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Effect of Spreader and Accessory Cone Size on Density of Obturation Using Conventional or Mechanical Lateral Condensation

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A simulated curved root canal in a resin block was enlarged to size 40 and used to compare the depth of accessory cone penetration and weight of obturation occurring with the use of different obturation techniques and spreader-accessory cone combinations. Twelve groups, each consisting of 10 obturations, were created. A conventional lateral condensation technique was used in six groups and a mechanical lateral condensation (MLC) technique was used in six matched groups. The six spreader-accessory cone combinations were either Fine-Medium or Fine nickel-titanium finger spreaders with either Fine, Medium-Fine, or size 25 accessory cones. Seven accessory cones were placed in every obturation. The depth of each accessory cone penetration into the canal was measured. After each obturation the gutta-percha was removed, sectioned, and the resulting mass was weighed. The means for each variable were determined and compared. MLC fills were significantly heavier and had greater depth of penetration on average than conventional lateral condensation. The best combination for heavy fills was MLC, Fine-Medium spreaders, and Fine accessory cones. The greatest mean accessory cone depth occurred with MLC, Fine-Medium spreaders, and size 25 accessory cones.

Conventional lateral condensation (CLC) of gutta-percha has long been the standard against which other methods of canal obturation have been judged (1). The basic technique, lateral compaction of a fitted gutta-percha master cone by a tapered spreader to make room for additional accessory gutta-percha cones, was described in 1930 (2).

Jerome et al. (3) suggested that the compatibility of the spreaders and accessory cones used in CLC may be a significant factor in successful obturation. Researchers have offered some guidance in size and type of spreader selection. Spreaders whose size and taper allow penetration into the empty canal to within 1 mm of the apex are recommended for all cases (4). In small curved canals nickel-titanium spreaders penetrate deeper than spreaders made of stainless steel, and dye leakage after obturating with finger spreaders is less than in canals obturated with hand instruments (5, 6).

Unfortunately the selection of accessory cones that are compatible with the spreaders is more of a problem. Ideally the accessory cone would be of proper diameter and taper to penetrate to the level of spreader penetration and to obliterate as much of the space created by the spreader as possible. Currently two basic shapes of accessory gutta-percha cones are available (7). Standardized accessory cones equate to the size and taper of standardized instruments, whereas conventional accessory points generally have a tip that is smaller than standardized instruments and a body that is wider.

Until recently spreaders were available in only two types of tapers: conventional sizes (Extra-Fine, Fine-Fine, Medium-Fine, Fine, Fine-Medium, and Medium) or the Luks size system (sizes A, B, C, or D). Hartwell et al. (8) compared diameters of conventional finger spreaders with diameters of similar sizes of accessory cones and found that very few diameters corresponded. To eliminate confusion in sizing, both Ingle and Bakland (1) and Hartwell et al. (8) successfully urged that spreaders be made available in standardized sizes.

Despite the availability of standardized combinations, authors of current endodontic textbooks (9–11) continue to advocate using conventional spreaders with conventional or standardized accessory cones.

Jerome et al. (3) compared obturation quality using four different combinations of spreaders and accessory cones in canals of extracted teeth enlarged to various sizes. They reported that no difference in dye leakage occurred between their groups, but fewer voids and overfillings and better fusion of gutta-percha occurred with standardized (size 25) accessory cones than with conventional (Fine-Fine cones). There was no difference between cases filled with a D11-T or size 30 spreader.

Recently mechanical lateral condensation (MLC) was introduced as an alternative lateral condensation technique (12). It was demonstrated that a greater volume of gutta-percha could be compacted into a standard canal using MLC than with CLC when a specified size and number of accessory points were condensed without sealer.

The purpose of the present study is to compare depth of accessory cone penetration and the volume of gutta-percha compacted into a standard canal when MLC or CLC are used with various spreader-accessory cone combinations.

MATERIALS AND METHODS

A clear resin block (Tulsa Dental, Tulsa, OK) with a simulated canal 18.5 mm in length and having a 30-degree curvature was used for all obturations. The canal was enlarged to a size 40 at 17.5 mm working length and flared to size 80 using a step-back instrumentation technique (13).

