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CORONAL MICROLEAKAGE OF VARIOUS TEMPORARY FILLINGS IN STANDARDIZED ENDODONTIC ACCESS CAVITIES

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ABSTRACT

Background and Aim: The aim of this study was to compare the coronal microleakage of various temporary fillings (TFs) in endodontic access cavities in extracted human teeth using a methylene blue dye penetration test.

Materials and Methods: Standardized access cavities were prepared in 100 extracted human premolars. The teeth were then randomly divided into 9 groups of 10 teeth, with the remaining teeth serving as positive and negative controls. The cavities in the experimental groups were filled with 4 mm of Cavit G, Coltosol F, BMS, Fermin, Ketac Molar Easymix, Clip, Pro-Fill, DuoTEMP, or TempBond Clear with Triclosan TFs according to the manufacturer's instructions. After thermocycling for 500 cycles (5-55°C), microleakage was measured by using a methylene blue dye penetration test. The teeth were sectioned, and the greatest depth of dye penetration was recorded. Coronal microleakage was evaluated with a stereomicroscope. Data was analyzed with Kruskal-Wallis and Mann-Whitney U tests with Bonferroni correction ($p \leq 0.05$).

Results: Positive controls displayed complete dye penetration, and negative controls showed no dye penetration. Whereas Pro-Fill led to a statistically significantly lesser coronal sealing ability than DuoTEMP, BMS, Coltosol, Cavit-G ($p \leq 0.05$), there was no significant difference between the other groups ($p>0.05$). However, Ketac Molar Easymix showed lowest leakage ($p \leq 0.05$).

Conclusion: All TFs displayed some degree of leakage. The results of this study indicate that Ketac Molar Easymix is not suitable material for temporary filling. Other materials can be used, but should be considered their variable leakage rates.

Key words: Access Cavity, Coronal Microleakage, Temporary Fillings

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CLINICAL DENTISTRY AND RESEARCH 2013; 37(2): 23-28 Orjinal Araştırma

ÇEŞİTLİ GEÇİCİ DOLGULARIN STANDARDİZE EDİLMİŞ ENDODONTİK GİRİŞ KAVİTELERİNDE KORONAL MİKROSIZINTISI

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ÖZET

Amaç: Bu çalışmanın amacı, çekilmiş dişlerdeki endodontik giriş kavitelerinde çeşitli geçici dolguların (GD) koronal mikrosızıntını metilen mavisi boya penetrasyon testi ile karşılaştırmaktır.

Gereç ve Yöntem: Yüz adet çekilmiş premolar dişe standart giriş kaviteleri hazırlanmıştır. Dişler rastgele 10'ar diş içeren 9 gruba ayrılmış, kalan dişler pozitif ve negative control olarak kullanılmıştır. Deney gruplarındaki kaviteler 4 mm derinliğinde; Cavit G, Coltosol F, BMS, Fermin, Ketac Molar Easymix, Clip, Pro-Fill, DuoTEMP, veya Triklosanlı TempBond Clear GD ile üretici firma önerilerine göre doldurulmuştur. Dişler 500 kez (5-55°C) termosiklusa tabii tutulduktan sonra, metilen mavisi boya penetrasyon testi ile dolguların mikrosızıntıları ölçülmüştür. Dişler ortadan ikiye ayrılmış ve boya penetrasyonunun en derin olduğu değer kaydedilmiştir. Koronal mikrosızıntı bir stereomikroskop ile değerlendirilmiştir. Veriler Kruskal-Wallis ve Bonferroni düzeltmeli Mann-Whitney U testi ile değerlendirilmiştir ($p \leq 0,05$).

Bulgular: Pozitif kontroller tam boya penetrasyonu gösterirken, negative kontrollerde hiç boya penetrasyonu görülmemiştir. Pro-Fil geçici dolgu, DuoTEMP, BMS, Coltosol, Cavit-G'den anlamı düzeyde daha az koronal örtme sağlamasına rağmen ($p \leq 0.05$), diğer gruplar arasında anlamlı bir fark bulunmamıştır ($p > 0.05$). Bununla birlikte, en az mikrosızıntıyı Ketac Molar Easymix göstermiştir.($p \leq 0.05$).

