Comparison of apical seal of four obturation techniques after delayed post space preparation.

Ali H. Al-Shimmary, B.D.S. (1)
Hussain F. Al-Huwaizi, B.D.S., M.Sc., Ph.D. (2)

ABSTRACT
Background: This in vitro study was conducted to compare the apical seal of four obturation techniques after delayed post space preparation.

Materials and methods: Sixty simulated straight canals in clear resin blocks were used. The samples which had the same length, size of apical preparation and taper, were divided into four groups obturated with lateral condensation, warm vertical compaction, Thermafil, and Softcore obturators. Apexit was used as root canal sealer. Delayed post space preparation was carried out by peeso reamers after one week leaving 6 mm of gutta-percha apically. The coronal cavity was sealed and the samples immersed in 2 % methylene blue dye for 7 days after which the samples were examined by stereomicroscope and calibrated grid to measure apical dye leakage in mm.

Results: Vertical compaction leaked significantly less than lateral condensation and Softcore, and Thermafil leaked significantly less than Softcore. Both Thermafil and Softcore were comparable to lateral condensation; there was no significant difference between vertical compaction and Thermafil.

Conclusion: Thermafil and Softcore had no effect on the apical seal when delayed post preparation was considered and that the apical seal obtained by Thermafil and Softcore was comparable to lateral condensation technique.

Keywords: Apical microleakage, post preparation, Thermafil, Softcore.

INTRODUCTION
The restoration of endodontically treated teeth often requires the use of intracanal posts, which are fitted into the root canal following removal of a portion of the root canal filling material. The final preparation of the post space is usually achieved with rotary instruments, which are often introduced into the canal to refine the space created. During such mechanical preparation of the post space it is possible that the root filling may become twisted or vibrated in such a way as to break the apical seal. Lateral compaction of gutta-percha is one of the most widely used techniques and often has been used as the standard to which the sealing ability of new filling techniques or materials are compared.

Disadvantages include the potential lack of homogeneity of the gutta-percha mass, a high percentage of sealer in the apical portion of the canal, and poor adaptation to root canal walls.

Warm vertical compaction of gutta-percha has been introduced, producing a more homogeneous mass of gutta-percha and a very thin layer of the dimensionally less stable sealer. This possibly reduces leakage along root fillings.

Vertical compaction technique may be more difficult and time consuming, especially for the incremental backfilling of the coronal part of the root canal.

Thermafil obturators were introduced to make root canal filling easier and less time consuming, with a clinical outcome apparently similar to cold lateral condensation therefore becoming a clinical alternative to other techniques.

Softcore is comparable to Thermafil, which belongs to the carrier obturation systems and involves thermoplasticized gutta-percha as a coating on a flexible carrier, but the difference is in the core carrier. The carrier of the Softcore is thinner and less tapered than that of Thermafil, rounded and hollow which should make post preparation easier.

MATERIALS AND METHODS
Sixty simulated straight canals in clear resin blocks were used in this study with main canal of 17 mm length and apical end corresponding to 2 canals prepared to MAF size 40 from which the dye material can penetrate. The canals were divided into 4 groups, 15 samples for each group.

Simulated canals were used in this study to eliminate the variables of canal anatomy, canal preparation which may produce variables in depth of dye penetration, and to standardize the internal canal volume. The transparency of the clear resin blocks enabled visibility of gutta-percha and penetrated dye material clearly without samples sectioning.

Group 1 (Lateral condensation technique)
Simulated canals were obturated by lateral condensation technique and Apexit root canal sealer. The sealer which had a creamy
homogenous consistency was picked up by K reamer and distributed on the canal wall by counterclockwise rotation of the reamer. All resin blocks were held by a previously prepared plaster mold. Master gutta-percha cone size 40 was selected and its tip was coated with sealer, inserted in the canal and condensed with finger spreader size 25. Accessory gutta-percha cones which their tips coated with sealer were used to fill the space created by finger spreader, condensed and adapted to canal wall until the spreader could not be introduced more than 3 mm in the canal. Excess gutta-percha was removed with a hot instrument and the remainder mass was condensed with endodontic plugger.

