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Gutta-Percha Obturation of Lateral Grooves and Depressions

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The purpose of this study was to evaluate the movement of gutta-percha into lateral grooves and depressions in the apical 7 mm of a root canal by using the System B Heat Source for the continuous wave of condensation and the Obtura II for the backfill. A split-tooth model was constructed with lateral grooves and dentin depressions prepared at 1, 3, 5, and 7 mm from working length (WL). The study included three experimental groups with 10 obturations in each group: group A—System B Fine heat plugger used at 5 mm from WL; group B—System B Fine heat plugger used at 4 mm from WL; and group C—System B Fine heat plugger used at 3 mm from WL. Group C had statistically better movement of gutta-percha into the 1-mm dentin depression than either group A ($p = 0.0005$) or group B ($p = 0.0025$) and better movement of gutta-percha into the 3-mm dentin depression than group A. A significant difference in gutta-percha flow into the lateral grooves was seen at 3 mm from WL with group C ($p < 0.0001$). Group C demonstrated gutta-percha in the grooves, whereas both groups A and B had no gutta-percha in the grooves.

Sealing root canal systems to preclude the leakage of residual bacteria and their by-products into the periradicular area is believed to be one of the critical elements for success in root canal therapy (1). A number of obturation materials and techniques have been used over the years. Gutta-percha was used by Dr. G. A. Bowman in 1867 and is a commonly used root canal obturation material (2). Lateral condensation (compaction) of gutta-percha has been shown to be a successful technique if adequate spreader depth is achieved (3). One of the potential shortcomings of lateral compaction is the relatively poor replication of the canal walls and the tendency to form voids and spreader tracts between the gutta-percha points (4–6).

Schilder popularized the vertical compaction of warm gutta-percha technique (7). He used heat to thermoplasticize gutta-percha and pluggers to pack the softened gutta-percha into root canals. A purported advantage of a thermoplasticized vertical compaction technique is the ability to soften gutta-percha so it can be molded to various configurations within the root canal system. This technique, as advocated by Schilder, is a multistep process. Other obturation techniques using heated gutta-percha have been developed, such as core-carrier thermoplasticized gutta-percha, in which heated gutta-percha is on a metal or plastic carrier and introduced into the canal system (8). Other techniques use high-temperature, thermoplasticized, injectable gutta-percha to obturate the canal system (9). The continuous wave of condensation (10) uses a plugger attached to a heat source. The heated plugger is used to vertically compact the gutta-percha in one motion. The proposed advantages of the continuous wave of condensation technique are the reduced time that is required to perform the downpack of thermoplasticized gutta-percha and convenience.

Several methods have been used to look at the adaptation of gutta-percha to the canal walls (4–6, 11, 12). A split-tooth model was introduced by Budd et al. (12) that allowed a reproducible natural human tooth to be obturated by using different techniques.

The purpose of this study was to evaluate the movement of gutta-percha into lateral grooves and depressions in the apical 7 mm of a root canal by using the System B continuous wave of condensation (Analytic Endodontics, Orange, CA) and the Obtura II (Obtura Spartan, Fenton, MO) for the gutta-percha backfill.

MATERIALS AND METHODS

A maxillary canine with a straight, single canal was used to produce a single split-tooth model that was used for all obturations. The tooth was mounted in plastic casting resin (ETI, Fields Landing, CA) and left to cure for 24 h at room temperature. A model trimmer was used to square the sides and the acrylic model was polished using a rag wheel and polishing compound. A drill press was used to place a total of four holes through the acrylic in a buccal-lingual direction, two on the mesial and two on the distal. The tooth was then separated into buccal and lingual halves through the center of the canal with an Isomet saw with a 0.15-mm kerf (Buehler, Lake Bluff, IL). The crown was removed, leaving 20 mm of total root length. WL was established 1 mm from the anatomic apex. The two halves were repositioned using four bolts that fit tightly in the predrilled holes. Preflaring of the coronal third of the canal was performed with Gates Glidden #3 and #4 drills (Moyco Union Broach, York, PA). Cleaning and shaping of the canal was performed using 0.04 taper ISO ProFile (Dentsply, Tulsa, OK) in a crown-down method, as recommended by the manufacturer, using an electric handpiece (Analytic Endodontics, Orange, CA) at 150 rpm with RC Prep lubrication (Stone Pharmaceuticals, Philadelphia, PA) and 0.5% sodium hypochlorite irrigation. The WL reference point was established at 19 mm, and the canal was prepared to a size #35 by using 0.04 tapered ProFile instruments at WL. Lateral grooves were placed with a 0.15-mm kerf Isomet saw blade at 1, 3, 5, and 7 mm from WL (Fig. 1). Depressions were made at the same levels in the canal with a high-speed handpiece to the width and depth of a 12-round bur. To allow for apical patency, an additional depression in the dentin was made with a 12-round bur at WL (Fig. 1). To ensure patency, a #20 K-file was passed from the canal into the depression after the two halves were reapproximated.