Sonuç: Tüm GDlar mikrosızıntı göstermiştir. Bu çalışmanın sonuçları Ketac Molar Easymix'in GD olarak kullanımının uygun olmadığını, diğer materyallerin değişik sızıntı değerleri göz önünde bulundurularak kullanılabileceklerini göstermiştir.

Anahtar Kelimeler: Geçici Dolgular, Giriş Kavitesi, Koronal Mikrosızıntı

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INTRODUCTION

One important step of root canal treatment is impervious temporary seal the endodontic access openings between visits or until a permanent restoration is placed with temporary fillings (TFs).[1] These fillings prevent the entry of saliva/fluids, microorganisms and other debris into the root canal system.[2] In addition, they inhibit the escape into the oral cavity of intracanal medicaments placed in the pulp chamber.[3] An ideal TF should be easily manipulated, effectively seal the tooth margins, be resistant to abrasion and compression resistance, be aesthetic appearance and be dimensionally stable in a moist environment.[4] Previous studies[5,6] have demonstrated that lack of satisfactory TFs during root canal treatment has been responsible for persistent postoperative complaints.

To date, Cavit and IRM are the most commonly used TFs in endodontics, even though their sealing capability has generated conflicting results.[7] Nowadays, many TFs with different microstructures, compositions and setting mechanisms are available on the market. Coltosol F (Coltene Whaledent, Langenau, Germany), BMS (BMS Dental, Capannoli, Italy), Fermin (Detax, Ettlingen, Germany), Ketac Molar Easymix (3M ESPE, Seefeld, Germany), Clip (Voco, Cuxhaven, Germany), Pro-Fill (WP Dental, Bramstedt, Germany), DuoTEMP (Coltene/Whaledent, Altstätten, Switzerland) and TempBond Clear with Triclosan (Kerr, Orange, CA, USA) are some of them. They have not yet been thoroughly researched.

Sealing properties of various TFs have been researched in previous studies. In these studies, different experimental methods have been used to assess coronal microleakage, such as; the use of radioactive isotopes,[8] dye, [3,4,9-12] bacteria,[13] and fluid filtration.[14]

The aim of this study was to compare the coronal microleakage of various TFs in endodontic access cavities in extracted human teeth using a methylene blue dye penetration test.

MATERIALS AND METHODS

Tested Materials

Nine currently used TFs were tested. Four composite resin based material: Clip (a light curing TF), Pro-Fill (a light curing TF), DuoTEMP (a dual curing TF) and TempBond Clear with Triclosan (a dual curing TF), three calcium sulphate based: Cavit G (a hydraulic TF), Coltosol F (a hydraulic TF), BMS (a hydraulic TF), one zinc sulphate based: Fermin (a hydraulic TF), and one glass-ionomer based: Ketac Molar Easymix (a glass ionomer cement). Composition of the tested materials and their manufacturers were showed in Table 1.

Specimen Selection

One hundred freshly extracted, unrestored, caries-free human premolars were selected for this study. All teeth were examined at X10 magnification, and those with microcracks were excluded. The teeth were cleaned of debris and soft tissue remnants and were stored in 0.9% saline solution at +4 °C until required.

Restorative Procedures

4X4 mm uniform endodontic access preparations were made through the occlusal surface using a #4 carbide round bur followed by a safe-end fissure diamond bur in a high-speed air turbine handpiece with water spray. Same operator (DÇ) prepared all access openings and removed pulp tissues in the chamber. Then, each cavity was irrigated using 5.25% NaOCl and after air dried a small dry sponge spacer was placed on the floor of the chamber. Finally, the depth of the cavity was measured with a periodontal probe and assuring that it could accommodate at least 4 mm thickness of the TF. After access cavity preparations, the teeth randomly divided into 9 experimental and 2 control groups. Each experimental group consisted of 10 premolar teeth, and each control group consisted of 5 premolar teeth. The specimens were immersed in cold acrylic resin to the cemento-enamel junction to ensure an apical seal, and after polymerization, the specimens were stored in an incubator at 37°C in 100% humidity for 24 hours.