**Group 2 (Vertical compaction)**

Schilder technique of warm vertical compaction of gutta-percha was used to obturate simulated canals by a set of hand endodontic pluggers after being pre-fitted at different levels of the canal lengths. Root canal sealer was applied on the canal walls by K reamer rotated counterclockwise. Apical two millimeters of master gutta-percha cone size 40 was cut and its tip was dipped in the sealer and placed in the canal. Canal down packing was achieved by alternating heating and compaction waves. The spreader was used as a heat carrier to soften and remove gutta-percha.

Compaction waves were accomplished by endodontic pluggers to condense the softened gutta-percha in the canal starting with the largest plugger coronally and ending with the smallest one apically, filling the apical third of the canal. Back filling was achieved by condensing softened pre-cut gutta-percha segments with pluggers to the level of canal entrance.

**Group 3 (Thermafil)**

Thermafil cones with plastic carrier size 40 were used to fill the canals after their walls were coated with Apexit sealer by K reamer rotated counterclockwise. Thermafil cone was placed in the heating chamber of Thermaprep Plus oven to soften the guttapercha according to the manufacturer's instructions. The softened Thermafil cone was inserted in the canal in a single motion without twisting with firm apical pressure until the full canal length determined by stopper on Thermafil shaft was reached. The handle of Thermafil cone was removed after 4-5 minutes when gutta-percha cooled by inverted cone bur in high speed handpiece.

**Group 4 (Softcore)**

Softcore obturators sizes 40 were used to fill the canals. Apexit sealer was picked up by K reamer which was rotated counterclockwise to distribute the sealer on the canal walls. Softcore obturators were softened in Softcore cordless oven according to the manufacturer's instructions then picked up and inserted in the canal in a manner similar to that of Thermafil. The handle and the insertion pin were removed after gutta-percha was cooled by twisting motion.

**Sample storage**

Samples were stored in normal saline solution, in an incubator at 37 °C for 7 days.

**Dowel space preparation**

All the obturated canals received dowel space preparation after 7 days storage period. Peeso reamers were used for post preparation because they are commonly used and have minimal influence on apical seal (7). Peeso reamers sizes 2 and 3 were used to 3 remove gutta-percha in straight slow speed handpiece rotating at 5000 rpm. The handpiece was attached to the swiveling arm of a modified surveyor to align Peeso reamers with the long axis of the canals which were placed in the plaster mold that was fixed to the surveyor base. Six millimeters of gutta-percha were left apically by removing 11 mm from the total canal length of 17 mm to obtain the best apical seal and decrease microleakage after post preparation (8, 9).

The post length was determined by silicon stops placed on Peeso shafts. The post space was filled by temporary filling material and the coronal orifice of the canal was sealed with sticky wax.

**Leakage study**

All the samples were placed in 2% methylene blue dye for a period of 7 days after which the samples were removed from the dye and washed with distilled water. Samples were examined for the apical dye penetration by light stereomicroscope under 40 X magnification with calibrated grid to measure the level of apical dye penetration in millimeters.

**RESULTS**

Mean values of apical dye penetration are shown in table 1. Vertical compaction had the least leakage followed by Thermafil and lateral condensation, while Softcore had the highest mean leakage value. One way ANOVA test showed statistically significant difference among four obturation groups, P value < 0.05 (table 2).

LSD test was employed to identify the significant difference between pairs representing each two groups; the results of LSD test are shown in table 3.
Table 1: Mean values of apical dye penetration in millimeters.

