INTRODUCTION

In most cases the long-term failure of root canal treatment is attributed to the inadequate seal of the root canal. Slow leakage of irritants into the periapical tissues causes an injury which is not manifested in the short term. Persistence and development of periapical lesions might not be diagnosed for months and even years after treatment. Therefore, re-evaluation of the response to treatment is of great significance [1]. Failure of root canal treatment might be attributed to various reasons; in this context, the importance of coronal seal is well established. If the irritants in the oral cavity gain access to periapical tissues, the resultant inflammation might lead to treatment failure. Such irritants include agents in the saliva such as microorganisms, foods, chemical agents or other factors that pass through the oral cavity [1]. If gutta-percha and the sealers contact saliva, the seal is dissolved and bacterial penetration and microleakage of toxins and chemical agents takes place into and around gutta-percha. The consequences of the loss of coronal seal are well established: a communication is established: a communication is held between the oral cavity and the periapical tissues. Irritants in the oral cavity gain access to periapical tissues, the resultant inflammation might lead to treatment failure. Such irritants include agents in the saliva such as microorganisms, foods, chemical agents or other factors that pass through the oral cavity [1]. If gutta-percha and the sealers contact saliva, the seal is dissolved and bacterial penetration and microleakage of toxins and chemical agents takes place into and around gutta-percha. The consequences of the loss of coronal seal are well established: a communication is established: a communication is held between the oral cavity and the periapical tissues.
followed by canal enlargement and shaping for post placement. During this procedure caution should be exercised because removal of excess amounts of gutta-percha compromises the apical seal. In addition, removal of large amounts of dentin weakens the root and might make the root susceptible to fracture. The odds of root perforation increases if the instrument deviates from the root canal path, if there is over-preparation of the post space, or if preparation extends beyond the straight portions of the root canal [1]. Gutta-percha remaining in the canal should not be less than 4 mm. Gutta-percha is removed from the root canal as needed and then the canal is shaped and enlarged. Rotary instruments such as Peeso reamers might entangle gutta-percha during its removal and compromise its seal [1]. Since the oral cavity is replete with bacteria and microbial agents it is possible for such agents to penetrate into the underlying tissues and result in odontogenic infections [3]. In addition, it is possible for bacteria to penetrate into the root canals through microleakage of dressing materials (4). Furthermore, crowns have limited longevity [2]. If a large number of irritants in the oral cavity penetrate into periapical areas, the resultant inflammation will lead to the failure of endodontic treatment [1]. Therefore, the coronal seal of intra-canal materials has a very important role in reducing the incidence of periapical inflammations [3]. On the other hand, placement of a layer of cement on the remaining gutta-percha has been recommended to decrease coronal microleakage [6].

MTA is a material with proper seal and good biocompatibility; it has a high pH value and proper antibacterial activity; and it sets in the presence of moisture whereas a sealer is washed away in the presence of moisture, resulting in microleakage [1]. Vizgirda et al [7] compared hot gutta-percha and lateral condensation technique with obturation of the root canal with only MTA and concluded that gutta-percha has a better apical seal compared to MTA [7]. Barrieshi-Nusair et al [8] evaluated the differences between glass-ionomer and MTA in yielding a proper seal when coronal placed on gutta-percha and reported that when MTA is placed on gutta-percha it results in a significantly better seal compared to glass-ionomer [8]. Mavec et al [6] evaluated the effect of a glass-ionomer barrier on the coronal microleakage in teeth with post preparation and reported that 3 mm of gutta-percha along with 1 mm of Vitrebond can decrease the odds of apical contamination [9]. Yamauchi et al [10] evaluated the effect of a plug on canal orifices on periapical inflammation in an in vivo study in dogs and concluded that the presence of a composite resin or IRM plug on the canal orifice results in a decrease in periapical inflammation in dogs [10]. Werkman et al [11] evaluated coronal microleakage in endodontic treatments and reported that if gutta-percha is covered with cement at canal orifice, coronal microleakage decreases [11]. Erkut [12] evaluated coronal microleakage around fiber posts and showed that microleakage takes place around all fiber posts along the entire post length [12]. Rahimi et al [13] evaluated the effect of three different lengths of gutta-percha remaining in the canal space on apical microleakage after post space preparation and concluded that microleakage decreases with an increase in the length of remaining gutta-percha [13]. Olmez et al [14] evaluated the effect of different thicknesses of MTA on coronal microleakage in deciduous teeth obturated with calcium hydroxide. They concluded that with an increase in MTA thickness up to 3 mm there is a decrease in microleakage. No significant differences were observed between 3 and 4 mm [14]. Yildirim et al [15] evaluated apical microleakage with the use of three different post space preparation techniques: immediate, delayed and 5 mm of MTA as a sealing material for the apical end of the canal; MTA exhibited significantly less microleakage [15].

