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A Comparison of Thermoplastic Obturation Techniques: Adaptation to the Canal Walls

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he purpose of this study was to directly compare e ability of the three types of Thermafil obtura-rs, the Obtura II thermoplasticized injectable chnique, and the lateral condensation technique obturate a standardized root canal. A split-tooth odel was constructed and the root canal was turated 20 times with each technique. The qual- of each obturation was graded according to tablished criteria of adaptation. Statistical anal-is of the results indicated that all the techniques ere significantly different from each other (p < 001) except for the plastic and titanium Ther-afil groups (p > 0.05), which were similar. Based the evaluated criteria, the Obtura II injectable chnique demonstrated the best adaptation to the epared root canal. This group was followed in deir by the plastic and titanium Thermafil obtura-rs, the stainless steel Thermafil obturators, and ally by the lateral condensation technique.

root canal is a complex system with many surface irregular-s, fins, accessory and lateral canals, and isthmuses (1). To seal system, the filling material must adapt to all portions of the canal. Incomplete obturation of the canal system may result in re of the endodontic treatment (2).

Gutta-percha is the most commonly used root canal obturation erial. Its physical properties have made possible several dif-nt obturation techniques. The cold lateral condensation of ta-percha is one of the most commonly used techniques in dontics. However, its ability to replicate the internal surface of root canal has been questioned. Voids, spreader tracts, incom-e fusion of the gutta-percha cones, and lack of surface adap-n have been reported (3).

The thermoplasticized injectable obturation techniques were duced to improve the homogenicity and surface adaptation of gutta-percha. High- and low-temperature delivery systems are ilable, and both are significantly better than lateral condensa-in replicating the root canal (4). Control of the apical extrusion e softened gutta-percha has been a major problem with these tion techniques (5).

In 1978, Johnson (6) introduced a technique in which alpha-phase gutta-percha was placed on a metal carrier, heated, and used to obturate the root canal. This system is commercially available as Thermafil Endodontic Obturators (Tulsa Dental Products, Tulsa, OK). Currently there are three different types of Thermafil obturators, the differences based on the carrier material for the gutta-percha. Stainless steel, titanium, and plastic carriers are coated with alpha-phase gutta-percha and become part of the final obturation. The manufacturer feels that this technique will produce a dense, homogenous, three-dimensional obturation of the root canal (7).

Juhlin et al. (8) evaluated the adaptation of Thermafil components to the walls of simulated canals in resin blocks. The adaptation of the gutta-percha, carrier, and sealer varied widely. They reported that in the cervical and middle thirds of the canal, the carrier was usually only partially encased in the gutta-percha, whereas in the apical 1 to 4 mm of the canal the carrier was surrounded by gutta-percha.

Gutmann et al. (9) evaluated the radiographic appearance of plastic carrier Thermafil obturations compared with the lateral condensation technique. They reported that the overall density and adaptation of the Thermafil obturation was statistically significantly better than lateral condensation, but there was no radiographic difference in the apical third of the roots. Apical extrusion of the gutta-percha and sealer was also significantly greater with the Thermafil obturations.

Several studies (10, 11) have shown that the adaptation of the material to the canal walls of transparent specimens appeared good, but these were only qualitative assessments. Quantitative measurements and comparisons are lacking.

To date, there have been no studies comparing the surface adaptation of all three Thermafil obturators. It is not known if there is a difference produced by the plastic or metal carriers. Therefore, the purpose of this study was to compare the ability of the Thermafil technique, using the three different types of carriers, to obturate a standardized root canal. This technique was directly compared with the Obtura II thermoplasticized injectable and the lateral condensation obturation techniques.

