THE EFFECT OF VARIOUS BACK-FILLING TECHNIQUES ON THE FRACTURE RESISTANCE OF SIMULATED PERFORATING INTERNAL RESORPTION CAVITIES REPAIRED WITH MTA

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ABSTRACT

Background and Aim: This study assessed the effect of various back-filling materials on the fracture resistance of teeth with simulated perforated internal resorption cavities repaired with MTA.

Materials and Methods: Sixty single-rooted teeth were used. Twelve teeth were not instrumented and served as a negative control (Group NC). Forty-eight roots were prepared and internal resorption cavities were created. Twelve teeth were served as a positive control (Group PC). The apical 4 mm of the 36 root canals were obturated with gutta-percha/sealer. Simulated internal resorption cavities were repaired with MTA and divided into 3 groups. Back-fillings were performed with MTA, FRC (Fiber-reinforced composite post) or GP (sealer+gutta-percha).

Results: The mean fracture values of NC were significantly higher than groups with FRC, GP, and PC (p<0.05) except for the group with MTA (p>0.05). No significant difference was found among FRC, MTA, and GP (p>0.05). Fracture resistance values of PC group were statistically lower than NC and MTA groups (p<0.05).

Conclusion: MTA may be a preferable material for the back-filling of the roots with perforated internal resorptions.
ÇEŞİTLİ DOLUM TEKNİKLERİNİN MTA İLE TAMİR EDİLEN YAPAY İÇ KÖK REZORPSİYON KAVİTELİLERİNİN KIRILMA DİRENÇLERİ ÜZERINE ETKİSİ

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ÖZ

Amaç: Bu çalışmada farklı dolum tekniklerinin MTA ile tamir edilen yapay olarak hazırlanmış iç kök rezorpsiyonlu dişlerin kirılma direnci üzerine etkisi değerlendirildi.

Gereç ve Yöntem: 60 adet tek köklü dış kullanıldı. 12 tane dış genişletilmedi ve negatif kontrol grubu olarak ayrıldı (NK). 48 dış genişletildi ve iç kök rezorpsiyon kaviteleri oluşturuldu. 12 dış pozitif kontrol (PK) grubu olarak ayrıldı. 36 dişin kök kanalının 4 mm’lik apikal kısmı gütarperka/kanal dolgu patı ile dolduruldu. Yapay olarak hazırlanan iç kök rezorpsiyon kaviteleri MTA ile dolduruldu ve dışler 3 gruba ayrıldı. İlk kanalları MTA,FRC (fiberle güçlendirilmiş kompozit post) veya GP(güta perka+kök kanal dolgu pat) ile dolduruldu. }

Bulgular: NK grubundaki ortalama kirılma değerleri, MTA grubu hariç olmak üzere (p>0.05), FRC,GP ve PK gruplarından istatistiksel olarak daha yüksek bulundu (p<0.05). FRC,MTA ve GP grupları arasında anlamlı fark bulunmadı (p>0.05). PK grubunun kirılma direnci değerleri NK ve MTA gruplarından istatistiksel olarak daha düşük bulundu (p<0.05).

Sonuç: MTA perfore olmuş iç kök rezorpsiyonlu dişlerin rezorpsiyon kavitesinin koronalinde yer alan kök kanalının dolumunda tercih edilebilir bir materyaldır.
INTRODUCTION

Root resorption is destruction of dental hard tissues (dentin, cementum or bone) as a result of clastic activities. Root resorption can be classified into two types, external and internal, according to the location of the resorption in relation to the root surface. Compared with external root resorption, internal root resorption is a relatively rare occurrence. The causes of the internal resorption (IRR), its etiology and pathogenesis have not been completely clarified. Nevertheless, reports in the literature support the view that trauma and pulpal inflammation/infection are the major contributory factors in the initiation of internal resorption. When the internal resorption remains untreated, it can eventually perforate the root. If the resorption area perforates the root, re-calcification treatment using calcium hydroxide (CH) and/or surgical approaches has been suggested as treatments of choice. MTA is most commonly used in surgical approaches. A hybrid technique is commonly used to obturate internal resorption teeth. The canal apical to the resorption defect is obturated with gutta-percha, and following the resorption, defect and associated perforation are sealed with MTA. In the treatment of internal resorption procedures, another significant concern is determining which material to use for filling the remaining canal space after obturation the resorption cavity. There are case reports that treated the remaining canal space with fiber post, gutta-percha and MTA after obturation of the resorptive area with MTA. However, a consensus on this issue has not been reached. Therefore, we aimed to evaluate the effect of various backfilling techniques including a fiber-reinforced composite (FRC) root canal post, MTA and gutta-percha/sealer combination, on the fracture resistance of simulated roots with perforating internal resorptive cavities. To date, no studies have directly compared these materials for their root-strengthening ability in teeth with perforated internal resorption. The null hypothesis tested was that the use of MTA, FRC post or gutta-percha had no different effect on the fracture resistance of teeth with simulated perforated internal resorption cavities.