The aim of the present study was to evaluate the coronal microleakage of the apical segment of root-canal filling materials after post space preparation and placement of an MTA layer on the remaining gutta-percha or filling the root canal with only MTA or gutta-percha to prevent coronal microleakage.

**MATERIALS AND METHODS**

In the present in vitro study, 34 human single-canal teeth which had been extracted for orthodontic reasons, caries or periodontal diseases were collected by simple sampling technique from various treatment centers and stored in physiologic serum. All the teeth were immersed in 5.25% sodium hypochlorite solution for 20 minutes. Then all the tooth surfaces were cleaned with #3 and #4 Gracey curettes in order to remove PDL from the surfaces and expose the tooth surfaces. All the teeth were observed under a stereomicroscope at ×10 for any cracks. Subsequently, the tooth crowns were cut away to leave a root length of 16 mm. Working length was determined with a #15 file at 0.5–1 mm short of the apex. The apical thirds of the root canals were prepared up to file #40 using the step-back technique. Then preparation and shaping of the coronal segments of the root canals continued up to file #70, using #4, #3 and #2 Gates-Gildden drills (Dentsply Maillefer).

The teeth were divided into 5 groups using random allocation method: groups A, B and C with 10 samples in each and groups D and E with two samples in each. In groups A and C, 20 samples were obturated with gutta-percha and AH26 sealer using the lateral condensation technique and the result was evaluated by radiography. The samples were immersed in physiologic serum and incubated at 37°C for one week. Subsequently, the root canals in group A were evacuated with Peeso reamers #1 to #4 (Dentsply Maillefer) to leave only 3 mm of gutta-percha at the apical end of the canal. Then 2 mm of MTA was placed on gutta-percha. Finally, a wet cotton pellet was placed in the canal and the canal orifice was closed with 4 mm of Cavit for 24 hours. In group...
B, the apical 5 mm of the root canal was obturated with only MTA, the cotton pellet was placed inside the canal and the canal orifice was covered with 4 mm of Cavit for 24 hours. The root canals in group C were evacuated using Peeso reamers #1 to #4 to leave only 5 mm of gutta-percha at the apical end of the root canal. In group D, two samples were selected as the negative control and the root canals were obturated only with gutta-percha and sealer. In group E, two samples were selected as the positive control and no materials were placed within the root canals. These samples underwent only cleaning and shaping. All the samples in each group were incubated at 37°C for one week.

All the tooth surfaces in group A, B, C and E were completely covered with two layers of nail varnish except for canal orifices. The root canal orifice in group D was covered with Cavit and all the surfaces were covered with two layers of nail varnish. In the next step, all the samples were immersed in 2% methylene blue and placed on a vibrator for 1 minute to prevent bubbles from forming on tooth surfaces. After three days the samples were retrieved from methylene blue and dried. All the samples were cut longitudinally under copious irrigation in order to evaluate dye penetration. All the samples were photographed perpendicular to the cut sample surface while a caliper was placed next to the samples with its mouth open for 2 mm, using a Camera (Cannon EOS 450D, Canon, Japan) (12.2 Megapixels). The images were saved on a computer and the measurement tool of Photoshop 8 software program was used to measure the extent of dye penetration in terms of the caliper used at an accuracy of 0.01 mm. Data were analyzed with one-way ANOVA using SPSS 17.

