Abstract: The purpose of this in vitro study was to evaluate two commonly used gutta-percha solvents for their effectiveness in dissolving several types of root canal sealers. Seven different sealers (AH26, AH Plus, Diaket, Roekoseal, Sankin Apatite Root Sealer, Sealapex, and Sultan U/P) were used in this study. After mixing according to the manufacturers’ directions, each material was syringed into 30 glass capillary tubes, and a total of 210 tubes were placed in a humidifier at 37°C for one week to allow the materials to set completely. Each group of 30 tubes, obturated with one type of sealer, was then randomly divided into three subgroups, including 10 tubes each. Chloroform was used in the first ten tubes from each sealer group. Halothane was used for the second group. In the last group, the sealer was removed with files, without using any solvent. The time necessary to pass a file through to the end of the tube was recorded for each sample in seconds. Results were analyzed using one-way analysis of variance. Sealapex did not set at all unless in contact with air. Roekoseal did not adhere to the glass capillary tubes, and was therefore easily removed from the tube in all samples. AH26 and AH Plus root canal sealers tightly adhered to the tube walls, so none of the techniques were effective in removing them from the tubes within 30 min. Diaket root canal sealer was easily removed using solvents ($P < 0.05$). There was no advantage in using solvents to remove Sankin Apatite Root Sealer ($P > 0.05$). Solvents were found to be very effective in dissolving the Sultan U/P root canal sealer ($P < 0.05$). (J. Oral Sci. 45, 123-126, 2003)

Key Words: gutta-percha solvents; chloroform; halothane; sealer.

Introduction

Gutta-percha points should be cemented into the prepared root canal with a sealer. Previously it was thought that the sealer played a secondary role by simply cementing (binding, luting) the core filling material into the canal; however, it is now appreciated that the sealer has a primary role in sealing the canal by obliterating the irregularities between the canal wall and the core material (1).

Removal of root filling material is often necessary to facilitate retreatment of a failed endodontic case or for restorative reasons, such as the preparation of a tooth for post-treatment. During retreatment of endodontically treated teeth, a solvent can facilitate the removal of gutta-percha by softening it. Chloroform is the most commonly used gutta-percha solvent because it acts very rapidly (2). However, investigations by the U.S. Food and Drug Administration have suggested that chloroform may be a potential carcinogen (3).

Because of the concerns about chloroform, clinicians and researchers have developed a renewed interest in finding alternative solvents (4-6). Wourms et al. (4) investigated the ability of 30 noncarcinogenic organic solvents to dissolve gutta-percha. They suggested that halothane was the most promising because it was as effective as chloroform in dissolving gutta-percha. Later, halothane ($C_2HBrClF_3$) was used as a gutta-percha solvent in dentistry, because of its chemical similarity to chloroform ($CHCl_3$). Furthermore, it has already been approved by the Food and Drug Administration for use as an inhalation
anesthetic (2).

Although these solvents are useful to soften gutta-percha, their softening effect on root canal sealers is unknown. The purpose of this in vitro study was to evaluate the dissolving effect of two commonly used gutta-percha solvents on seven different root canal sealers.

**Materials and Methods**

The following sealers were used in this study: resin-based - AH26 (Dentsply, De Trey, Germany), AH Plus (Dentsply, De Trey, Germany) and Diaket (ESPE, Germany); polydimethylsiloxane-based - Roekoseal (Roeko, Germany); tricalcium phosphate-based - Sankin Apatite Root Sealer (Sankin Kogyo KK, Tokyo); calcium hydroxide-based - Sealapex (Kerr, USA); and ZnOE-based - Sultan U/P root canal sealers (Sultan Chemist, USA). Sealers were mixed according to the manufacturers’ directions. Each sealer was placed in 5 ml plastic syringes (Ayset Plastik San AS, Turkey) and syringed into 30 glass capillary tubes (1 mm internal diameter, 20 mm long). Tubes were filled to a level of 15 mm. A total of 210 tubes were filled with sealers and placed in a humidifier at 37°C for one week to allow the materials to set completely.

Each group of 30 tubes obturated with one type of sealer was then randomly divided into three subgroups of ten tubes. Chloroform was used for the first group of ten tubes, and halothane for the second. In the last group, the sealer was removed with a file, instead of a solvent. A size 25 Hedström file (FKG Dentaire, Swiss) was used with a push-pull and rotary action with moderate pressure, to attempt penetration into the test sample. The solvents were refreshed every minute in the top portion of the capillary tubes. The time necessary to pass a file through to the end of the tube was recorded for each sample in seconds. If penetration was not achieved after 30 min, the test was terminated.

Means ± SD were calculated from the times recorded for each group. Results were analyzed using a one-way analysis of variance.

**Results**

The file penetration time for each of the groups is listed in Table 1.

The AH26 and AH Plus root canal sealers tightly adhered to the tube walls such that none of the techniques were effective in removing them from the tubes within 30 min. Sealapex did not set at all, unless it was in contact with air. Roekoseal did not adhere to the glass capillary tubes, and was therefore easily removed from the tube in all samples. Data were not obtained for these materials.

Diaket root canal sealer was easily removed using chloroform (258 ± 35.21 sec.) and halothane (285 ± 32.40 sec.), but this sealer was not removable without solvent ($P < 0.05$).

There was no advantage in using solvents to remove Sankin Apatite Root Sealer ($P > 0.05$). It was removed with chloroform in 36 ± 7.37 sec., with halothane in 37 ± 6.32, and without solvent in 34 ± 4.59 sec.