MATERIALS AND METHODS

Sixty extracted mandibular human premolars, macroscopically similar in size and with straight and single root canals, were selected. The mesiodistal and buccolingual diameters of the teeth were measured at the cemento-enamel junction with a digital caliper. Roots presenting a difference of 20% from the mean were discarded. Teeth were decoronated at the cemento-enamel junction using a high-speed diamond bur under water spray to obtain a standard root length of 12 mm. Teeth were randomly divided into five groups. Twelve teeth were not instrumented and served as the negative control. The methodology was conducted as described in a previous report. The remaining teeth were prepared as follows: working length was established 1 mm short of the apical foramen with a size of 1.0 K file, and root canals were instrumented with ProTaper Next rotary instruments (Dentsply, Maillefer) to a master apical size of X3. The root canals were copiously irrigated using 3 mL 2.5% NaOCl during instrumentation. After preparation was completed, each specimen was then placed in Eppendorf tubes filled with additional polyvinyl silicone impression material (Hydorise Light, Zhermack, Italy). After polymerization of impression material, the roots were taken out. The lengths of the halves were measured by digital caliper (Liaoning MEC Group, Dalian, China), and the localizations of the resorption cavity were determined. The cavities were located 6 mm from the apex and were created with a size 8 round bur leaving a diameter of 2.3 mm on the middle half of the roots (Figure 1a). A final irrigation was applied for 1 minute using 2 mL 17% EDTA (Ultradent, South Jordan, UT, USA) in order to remove the smear layer. The root canals were then rinsed with 5 mL distilled water and dried with paper points and put into their respective sockets in Eppendorf tubes. Twelve teeth were randomly selected to serve as a positive control (unfilled). The apical 4 mm of the 36 remaining root canals were filled with AH Plus sealer (Dentsply De Trey, Konstanz, Germany) and X3 gutta-percha cones using single cone technique. With the aid of a calibration ruler, extending up to 1 mm from the WL was selected and then passively inserted into the root canal with a small amount of endodontic sealer, taking care to avoid extrusion into the resorbed area. The gutta-percha was partially removed with a heated plugger, leaving 4 mm of apical filling. Then, resorptive cavities of these 36 roots were filled with MTA. The powder of MTA was mixed with sterile water in a 3:1 powder/liquid ratio. Following this, cement was incrementally placed in the resorption cavities with an amalgam carrier and condensed with hand pluggers. Afterwards, roots were divided into 3 experimental groups according to the back filling material used in the canal to coronal of the resorption cavity as detailed below (n=12).
Group MT A, (Backfilling with MTA); the powder of MTA was mixed with sterile water in a 3:1 powder/liquid ratio. Then, the cement was incrementally placed into the root canal coronal to cavities with amalgam carrier and was condensed using hand pluggers.

Group FRC, (Backfilling with Fiber-reinforced composite (FRC) posts (EverStick) + self-adhesive resin cement); FRC post diminished by a sharp scissor from apical part until it goes full length of the root canal coronal to resorption cavity. StickTM resin (Stick Tech Ltd Turku, Finland) was applied on the post surface according to manufacturer’s recommendations, and posts were luted with a self-adhesive luting agent (RelyX U100, 3M ESPE, Seefeld, Germany) according to the manufacturer’s instructions. The luting agent was light cured with a LED light-curing unit (Elipar S10, 3M ESPE, St. Paul, MN) for 20 s in each of the four directions.

Group GP, (Backfilling with AH Plus sealer + warm vertical compaction of gutta-percha); the root canal was obturated with warm vertical compaction of gutta-percha combined with AH-26 sealer (Dentsply De Trey, Konstanz, Germany) with hand pluggers.

Then roots were taken out from eppendorf tubes and excess material was trimmed from the surface of the specimens using a scalpel. In groups where resorption cavities were filled with MTA, the samples were wrapped in wet gauze, placed in an incubator, and allowed to set for 24 h at 37°C with 100% humidity to allow complete setting of the cements prior to backfilling of the canal. Then, to confirm the obturation quality, a periapical radiograph was taken for each specimen (Figure 1b). After backfilling procedures were completed, all specimens were stored for 1 week until tested for fracture resistance.