MATERIALS AND METHODS

The split-tooth model used in this study was described in detail in a previous publication (4). Briefly, a human maxillary central incisor was completely embedded in a block of clear orthodontic acrylic resin (Caulk/Dentsply, Milford, DE). Four alignment holes

were drilled through the acrylic block perpendicular to the long axis of the root below the level of the cementoenamel junction. The tooth was sectioned longitudinally in a buccal lingual direction through the center of the root canal with a low-speed diamond saw (Buehler Ltd., Lake Bluff, IL). The two halves of the sectioned tooth could then be reapproximated and secured with four nuts and bolts placed in the alignment holes. The crown of the tooth was removed by grinding with a model trimmer to the level of the middle third of the pulp chamber. Direct, straight-line access to the root canal was made with a #6 round bur in a slow-speed handpiece. The two halves of the root were separated, and the access preparation was examined for adequacy.

The working length of the root canal was established by visually placing a size 10 K-Flex file (Kerr, Romulus, MI) 1 mm short of the anatomic root apex on one of the halves. The two halves of the root were repositioned and secured. The root canal was cleaned and shaped using a step-back preparation to a size 60 K-Flex file at the established working length. Saline irrigation was used throughout the instrumentation phase. The two halves of the block were separated after the root canal was instrumented and visually examined to ensure equal preparation of the canal in both halves of the root.

Root canal irregularities were artificially produced by hand with a 1/2 round bur. Three shallow depressions, less than 0.5 mm deep, were placed on the distal side of the canal at 1, 3, and 5 mm from the working length. Two similar depressions were made on the mesial half of the root at 2 and 4 mm from the working length. The extra depression on the distal side of the root allowed for visual orientation of the gutta-percha obturation after it was removed from the canal.

Twenty obturations were performed in the model without sealer for each of the techniques evaluated. All obturations were completed by the one operator. The manufacturers' instruction manuals (7, 12) and videotapes were reviewed thoroughly for each thermoplastic obturation technique. Natural and artificial root canals were obturated as part of a pilot project to gain proficiency. The manufacturers' recommended procedures were followed during the obturation process. Before each obturation, the root canal was inspected and cleaned of any gutta-percha remaining in the root canal.

In Group 1, a size 60 Thermafil obturator with a stainless steel carrier was heated in the Thermaprep oven for a minimum of 10 min. This was midway between the 5 to 15 min heating time recommended by the manufacturer (7). The heated obturator was slowly inserted into the canal to the previously determined working length. After 1 min of firm apical pressure, the shaft of the carrier was severed with a new #35 inverted cone bur in a high-speed handpiece with air-water coolant. The gutta-percha at the coronal opening of the canal was vertically condensed with a #11 endodontic plugger (Union Broach, York, PA) for an additional 2 min as the filling material cooled. In Groups 2 and 3, the standardized root canal was obturated in exactly the same manner as in Group 1. Size 60 Thermafil obturators with a plastic carrier were used in Group 2, and titanium carriers were used in Group 3. The canal in Group 4 was obturated with a high-temperature thermoplasticized injectable gutta-percha system (Obtura II; Obtura Corp., Fenton, MO). The temperature control on the unit was adjusted to 185°C. The 23-gauge injection needle was placed to within 2 mm of the working length and the canal was obturated. Vertical condensation pressure was maintained for 2 min with the #11 endodontic plugger as the gutta-percha cooled. In Group 5, a standard lateral condensation technique was used. A #60 master gutta-percha cone (Sybron/Kerr, Romulus, MI) was fitted to within 0.5 mm of working length with tugback. A size #25 finger spreader (Ur Broach) was advanced to within 1 mm of the working len rotated, and removed. A #25 accessory gutta-percha cone (Syb Kerr) was inserted into the prepared space. Lateral condensatio accessory cones continued until the spreader could not be adva for more than 2 mm into the root canal. The excess gutta-per was removed from the coronal opening of the canal with a w instrument, and the gutta-percha was vertically condensed f min.

Following each obturation, the gutta-percha was allowed to for an additional 3 min before the halves of the model w separated. The mesial and distal sides of each obturation w examined with an operating microscope (JEDMED Instrum Co., St. Louis, MO) at ×32 magnification. A videotape of mesial and distal sides of the obturation was made for evaluat

Using this videotape, two of the authors simultaneously eva ated the quality of the obturations using the following criteria

1. Replication to working length: 0 = No gutta-percha extended to the working length. 1 = Some gutta-percha extended to the working length, but some space remained. 2 Gutta-percha was extended completely to the working length.

