The apical sealing ability of a tricalcium phosphate sealer was compared with that of three other sealers. Seventy roots of human incisors were cleansed and shaped and randomly assigned to one of seven groups of ten roots each. The root canal systems were obturated with gutta-percha and one sealer using the lateral-vertical condensation technique. The canal was sealed with Roth’s sealer, Sealapex, Kerr root canal sealer, or Sankin apatite root sealer (Type I, II, or III). One group was filled with gutta-percha without sealer to serve as a control. After the roots were immersed in silver nitrate, the degree of dye penetration was measured under a dissecting microscope. Results indicated that Sealapex had the best sealing ability, followed by Sankin apatite root sealer, Type II. Roth’s cement showed the most dye penetration. Canals that were obturated without sealer showed significantly greater apical leakage.

(Quintessence Int 1992;23:515-518.)

Introduction

Solid core filling material, such as gutta-percha, has been used to obturate the root canal in conjunction with a sealer. The objective is total obliteration of the root canal system and prevention of the ingress and accumulation of irritants that could cause biologic breakdown of the attachment apparatus.

Dow and Ingle¹ suggested that failures in endodontic therapy may be due to poor obturation of root canals. Since then, many different obturation techniques and materials have been introduced to increase the quality of the apical seal.

Recently, several bone implant materials composed of hydroxylapatite (HA) and related tricalcium phosphates (TCP) have been promoted for use in restoring osseous defects associated with periodontal disease.²⁻⁴ These materials have also been advocated for apexification⁵,⁶ and enhancement of bone fill after periapical surgical procedures.⁷ Both HA and TCP appear to be biocompatible, since they do not produce an inflammatory or immune response when placed in contact with bone or soft tissue.²⁻⁸ Calcium phosphate biomaterials have been reported to be effective in healing mechanical perforations of the pulp chamber floor,⁹ apical closure,¹⁰ and pulp capping.¹¹,¹²

Krell and Webel¹³ reported that, under scanning electron microscopic analysis, calcium phosphate cement (CPC) appears to be similar to Grossman’s cement in adherence to the root canal wall. Chohayeb et al.¹⁴ in animal studies, showed that CPC has a uniform and tight adaptation to the dentinal surfaces of the pulp chamber and root canal walls. Krell and Madison¹⁵ reported that CPC permits greater dye penetration than does Grossman’s cement.

The purpose of this study was to compare the apical seal produced by apatite root sealers with that achieved by calcium hydroxide sealers.

Method and materials

Seventy recently extracted human maxillary anterior teeth were obtained and stored in 10% formalin. They
Table 1  Mean apical leakage into the canals (n = 10 per group)

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean (mm)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roth's sealer</td>
<td>1.230</td>
<td>0.336</td>
</tr>
<tr>
<td>Sealapex</td>
<td>0.331</td>
<td>0.170</td>
</tr>
<tr>
<td>Kerr sealer</td>
<td>1.200</td>
<td>0.240</td>
</tr>
<tr>
<td>Apatite Type I</td>
<td>0.731</td>
<td>0.440</td>
</tr>
<tr>
<td>Apatite Type II</td>
<td>0.590</td>
<td>0.207</td>
</tr>
<tr>
<td>Apatite Type III</td>
<td>0.870</td>
<td>0.171</td>
</tr>
<tr>
<td>Control (no sealer)</td>
<td>2.840</td>
<td>0.668</td>
</tr>
</tbody>
</table>

were radiographed to confirm root canal patency, closure of the apex, and absence of fracture. The teeth were immersed in 2.6% sodium hypochlorite for 1 week to remove soft tissue from the root surfaces. The clinical crown was removed at the cementoenamel junction with a high-speed fissure bur. The root canal system was cleansed and shaped to the apical foramen to a 25 K file. The rest of each canal was flared by the step-back filing technique to a size-60 file. The canal was irrigated with a 2.6% solution of sodium hypochlorite before cleansing and after use of each file. All roots were then stored in distilled water. The root canal was obturated with gutta-percha (Mynol Chemical Co) and one of the sealers using lateral-vertical condensation technique.