The apical 4 mm of all roots was covered with a thin layer of polyvinyl siloxane impression material to provide a layer simulating periodontal membrane. Then, the roots were mounted vertically in self-cure acrylic resin blocks, exposing 8 mm of the coronal parts. Acrylic blocks including specimens were placed in a universal testing machine (Lloyd LR 30 K, Fareham, England) (Figure 1c). A loading fixture with a spherical tip (r=2 mm) was aligned with the center of the canal opening of each specimen. A compressive vertical loading at a speed of 1 mm/min was applied with spherical tips contacting the entire surface of the roots. The force when the fracture occurred was recorded in Newtons (Figure 1d). The data were statistically analyzed with one-way analysis of variance and Bonferroni tests at p=0.05.

RESULTS

The mean and standard deviation values of the fracture strength test are shown in Table 1. There was a statistically significant difference between the groups according to the one-way analysis of variance (p<0.05). Bonferroni test revealed that the negative control group had a statistically higher resistance to fracture compared with FRC, GP, and PC group (p<0.05) except group MT A (p>0.05). No significant difference was found among FRC, MTA, and GP (p>0.05). Fracture resistance values of PC group were statistically lower than those of negative control and MTA groups (p<0.05).

DISCUSSION

Extensive internal root resorption with perforation may complicate the prognosis of endodontic treatment due to weakening of the remaining dental structure and possible
periodontal involvement. Therefore, materials that were suggested to have reinforcing capacity should be preferred for filling the areas to prevent fractures. MTA is used commonly for filling the resorbed area because of its favorable properties, including mechanical strength, good sealing ability, and biocompatibility and moisture resistance. In the treatment of perforated internal resorption procedures, another significant concern is determining which material to use for filling the remaining canal space after obturation in the resorption cavity. A consensus on this issue has not yet been reached.

In the present study, the reinforcing capability of backfilling materials including fiber reinforced composite post, gutta-percha and MTA were tested in restoration of teeth with simulated perforated internal resorption. To test the fracture resistance, compressive loading test with vertical forces (90° angle) were applied to specimens as previously demonstrated by Teixeira et al. Although the force applied in ex vivo studies cannot completely simulate the clinical situations, standardizing the force in all of the study groups makes it possible to compare the strengthening effect of the materials tested.

According to results of this study, the teeth without any filling (positive control group), showed significantly lower fracture strength in comparison to the ones with MTA. On the other hand, there were no significant differences among NC, FRC and GP filled teeth. Teeth backfilled with gutta-percha showed the lowest mean fracture resistance values; whereas, MTA the highest. However, no significant differences were observed amongst the three experimental groups. MTA backfilled teeth revealed a comparable fracture resistance with unprepared group. Similarly, in a previous report samples completely obturated with MTA showed similar fracture resistance to the group including non-prepared intact roots. Several authors also reported that mature or simulated immature roots which were reinforced with CSCs revealed similar fracture resistance values compared to intact controls as in the present study. This finding suggests that MTA could be used to obturate whole length of root canal in perforated internal root resorptive teeth.

Due to the limited in vitro studies concerning the fracture resistance of teeth with internal resorption, findings of the present study were compared with the findings of the immature teeth studies conducted with MTA. In a previous study by Tanalp et al. it was shown that teeth reinforced with fiber post were no stronger than those restored with gutta-percha. This finding is in agreement with our findings despite the differences between the study designs. They performed a simulated immature tooth model instead of an internal resorption model. The results of another study showed that the fracture resistance values of immature teeth restored with fiber post were higher than that for both the unprepared group and the group backfilling with gutta-percha. Similarly, the results of a recent study showed that teeth restored with fiber posts had higher fracture resistance than those restored with gutta-percha after apexification with MTA. Different results of these in vitro studies may be related to the different type of fiber posts used. In the present study, Everstick post (StickTech, Turku, Finland), which is made of glass fibers embedded in an unpolymerized resin matrix, was used. The post is supplied in a soft form and hardens upon polymerization with light.

In the limitation of this in vitro study, it may be concluded that MTA may be a preferable material for the back-filling of the roots with perforated internal resorptions.

### Table 1. Fracture Resistance Values (Newton) of experimental groups as mean ± standard deviation (SD) (n=12)

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean ± SD*</th>
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<tbody>
<tr>
<td>Group MTA</td>
<td>310.34 ± 65.29a</td>
</tr>
<tr>
<td>Group FRC</td>
<td>270.45 ± 71.23ac</td>
</tr>
<tr>
<td>Group GP</td>
<td>265.19 ± 64.12ac</td>
</tr>
<tr>
<td>Negative control</td>
<td>382.74 ± 50.39a</td>
</tr>
<tr>
<td>Positive control</td>
<td>200.52 ± 51.76c</td>
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</tbody>
</table>

*Different superscripts mean statistical significant difference (p<0.05)

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The authors deny any conflicts of interest.
REFERENCES