All obturations were accomplished in the same canal by one operator. For each obturation a size 40 master cone (Spectra-Point, Hygenic, Akron, OH) was fit to have tugback at the working length and Roth 801 Sealer (Roth Drug Co., Chicago, IL) was placed into the canal using a size 35 K-file rotated counterclockwise. During obturation the spreader was placed between the gutta-percha and the canal wall and was advanced apically using a reciprocating motion while exerting light to medium apical pressure. The operator attempted to penetrate as close as possible to a level 1 mm short of the working length. When maximum penetration was achieved using CLC, pressure was maintained on the spreader for 10 to 60 s to allow the gutta-percha to deform before the spreader was removed (13). When MLC was used the activated spreader was removed after about 5 s of reciprocating action at the final depth of penetration. Accessory cones were streaked with sealer and placed as far into the space as possible. The final depth of the accessory cone penetration was determined by removing the accessory cone with cotton pliers and measuring with a ruler. After measuring the cone was quickly reinserted into the canal. Occasionally the accessory cone could not be replaced to its original depth. These cones were discarded and the measurement was disregarded. If accessory cone penetration of at least 5 mm could not be achieved the cone was not removed for measurement. For those cases a penetration depth of 5 mm was recorded. Seven accessory cones were used with all obturations.

After obturation was complete the gutta-percha mass was removed from the canal, sectioned, and weighed. The edges of the beaks of a straight hemostat were held flush against the flat surface of top of the block and the mass was grasped and elevated out of the canal. The mass was sectioned using a #11 scalpel blade held flat against the flat surface of the hemostat beaks. After allowing 24 h for setting of the sealer the mass was weighed on an analytic balance.

Twelve groups, each having 10 obturations, were created. The first six groups were obturated using MLC. Groups VII to XII were matched with the first six (the same spreader and the same size accessory cones were used), but CLC was used. HYFLEX (Hygenic, Akron, OH) nickel-titanium spreaders and Hygenic accessory cones were used for all obturations. The groups were:

Group I: MLC using a size Fine-Medium spreader and Fine accessory cones.
Group II: MLC—Fine-Medium spreader—Medium-Fine accessory cones
Group III: MLC—Fine-Medium spreader—size 25 accessory cones
Group IV: MLC—Fine spreader—Fine accessory cones
Group V: MLC—Fine spreader—Medium-Fine accessory cones
Group VI: MLC—Fine spreader—size 25 accessory cones
Group VII: Same as group I, except CLC used
Group VIII: Same as group II, except CLC used
Group IX: Same as group III, except CLC used
Group X: Same as group IV, except CLC used
Group XI: Same as group V, except CLC used
Group XII: Same as group VI, except CLC used.

TABLE 1. Mean weights (in μg) and SDs for 12 groups, each group having weights for 10 obturations

Group	Mean Weight	SD
I	380.10	7.42
II	375.40	5.80
III	363.90	7.82
IV	364.90	7.71
V	348.70	15.28
VI	356.20	7.47
VII	369.10	7.94
VIII	366.80	8.55
IX	350.10	10.46
X	356.10	16.92
XI	343.50	13.66
XII	335.40	8.10

The mean accessory cone penetration depth and obturation weight was calculated for each group. A repeated-measures factorial ANOVA was performed to analyze the effect of technique (MLC vs. CLC) by spreader type (Fine-Medium vs. Fine) by accessory cone size (Medium-Fine vs. Fine vs. 25) on obturation weight and accessory cone penetration depth.

RESULTS

Comparison of Mean Weights

Mean obturation weights for all 12 groups are presented in Table 1.

All three main effects showed statistically significant differences.

The MLC technique (mean = 364.9) produced heavier fills on average than the CLC technique (mean = 353.5), $F(1,9) = 92.25$, $p < 0.001$.

Fine-Medium spreaders (mean = 367.6) produced heavier fills on average than Fine spreaders (mean = 350.8), $F(1,9) = 92.3$, $p < 0.001$.

There was a significant main effect for accessory cone type, Fine cones (mean = 367.6) produced heavier fills on average than Medium-Fine (mean = 358.6), both of which were significantly heavier than size 25 cones (mean = 351.4).

Comparison of Depth of Penetration

Table 2 contains mean depths of penetration for each group. Again all main effects were significant.

The MLC technique produced a greater average depth than CLC (mean = 9.61) vs. (mean = 8.30).

Fine-Medium spreaders produced deeper penetration (mean = 9.47) than Fine (mean = 8.98).

TABLE 2. Mean depths of penetration (in mm) of accessory cones into the canal during obturation and SDs

Group	Mean Depth	SD
I	9.81	3.01
II	10.20	3.40
III	10.90	2.73
IV	8.59	2.75
V	8.81	3.05
VI	9.35	3.20
VII	8.10	3.13
VIII	8.73	2.96
IX	9.07	2.78
X	7.47	2.57
XI	8.17	2.96
XII	8.24	3.21

Twelve groups are included, each group having 10 obturations and each obturation using 7 accessory cones.

Least squares difference pairwise comparisons showed that size 25 accessory cones had significantly deeper penetration (mean = 9.39) than Medium-Fine (mean = 8.98) or Fine accessory cones (mean = 8.49).