2. Replication of five round artificial depressions: 0 = depressions were reproduced in the obturation. 1 = One to th depressions were reproduced. 2 = More than three depressi were reproduced.

3. Voids: 0 = Evidence of two or more areas that lacked surf adaptation to the canal wall. 1 = One such area was present. 2 No voids were present.

4. Homogenicity of obturation: 0 = Gross evidence of indi ual accessory cones, spreader tracts, or folding over of gutta-per was visible. 1 = Minor evidence of individual accessory co spreader tracts, or folding over of the gutta-percha was visible. 2 The gutta-percha exhibited a smooth surface with no visible formities. The results of the evaluations were subjected to sta tical analysis using an analysis of variance and a Student-Newm Keuls test.

RESULTS

The mean scores for each criterion and the total mean scores each group are shown in Table 1. Statistical analysis of the resu indicated highly significant differences among the groups ($p < 0.0001$). All groups were significantly different from each oth ($p < 0.05$) except for the plastic and titanium Thermafil grou which were not significantly different from each other ($p > 0.0$ Based on the evaluated criteria, the Obtura II thermoplasticiz injectable technique demonstrated the best adaptation to the pr pared root canal. This group was followed in order by the plast and titanium Thermafil obturators, the stainless steel Therma obturators, and lastly by the lateral condensation technique.

DISCUSSION

Each obturation technique had unique characteristics of adap tation when the halves of the root canal were separated. The Obtur II thermoplasticized injectable technique (Fig. 1) was judged to have the best overall adaptation to the canal walls. This is in agreement with Budd et al. (4) who showed that the high- and low-temperature injectable techniques were significantly better

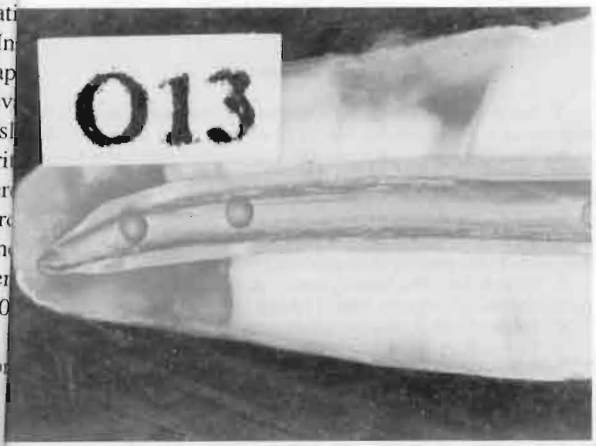
FIG 1. injectab

FIG 2. group

TABLE 1. Mean scores for each criteria (n = 20)

Group	Criteria				
	Working Length	Round Depressions	Voids	Homogenicity	Total (SD)
ainless Steel Thermafil	0.50	0.60	0.10	1.95	3.15 (1.27)
astic Thermafil	0.25	1.40	0.00	2.00	3.65 (0.75)*
anium Thermafil	0.60	1.15	0.00	2.00	3.75 (0.97)*
otura II	2.00	2.00	1.80	2.00	7.80 (0.41)
teral Condensation	1.45	0.70	0.00	0.10	2.25 (0.89)

ignificant differences between the groups ($p > 0.05$). All other groups significantly different from each other ($p < 0.05$).



. Representative sample of the Obtura II thermoplasticized able group (original magnification ×10).