<table>
<thead>
<tr>
<th>Obturation Techniques</th>
<th>Sample No.</th>
<th>Mean ± Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral</td>
<td>15</td>
<td>0.61 ± 0.087</td>
</tr>
<tr>
<td>Vertical</td>
<td>15</td>
<td>0.55 ± 0.081</td>
</tr>
<tr>
<td>Thermafil</td>
<td>15</td>
<td>0.57 ± 0.072</td>
</tr>
<tr>
<td>Softcore</td>
<td>15</td>
<td>0.63 ± 0.070</td>
</tr>
</tbody>
</table>

Table 2: Analysis of variance of means (ANOVA) test

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>0.060</td>
<td>3</td>
<td>0.020</td>
<td>3.26</td>
<td>0.028</td>
</tr>
<tr>
<td>Within Groups</td>
<td>0.343</td>
<td>56</td>
<td>0.006</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>0.403</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Least significant difference (LSD) test

<table>
<thead>
<tr>
<th>Obturation Techniques</th>
<th>P value</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral-Vertical</td>
<td>0.040</td>
<td>S</td>
</tr>
<tr>
<td>Lateral-Thermafil</td>
<td>0.167</td>
<td>NS</td>
</tr>
<tr>
<td>Lateral-Softcore</td>
<td>0.487</td>
<td>NS</td>
</tr>
<tr>
<td>Vertical-Thermafil</td>
<td>0.487</td>
<td>NS</td>
</tr>
<tr>
<td>Vertical-Softcore</td>
<td>0.007</td>
<td>S</td>
</tr>
<tr>
<td>Thermafil-Softcore</td>
<td>0.040</td>
<td>S</td>
</tr>
</tbody>
</table>

DISCUSSION

Vertically compacted gutta-percha showed significantly less apical dye penetration than the lateral condensation. This comes in agreement with Pommel and Camps (10), and Jarrett et al. (11).

Lateral condensation produces many irregularities in the final mass of gutta-percha, higher percentage and inadequate dispersion of sealer, voids around gutta-percha due to the repeated procedure of addition of accessory gutta-percha cones and spreader insertion. Vertical compaction technique is conductive to better canal adaptation. The canals are densely filled with 4 homogenous mass of gutta-percha.

No significant difference was found between lateral condensation and Thermafil. The results of the dye leakage study confirmed further the overall impression that Thermafil obturators were as effective as lateral condensation. These findings are in agreement with those of Saunders et al. (12), Dalat and Spangberg (13), Rybicki and Zillich (14). Al-Shimmary (15) found that lateral condensation had a better adaptation apically to canal wall than Thermafil. Contradictory results have been reported between Thermafil obturation technique and lateral condensation which can exhibit less; Ricci and Kessler (16), or more apical leakage; Mattison et al. (17) than Thermafil while using passive dye penetration. These discrepancies in literature may be related to some variations in the root canal preparation. These variations are eliminated by using standardized simulated canals.

No significant difference in dye penetration was found between lateral condensation and Softcore. There is disagreement with DeMoor and Martins (18), DeMoor and De Boever (19), De Moor and Hommez (20), who found that Softcore had higher leakage than lateral condensation, and with Boussetta et al. (5), in which Softcore leaked less than lateral condensation. The different characteristics of resin used in this study and dentin walls used in previous studies may affect the distribution of the sealer and the adaptation of gutta-percha and may result in differences in the apical leakage.

Vertical compaction was not significantly different from Thermafil in apical dye penetration. This agrees with the findings of Bhambhani and Sperchman in (21), Qiong et al. (22). Both techniques achieved good adaptation of gutta-percha to canal walls. The use of Peeso reamers in post preparation with parallel sides design may provide vertically directed condensing force against apical root filling which is softened by frictional heat; this may reduce the disruption of apical seal.

Vertically compacted gutta-percha and Thermafil leaked significantly less than Softcore which agrees with DeMoor and DeBoever (19), DeMoor and Hommez (20). They found that the pre-heated gutta-percha of Softcore appeared to be porous when viewed under the microscope which may explain the higher leakage in Softcore. The carrier of Softcore is thinner than that of Thermafil which means more gutta-percha and more volumetric shrinkage in Softcore. When Softcore gutta-percha was removed it stacked to Peeso reamer more than Thermafil, which upon Peeso removal from the canal may cause coronal dislodgement of apical filling, accounting for higher leakage scores in Softcore.

REFERENCES

Comparison of apical Restorative Dentistry