Correlation Between Fill Weight and Depth

Pearson's correlation was performed to test the relationship between average cone depth (mean = 8.95, SD − 0.98) and fill weight (mean = 359.18, SD = 16.11) for groups I through XII and revealed a significant positive linear relationship.

DISCUSSION

One goal of the research was to simulate clinical conditions. Therefore obturation was accomplished by an operator instead of a machine that uses a constant load for spreader penetration (3). This introduces a variable, differences in obturation forces, that is difficult to account for. The same method of achieving spreader penetration was used for both techniques in an attempt to minimize the differences in spreader forces. Spreaders were advanced while using a reciprocating motion. After initial penetration spreaders were withdrawn, then reinserted and advanced further apically, then withdrawn and reinserted and advanced apically one final time. This sequence was used because it seemed to result in optimal spreader penetration with both techniques.

Root canal sealer was used in this study, again to simulate clinical conditions. Because the same block was used for all obturations there was concern that sealer build-up in the canal might decrease the space for gutta-percha. The 12 groups were obturated in the order listed. After all 12 groups were completed a second group of 10 canals were obturated using the combination used previously in group I. The depths of penetration were similar for the two groups, and the mean weight was slightly heavier with the second group, suggesting that sealer build-up was not a problem. The result also suggests that the canal may have been slightly enlarged by the frictional abrasion that occurred during obturation.

Several factors affected our selection of spreader-accessory cone combinations. Although several authors recommend using stainless-steel spreaders for CLC (9–11), they were not used in this study because they caused excessive frictional abrasion or fracture when used with MLC in curved canals. Standardized nickel-titanium spreaders were not used because they could not be matched with gutta-percha made by the same manufacturer.

Some disagreement exists regarding whether spreader size should be equal or larger than the accessory cone size (9, 11, 13). Combinations of equal sizes were used in Groups IV and X, and the resulting depths of penetration were the lowest in the matched groups. The difficulty in achieving accessory cone penetration for these groups was especially evident when the first accessory cone was placed during obturation (the average depth was 11 to 12 mm, compared with 15 to 16 mm for most other groups). However, the mean weights for these groups were relatively high. This was probably due to the greater bulk of Fine cones, compared with Medium-Fine or size 25. There also may have been further penetration of accessory cones. Researchers (13, 14) using CLC have demonstrated that elongation or total apical displacement of previously placed accessory cones can occur during subsequent spreader placement.

Size 25 accessory cones were used in this study because Jerome et al. (3) found them superior to conventional Fine-Fine accessory cones. In the present study greater penetration depth occurred with the size 25 cones, but the mass had less weight than with conventional cones. This was expected because standardized cones have less taper and bulk than conventional cones; therefore, they weigh less but penetrate farther.

In previous research using MLC (12), the combination of the largest conventional size nickel-titanium spreader that fit to within 1 mm of the working length and the next smaller size of accessory cone seemed to be the most efficient. In the present research this combination was Fine-Medium spreaders and Fine accessory cones. This combination was used with MLC in group I and CLC in group VII. Tables 1 and 2 show that these groups had the highest mean weights for their respective techniques, whereas their mean depths of penetration were approximately average.

The clinical significance of deeper *spreader* penetration is established (4), which suggests that deeper *accessory cone* penetration would also be an advantage. The clinical significance of the weight of obturation is still uncertain. Overall analysis showed a significant correlation between increased accessory cone penetration and increased weight. Further research is needed to establish whether these occurrences correlate with improved apical seals and higher rates of clinical success.

If the correlation exists, results from this study indicate that the combination of MLC and Fine-Medium spreaders would produce optimal obturations of curved canals enlarged to a 40 Master Apical File. The choice of accessory cones would be more complicated. Size 25 cones should be used if depth of penetration was found to be of greater importance; size Fine or Fine-Medium should be used if weight of fill was found to be more important. An additional option to consider would be using a combination of accessory cone sizes to maximize the advantages of each size.

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You Might be Interested

Public education efforts notwithstanding, dental procedures are still equated by many with pain, and a corollary is that dental scientists remain interested in the neural substrate of discomfort. It behooves those of us still having potential exposure to examinations—boards, graduate programs, etc.—to therefore be aware of the latest pain theories. A fair amount of scientific noise has been generated because a group (Nature 372:770) recently located a thalamic nucleus, the posterio ventral medial, which appears specific for pain and thermal activation. No doubt a flurry of papers will follow this "new" and "exciting" discovery—ignoring the fact that Mountcastle postulated a similar structure decades ago.

William Cornelius