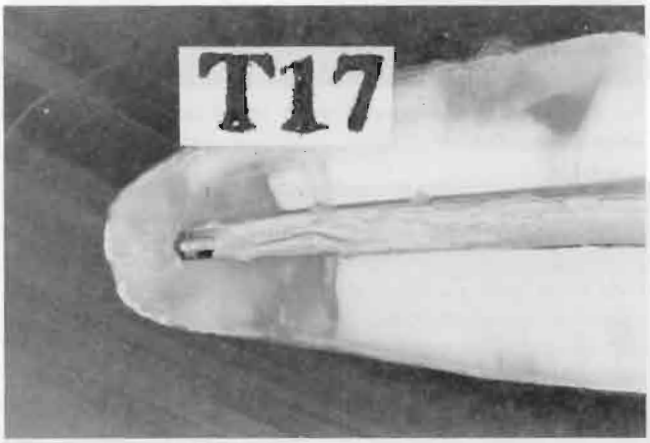
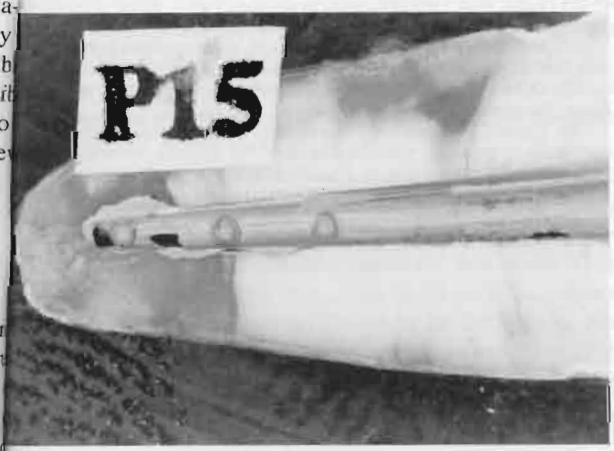


FIG 3. Representative sample of the titanium Thermafil obturator group (original magnification ×10).



2. Representative sample of the plastic Thermafil obturator up (original magnification ×10).

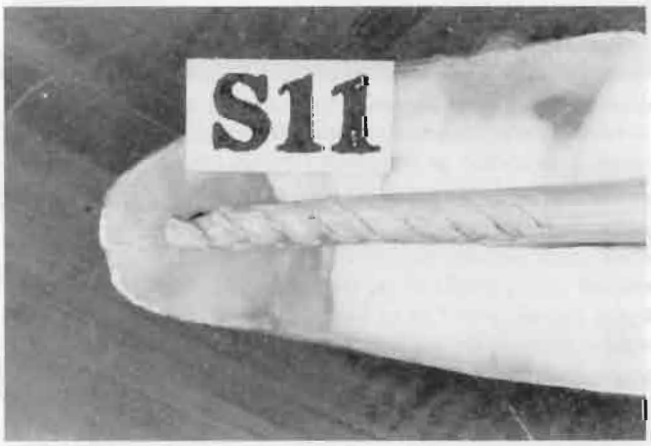


FIG 4. Representative sample of the stainless steel Thermafil obturator group (original magnification ×10).

n the lateral condensation technique. The Obtura II injectable hnique was the only method that obturated the root canal con- ently to the working length. Extrusion of the gutta-percha ween the two halves of the model was also seen (Fig. 1). Very voids were present, and excellent smooth surface adaptation seen in all the obturations of this group.

The scores of the three Thermafil obturations were between the tura II and lateral condensation groups. All three Thermafil ups showed incomplete extension of the gutta-percha to the king length (Figs. 2–4). Some space usually remained between obturator and the end of the prepared canal. This is contrary to dies that reported a propensity for apical extrusion of the Ther- fil filling materials (9, 10). No explantation for this difference could be determined from this study. A standardized, large, relatively straight root canal was used to directly compare each obturation technique in the split-tooth model.

Exposure of the underlying plastic or metal carriers accounted for the high incidence of voids in all Thermafil groups. Shrinkage of the gutta-percha into the spiral flutes of the stainless steel carrier was found, whereas the solid core carriers showed a stripping of the gutta-percha from the carrier surface. The shrinkage of material into the flutes may also have accounted for the lower number of surface depressions reproduced in the stainless steel Thermafil group. All three Thermafil groups demonstrated a very smooth surface of the gutta-percha.