RESULTS AND DISCUSSION

Results:

Thirty-four extracted single-canal anterior teeth were used in the present study. In groups A (MTA + gutta-percha), B (MTA) and C (gutta-percha) there were 10 teeth in each group and in the control groups D (negative) and E (positive) there were two teeth in each. The means of dye penetrations in groups A, B and C were 2.01±0.8, 2.46±0.54, and 4.04±1.6 mm, respectively (Table 1). The positive control group samples exhibited complete dye penetration and none of the negative control group samples showed any dye penetration. Comparison of the means of dye penetration between groups A and B revealed less dye penetration in group A but the difference was not statistically significant (P=0.4) (Table 2). The gutta-percha group showed more dye penetration compared to groups A and B and the difference was statistically significant (P=0.01 and P=0.04, respectively).

<table>
<thead>
<tr>
<th>Group</th>
<th>GP+MTA (A)</th>
<th>MTA (B)</th>
<th>GP (C)</th>
<th>Negative (D)</th>
<th>Positive (E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>2.01±0.8</td>
<td>2.46±0.5</td>
<td>4.04±1.6</td>
<td>0</td>
<td>16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P-Value</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.04</td>
<td>A, B</td>
</tr>
<tr>
<td>0.04</td>
<td>B, C</td>
</tr>
<tr>
<td>0.01</td>
<td>A, C</td>
</tr>
</tbody>
</table>

Discussion:

In the present study, coronal microleakage was evaluated and compared in three different groups, the samples in each of which had been obturated using a different technique in the apical 5 mm of the root canal. In the present study, use of MTA alone or in combination with gutta-percha yielded better results in comparison to the use of gutta-percha alone in preventing microleakage into the periapical areas.

Viable and non-viable pathogens in the oral cavity are the etiologic agents of endodontic diseases. The most common problem in the failure of root canal therapy is a lack of coronal seal, which is more severe in anterior teeth compared to posterior teeth. Temporary crowns and posts cannot produce a sufficient seal. Cavit, which is a temporary dressing material, should be at least 4 mm thick for sufficient seal; considering its properties as a material with low strength and rapid wear, it is possible for this material to have thicknesses less than 4 mm, leading to microleakage [1]. In a study by Erkut et al (2008) coronal microleakage was observed along the entire length of carbon fiber posts bonded to dentin; therefore, despite the importance of root-end filling materials in preventing microleakage into the periapical areas, the study showed the drawback of gutta-percha in providing a coronal seal [12]. The results of the present study are consistent with those of a study by Yieldrin et al (2009), in which it was shown that apical microleakage of gutta-percha was higher than that of MTA. Since they used fluid filtration technique to evaluate microleakage, it appears the technique to evaluate microleakage, it appears the evaluation technique had no effect on the failure results [15]. The results of the present study are consistent with those of a study by Werkman et al [11]. They reported that if the canal orifice gutta-percha is covered with another material, coronal leaking decreases. However, it appears the type of the material covering the canal orifice is of particular importance because in the present study when the entire 5-mm length of the apical...
segment of the root canal was obturated with MTA, again a decrease in microleakage was observed [11]. Mavec et al (2006) showed that placement of a coronal barrier (Vitrebond) on gutta-percha results in a decrease in coronal microleakage, consistent with the results of the present study [9]. There was discrepancy between the results of the present study and those of a study by Vizgirda et al [7]. They compared the gutta-percha lateral compaction technique and obturating the entire canal length with MTA alone and concluded that gutta-percha provides better seal compared to MTA; however, the present study showed better seal with MTA. The difference between the results of these two studies might be attributed to differences in the techniques used to evaluate microleakage. In the study carried out by Vizgirda et al the apical seal was evaluated but in the present study the coronal seal of the apical segment was evaluated [7]. It does not appear the coronal seal achieved by coronal covering of gutta-percha by glass-ionomer in studies carried out by Mavec et al and Barriessi-Nusair et al can be attributed only to the capacity of glass-ionomer to bond to dentin because based on the results of the present study MTA resulted in a significant decrease in coronal microleakage although it cannot bond to dentin [8]. The results of the present study are consistent with those of Olmez et al [14]. They reported that MTA could decrease microleakage up to a thickness of 3 mm and higher thicknesses did not result in significant differences, consistent with the results achieved in MTA and MTA+GP groups [14].

Conclusion:
The results of the present in vitro study suggest that MTA is a suitable material to achieve adequate coronal seal and prevent contamination of the apex with microorganisms and their toxins in teeth requiring post-and-core treatment procedures.

REFERENCES