The access cavities of the teeth in the experimental groups were then filled with 4 mm of Cavit G, Coltosol F, BMS, Fermin, Ketac Molar Easymix, Clip, Pro-Fill, DuoTEMP, or TempBond Clear with Triclosan TFs according to the manufacturer's instructions. Complete filling and temporization of all canals were confirmed with radiographs taken in a buccolingual and mesiodistal directions. No cavity preparation was made in the negative control group and the teeth had intact crowns. In the positive control group, access cavity prepared and then only a small dry cotton pellet was placed on the floor of the chamber but not restored with a TF. The teeth were then thermocycled for 500 cycles (5-55±2 °C) was subjected with a dwell time of 30 seconds in each bath.[11] After thermal cycling, the specimens were air dried and covered with two layers of nail varnish in the negative control group. The teeth of the experimental groups and

Table 1. Composition of the materials and their manufacturers.

Materials	Composition	Manufacturers
DuoTEMP	Zinc oxide, urethane dimetacrylate, zinc sulphate monohydrate	Coltene/Whaledent, Altstätten, Switzerland
TempBond Clear with Triclosan	Base: uncured urethane diacrylate, monomers, Catalyst: dibutyl phthalate, monomers, uncured urethane diacrylate, monomers	Kerr, Orange, CA, USA
Clip	Hydroxyethylmethacrylate, butylhydroxytoluene, acrylate ester, polymers	Voco, Cuxhaven, Germany
Pro-Fill	Aliphatic dimethacrylate, siliciumdioxide, urethane dimethacrylate	WP Dental, Bramstedt, Germany
Cavit G	Zinc oxide, calcium sulphate, zinc sulphate, glycol acetate, polyvinyl acetate resin, polyvinyl chloride acetate, triethanolamine, colour pigment	3M ESPE, Seefeld, Germany
Coltosol F	Zinc oxide, calcium sulphate, zinc sulphate, ethylene vinyl acetate copolymer	Coltene Whaledent, Langenau, Germany
BMS	Zinc oxide, calcium sulphate	BMS Dental, Capannoli, Italy
Fermin	Zinc oxide, zinc sulphate	Detax, Ettlingen, Germany
Ketac Molar Easymix	Powder: Al-Ca-La fluorosilicate glass, copolymer acid (acrylic and maleic acid), Liquid: Polyalkenoic acid, tartaric acid, water	3M ESPE, Seefeld, Germany

the positive control group were coated with two layers of nail varnish except for 1 mm around the tooth-restoration interface.

Coronal Leakage Test and Analysis

All specimens were placed in 2% methylene blue solution at neutral pH (pH=7) in an incubator, at 37°C and 100% humidity for 7 days. They were then removed from the dye solution, washed under tap water, and air dried. Sectioning was performed in a buccolingual direction with a low-speed diamond saw (MicraCut; Metkon, Bursa, Turkey) along root specimens' longitudinal axis and the greatest depth of dye penetration on both halves for each specimen was photographed by a digital camera (Nikon Coolpix 885; Nikon, Tokyo, Japan) adapted to a trinocular stereomicroscope with X25 magnification. These recorded images evaluated with dye penetration test. Dye penetration was determined based on the following scores[10]: 0- No dye penetration into the filling material or along the filling-tooth interface: 1- Dye penetration into the filling material or along the filling-tooth interface up to the enamel dentine interface: 2- Dye penetration into the filling material or along the filling-tooth interface up to the filling edge: 3- Dye penetration into the filling material or along the filling-tooth interface up to the endodontic cavity (cotton pellet is discolored). Leakage of the TFs was analyzed with the Kruskal-Wallis test. Furthermore, dichotomous comparisons were made using the Mann-Whitney U test with Bonferroni correction in order to determine the groups between which the difference was present ($p \leq 0.05$).

RESULTS

Results are shown in Table 2. The positive controls displayed complete dye penetration and the negative controls showed no dye penetration. In the experimental groups, whereas Pro-Fill led to a statistically significantly lesser coronal sealing ability than DuoTEMP, BMS, Coltosol, Cavit-G ($p \leq 0.05$), there was no significant difference between the other groups ($p > 0.05$). However, Ketac Molar Easymix showed lowest leakage ($p \leq 0.05$).

DISCUSSION

Coronal leakage can compromise the success of root canal treatment. Therefore, a TF should prevent coronal leakage between appointments. In this study composite resin based, calcium sulphate based, zinc sulphate based and glass-ionomer based TFs were compared with each other. According to the results, all experimental groups demonstrated leakage within the material.