The lateral condensation technique demonstrated the lowest

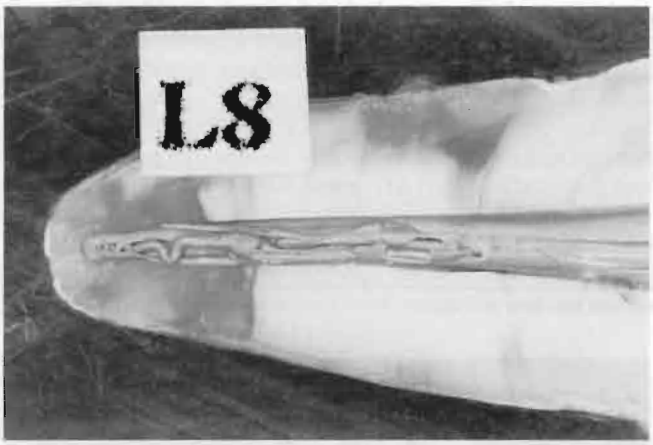


FIG 5. Representative sample of the lateral condensation group (original magnification ×10).

overall mean scores for the criteria evaluated. The gutta-percha was usually close to the working length, probably due to the master cone being prefitted 0.5 mm from the working length. Voids, individual accessory cones, spreader tracts, and folding of the gutta-percha were commonly seen, and very few of the surface depressions were replicated (Fig. 5).

Each obturation was videotaped on both the mesial and distal sides for evaluation of the adaptation to the canal wall. This necessitated careful removal of the obturation material from the model system. This was easily performed with all the techniques and materials used in this study, and the use of a solvent or lubricant in the root canal was not necessary. Budd et al. (4) reported problems with brittleness with both the high- and low-temperature injectable systems in their study. This was not found in the present study. However, the accessory points in the lateral condensation group would occasionally tend to separate when the model was opened, as previously reported (4).

A root canal sealer was not used in this study. Only the adaptation of the obturation material itself to the canal wall was evaluated. It was not the purpose of this study to evaluate the sealer distribution or film thickness in the split-tooth model. However, a sealer is always indicated with any obturation technique to reduce clinical microleakage into the root canal system (13, 14).

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References

1. Davis SR, Brayton SM, Goldman M. The morphology of the prepared root canal: a study utilizing injectable silicone. Oral Surg 1972;34:642–8.
2. Dow PR, Ingle JI. Isotope determination of root canal failure. Oral Surg 1955;8:1100–4.
3. Brayton SM, Davis SR, Goldman M. Gutta-percha root canal fillings. Oral Surg 1973;35:226–31.
4. Budd CS, Weller RN, Kulild JC. A comparison of thermoplasticized injectable gutta-percha obturation techniques. J Endodon 1991;17:260–4.
5. ElDeeb ME. The sealing ability of injection-molded thermoplasticized gutta-percha. J Endodon 1985;11:84–6.
6. Johnson WB. A new gutta-percha technique. J Endodon 1978;4:184–8.
7. Thermafil Endodontic Obturators. Detailed Instructions for the use of Thermafil Endodontic Obturators. Tulsa Dental Products, Tulsa, OK. 1991:1–29.
8. Juhlin JJ, Walton RE, Dovgan JS. Adaptation of Thermafil components to canal walls. J Endodon 1993;19:130–5.
9. Gutmann JL, Saunders WP, Saunders EM, Nguyen L. An assessment of the plastic Thermafil obturation technique. Part 1. Radiographic evaluation of adaptation and placement. Int Endodon J 1993;26:173–8.
10. Gutmann JL, Saunders WP, Saunders EM, Nguyen L. An assessment of the plastic Thermafil obturation technique. Part 2. Material adaptation and sealability. Int Endodon J 1993;26:179–83.
11. McMurtrey LG, Krell KV, Wilcox LR. A comparison between Thermafil and lateral condensation in highly curved canals. J Endodon 1992;18:68–71.
12. Obtura II Heated Gutta-Percha System, Operator's Manual. Obtura Corp., Fenton, MO. 1993:1–22.
13. Lares C, ElDeeb ME. The sealing ability of the Thermafil obturation technique. J Endodon 1990;16:474–9.
14. Hata G-I, Kawazoe S, Toda T, Weine FS. Sealing ability of Thermafil with and without sealer. J Endodon 1992;18:322–6.