Groups I, II, III, IV, V, and VI consisted of roots in which the canal was sealed with Roth's sealer (Roth Drug Co), Sealapex (Kerr/Sybron Corp), Kerr root canal sealer (Kerr/Sybron Corp), apatite root sealer Type I, apatite root sealer Type II, or apatite root sealer Type III (Sankin Industry Co), respectively. Group VII was filled with gutta-percha and without sealer to serve as a control. The access opening was filled with amalgam.

Each tooth was placed in a capped vial containing 2 x 2-inch gauze pads saturated with distilled water, and the sealer was allowed to set at 37°C in the humidor for 48 hours. The root, except for the apical 2 mm, was coated with two layers of clear varnish. The root was immersed in 50% aqueous silver nitrate solution in the absence of light for 6 hours. The tooth was rinsed for 1 minute in distilled water before the specimen was exposed to fluorescent light. The specimen was immersed in a photodeveloping solution for 2 hours. The root was sectioned longitudinally, and the degree of dye penetration was measured under a dissecting microscope with a digital ruler.

A Student-Newman-Keuls test was performed on the means to determine statistical differences among the groups.

Results

The mean values and standard deviations of the measurement of dye penetration in all groups are shown in Table 1. Examples of the extent of dye penetration in apatite-sealed and control canals are shown in Figs 1 and 2, respectively. Results of the Student-Newman-Keuls test are presented in Table 2. The test showed no statistically significant difference between dye penetration with apatite root canal sealers and that with Sealapex sealer. No statistically significant difference was found among apatite root canal sealers. Canals that were obturated with gutta-percha and without sealer showed significantly greater apical leakage (P < .05).

Discussion

Root canal sealers that could stimulate the deposition of hard tissue at the root apex, forming a biologic seal, would be beneficial in root canal therapy. From a biologic point of view, the ideal response of periapical tissue after root canal treatment would be a closure of the apical foramen by hard tissue. To reach this objective, a root canal sealer containing calcium has been developed.

Hydroxylapatite and TCP ceramic implant materials have been advocated for osseous reconstruction procedures, alveolar ridge augmentation,17 pocket reduction, and bone fill in periodontal therapy,18,19 as well as for acceleration of healing of endodontic lesions.7 Apatite root canal sealer is a root canal obturation material that utilizes tricalcium phosphate and hydroxylapatite and has superior affinity with biologic tissue. Apatite root sealer Type I is a combination of TCP and HA. Radiographically, it responds similarly to a natural tooth. This sealer does not have antibacterial activity. Apatite root sealer Type II contains 30% iodoform and is easily observable in radiographs. Apatite root sealer Type III contains 5% iodoform and basic bismuth carbonate to enhance its radiographic property.

Gruninger et al20 reported that CPC is biocompatible in animals. Therefore, extrusion of this material to periapical tissue should not produce an inflammatory response. A tricalcium phosphate and hydroxylapatite
compound has been shown to provide the best dentinogenic effect in primary teeth. Collagen–calcium phosphate gel appears to be capable of inducing revitalization of pulpless open-apex teeth.

The silver staining method was selected as a staining procedure because of the strong optical contrast of silver particles. Silver staining produces a much sharper picture of dye penetration and therefore is measured easily. Because silver ions precipitate into fine particles, no further diffusion of these particles is likely.

The present results demonstrated that the calcium hydroxide–containing sealer had the best sealing property, which is in agreement with our previous finding. Apatite root canal sealer had minimal dye penetration, and no statistically significant difference was found between Sealapex and apatite sealer. Roth's cement showed the most dye penetration. A significant difference was found between Sealapex and Kerr root canal sealer. Canals obturated with gutta-percha and no sealer had significantly more dye penetration than did any other group. These findings support the recommendation to use a root canal sealer with solid core filling materials.

### Table 2  Statistical differences among groups

<table>
<thead>
<tr>
<th>Not significant</th>
<th>Significant ($P &lt; .05$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I vs III, VI</td>
<td>I vs II, IV, V, VII</td>
</tr>
<tr>
<td>II vs V</td>
<td>II vs III, IV, VI, VII</td>
</tr>
<tr>
<td>III vs VI</td>
<td>III vs IV, V, VII</td>
</tr>
<tr>
<td>IV vs V, VI</td>
<td>IV vs VII</td>
</tr>
<tr>
<td>V vs VI</td>
<td>V vs VII</td>
</tr>
<tr>
<td>VI vs VII</td>
<td>VI vs VII</td>
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</tbody>
</table>

### References


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