate aesthetics and function during the 12-month follow-up with or without fiber reinforcement. The relatively short follow-up period is the limitation of this study. Long term follow-ups are needed to assess whether there is a difference between two restoration groups.

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