Solvents were found to be very effective in dissolving Sultan U/P root canal sealers ($P < 0.05$). Although the time necessary to pass a file through to the end of the tube was 41 ± 9.36 sec. for chloroform and 45.5 ± 8.64 for halothane, it took 127.5 ± 9.20 sec. when no solvent was used.

**Discussion**

The glass capillary tube is one of the models used for testing the solubility of endodontic sealers. Natural teeth can also be used to simulate the clinical situation. These have the inherent variabilities of the prepared canal and there is less control over the insertion of the material used as the root filling (7). On the other hand, care must be taken

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**Table 1 Efficiency of solvents on root canal sealers**

<table>
<thead>
<tr>
<th>Time for Penetration (s)</th>
<th>AH26</th>
<th>AH Plus</th>
<th>Diaket</th>
<th>Roekoseal</th>
<th>Sankin</th>
<th>Sealapex</th>
<th>Sultan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloroform</td>
<td>&gt; 1800</td>
<td>&gt; 1800</td>
<td>258 ± 35.21</td>
<td>0*</td>
<td>36 ± 7.37</td>
<td>0*</td>
<td>41 ± 9.36</td>
</tr>
<tr>
<td>Halothane</td>
<td>&gt; 1800</td>
<td>&gt; 1800</td>
<td>285 ± 32.40</td>
<td>0*</td>
<td>37 ± 6.32</td>
<td>0*</td>
<td>45.5 ± 8.64</td>
</tr>
<tr>
<td>No solvent</td>
<td>&gt; 1800</td>
<td>&gt; 1800</td>
<td>&gt; 1800</td>
<td>0*</td>
<td>34 ± 4.59</td>
<td>0*</td>
<td>127.5 ± 9.20</td>
</tr>
</tbody>
</table>

* Material did not adhere to the glass capillary tubes.

* Material did not set after one week.
when using glass capillary tubes, as the force of the file may cause them to break.

In a typical clinical situation, canals are obturated with laterally condensed gutta-percha and a sealer, but gutta-percha was not used in this study. With obturation of glass capillary tubes, it is too difficult to control the placement of the gutta-percha. With the combination of materials, the softening of the sealer may be affected by the presence of the gutta-percha.

It is important to remove as much sealer and gutta-percha as possible in order to uncover any remnants of necrotic tissue or bacteria which may be responsible for the endodontic failure. Thermal, mechanical or chemical methods are used to remove the root canal filling, or a combination of the three (8). Using purely mechanical means to remove gutta-percha is problematic, because root perforation, canal straightening or alteration of the original canal shape may result. Although chemical methods for removing gutta-percha have been used for years, the most effective chemicals are also toxic or otherwise hazardous. Wourms et al. (4) suggested that halothane was an effective organic solvent for gutta-percha. Halothane, a volatile, nonflammable and relatively nontoxic fluorinated hydrocarbon, has been used for induction anesthesia since 1956. It is presently the most commonly used volatile anesthetic agent and has accumulated the best overall safety record. It has a sweet odor, is slightly more soluble in tissues than ether, and is minimally soluble in blood. But care must be taken to minimize environmental exposure because of its ability to produce respiratory depression (4).

In this study, the time taken for even the slowest solvent to dissolve enough material to allow penetration of the file was less than 60 sec. for the Sultan and Sankin Apatite sealers, and 330 sec. for the Diaket root canal sealer. The results of this study correspond with those of a study by Hunter (2), who reported that the necessary time to soften gutta-percha was less than 90 seconds, independent of the solvent type. Furthermore, the time of file penetration with solvents was less than four minutes in Hansen’s study (7).

Sealapex did not set in the capillary tubes in this study. This finding is the same as that reported by Hansen (7). In previous studies, it was reported that Sealapex set very quickly in clinical conditions. It was claimed that any area of Sealapex in contact with air would set. According to Hansen (7), however, the material never sets in the root canal. This would have serious effects on post-preparation, because there would be no adhesion of the filling material to the tooth root and there would be a likelihood of movement and disturbance of any seal.

Roekoseal did not adhere to the glass capillary tubes, and was therefore easily removed from the tube in all samples. This sealer was reported to have adhered to the root canal walls. Saleh et al. (9) found that Roekoseal’s adhesion to dentin was better than that for Grossman’s Sealer, Apexit or Ketac Endo. In addition, Roekoseal’s adhesion to dentin was increased with an experimental primer. In this study, we could not determine the dissolving effect of Roekoseal. Therefore, the effect of solvents on Roekoseal must be evaluated using extracted teeth in a future study.

AH26 and AH Plus root canal sealers are resin materials. There is little information in the literature to suggest which solvents may be effective on these sealers. Wilcox (10) stated that chloroform did not have a solvent action on AH26. But Hansen (7) reported that the time needed for penetration with chloroform for AH26 was 35 min. In this study, these sealers tightly adapted to the tube walls, such that none of the techniques were effective in removing them from the tubes within 30 min.

Krell and Wefel (11) indicated that calcium phosphate cement sealer has very similar physical properties to the clinically accepted Grossman’s sealer. Therefore, it was removed very quickly in this study. There was no advantage in using solvents to remove Sankin Apatite Root Sealer.

Chloroform is a very effective solvent for zinc oxide and eugenol-based root canal sealers. It has been suggested that if enough residual chloroform contacts the sealer, its sealing effectiveness could be reduced in solvent-dip techniques (12). Here, solvents were found to be very effective in dissolving the Sultan U/P root canal sealers.

The time necessary for both solvents tested in this study to dissolve the Diaket and Sultan U/P root canal sealers was significantly lower than that for the non-treated groups. There was no advantage in using solvents to remove Sankin Apatite Root Sealer. The results of this study also indicated that halothane is a suitable alternative to chloroform.

**References**