Ketac Molar Easymix is an improved version of established high-viscosity glass ionomer cements. Its powder-liquid ratio is improved as 25% when compared with the commonly used

Table 2. Number of teeth with different leakage scores.

Leakage scores					Median	Min.	Max.
Groups	0	1	2	3			
Cavit G[a]	-	10	-	-	1	1	1
Coltosol F[a]	-	10	-	-	1	1	1
BMS[a]	-	10	-	-	1	1	1
Fermin[a,b]	-	5	5	-	1,5	1	2
Ketac M. Easymix[c]	-	-	-	10	3	3	3
Clip[a,b]	-	7	3	-	1	1	2
Pro-Fill[b]	-	-	10	-	2	2	2
DuoTEMP[a]	-	10	-	-	1	1	1
TempBond Clear[a,b]	-	6	4	-	1	1	2
Negative Control[d]	5	-	-	-	0	0	0
Positive Control[e]	-	-	-	5	3	3	3

The same superscript letters indicate statistically no significant values.

high-viscosity glass ionomers. The results of the present study are in agreement with other studies showing that glass ionomer cement has a gross microleakage when used as a TF.[12,15,16] Cavit-G, Coltosol F, BMS, DuoTEMP Fermin, Clip and TempBond Clear with Triclosan showed least leakage, whereas Ketac Molar Easymix showed complete leakage along the filling-tooth interface up to the endodontic cavity. Cavit-G, Coltosol F, BMS and Fermin are premixed TFs which contain dominantly zinc oxide. These materials are hydraulic TFs. They have hygroscopic properties causing them to expand and set when they come in contact with moisture.[9] This expansion probably causes the material to adapt better against the dentin walls and this adaption provides a good seal under different conditions including thermo cycling.[9,17] Several studies found that hydraulic materials ensured an adequate seal if used in a thickness of at least 3.5 mm.[11,12] In this study a thickness of 4 mm of restorative material inserted in all specimens.

Pro-Fill and Clip are noneugenol-containing, light-activated diurethane dimethacrylate resins. However, under the conditions of this study Clip showed superiority to Ketac Molar Easymix ($p \leq 0.05$) and similar results with other experimental groups ($p > 0.05$) whereas Pro-Fill showed less effective seal than Cavit-G, Coltosol F, BMS and DuoTemp. Similar to the result of Ciftci et al.[12] we found that Clip seals against marginal leakage as effectively as Cavit-G. DuoTEMP is one of the first dual-cure TFs. It is eugenol-free, radiopaque and is formulated from zinc oxide and zinc sulphate. In spite of the dual-cure property, similar to results of Hartwell et al.[18] DuoTemp did not show superiority to hydraulic TFs. TempBond Clear with Triclosan is a dual-cured resin based dental temporary cement and restorative material, available in a convenient automix syringe, it offers a dual cure for added security and flexibility, ease of handling, and easy removal from preparations. There is no information about whether this material is efficient to provide satisfactory sealing endodontic access preparations. Under the conditions of the present study, results indicate that TempBond Clear with Triclosan seals against marginal leakage as effectively as Clip and Fermin, leaked significantly lower than Pro-Fill and Ketac Molar Easymix but higher than DuoTEMP, BMS, Coltosol and Cavit-G when used as a TF.

The major drawback of this study is that the experimental design did not totally mimic actual clinical conditions (e.g. the present study evaluation of the materials with four dentinal walls, lack of saliva and masticatory forces). The thickness of each material and the method of accessing each tooth were standardized, however it was impossible to control

the exact volume of TF used in each tooth. The materials in the study were not applied uniformly at standard volume; this could have potentially affected the results because leakage in TFs might occur either at the tooth-material interface or through the material itself.[14] However, the data provide useful preliminary information about the sealing properties of the materials.[11] Because an ideal TF should possess a combination of long-term bacterial sealing ability with adequate mechanical properties, further clinical and laboratory experiments are recommended to test the ability of dual-cured temporary restorative material DuoTEMP to seal against bacteria and to withstand mechanical loading.

CONCLUSION

All TFs displayed some degree of leakage. The results of this study indicate that Ketac Molar Easymix is not suitable material for temporary filling. Other materials can be used, but should be considered their variable leakage rates.

CONFLICT OF INTEREST

The authors deny any conflicts of interest.

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