The tooth model was stored in an incubator that was set at 37°C and was removed only during obturation of the canal. During each obturation, the apical two thirds of the tooth model was kept submerged in a container that was filled with 37°C water. A scale (model #TR 8101, Denver Instrument Co., Denver, CO) was used during each obturation to limit compaction force to less than 2.5 kg (13, 14). A System B heat source (Analytic Endodontics) set at 200°F and a power setting of 10 with a Fine Buchanan Plugger (Analytic Endodontics) was used in the continuous wave of condensation technique. A silicone stop was placed on the plugger at the desired depth before insertion. Heat was applied during the downpack to a depth of 3 mm from the silicone stop, following the manufacturer's instructions. At that point, apical pressure was

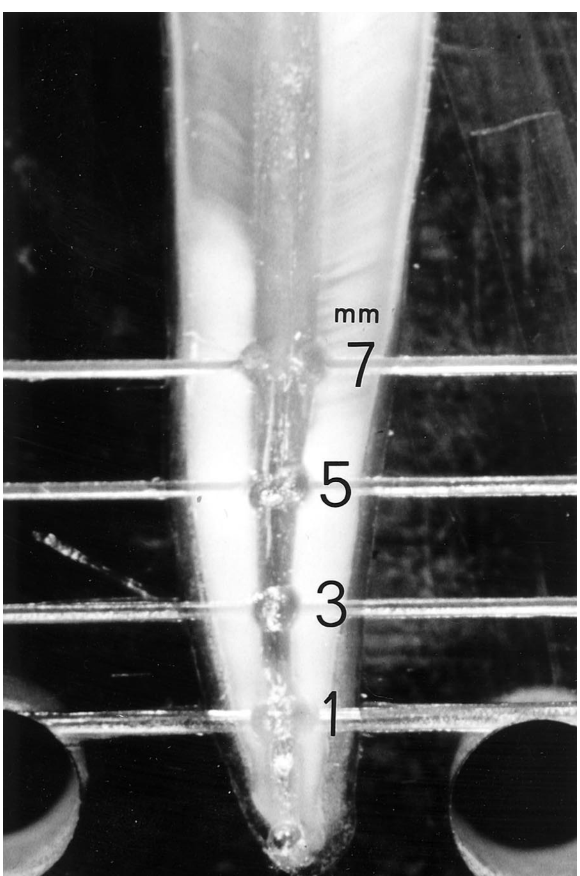

FIG 1. Longitudinal section of tooth model with lateral grooves and depressions at 7, 5, 3, and 1 mm from the WL.

maintained for approximately 10 s, until the silicone stop reached the reference point. The heat button was then activated for 1 s for a separation burst of heat. After a 1-s pause, the plugger was removed with the coronal and midroot gutta-percha usually attached to the plugger. A #5 plugger (Thompson, Missoula, MT) was used to compact the gutta-percha. Backfilling was performed by using an Obtura II that was set at 200°F with a 23-gauge needle. A one-step backfill was accomplished by engaging the apical mass of gutta-percha with the warm needle and expressing gutta-percha until small excess was above the orifice. A #9 plugger (Thompson) was used to compact the gutta-percha flush with the orifice during cooling.

Three experimental groups and one comparison group were used. Ten obturations were performed for each experimental group by using 0.04 taper size #35 gutta-percha cones (DiaDent Group International Inc., Burnaby, British Columbia, Canada) that were lightly coated with Roth 801 sealer (Roth Drug Co., Chicago, IL) mixed according to the manufacturer's instructions. In group A, the System B Fine heat plugger was inserted to a depth of 5 mm from WL. In group B, the System B Fine heat plugger was inserted to a depth of 4 mm from WL. In group C, the System B Fine heat plugger was inserted to a depth of 3 mm from WL. Group D was a comparison group in which lateral compaction of gutta-percha was accomplished using a fine-fine nickel-titanium finger spreader (Moyco Union Broach). Five obturations were performed by using the lateral condensation method with a #35 master cone (Kerr USA, Romulus, MI), fine-fine accessory points (Kerr USA), and Roth 801 sealer. The initial spreader depth was 1 mm short of WL, and each accessory point was inserted to the same depth as the spreader. Lateral compaction was considered complete when the spreader would not penetrate more than 3 mm into the canal.

After each obturation, the model was allowed to cool for 5 min. The halves of the model were then separated and photographed at ×10 magnification. Photographic slides were taken of the gutta-percha in the model and after the gutta-percha was taken out of the model with its sealer removed. Both halves of the model were then cleaned of remaining gutta-percha and sealer by using a cotton swab with Isopropyl alcohol before placing the model in the 37°C incubator.

The slides were coded, randomly ordered, and projected at ×100 for evaluation. Evaluation of the obturation at each level (1, 3, 5, and 7 mm from WL) was scored as follows:

Lateral grooves:
0 = No gutta-percha.
1 = Some gutta-percha.
Dentin depressions:
0 = No flow of gutta-percha.
1 = Partial flow of gutta-percha.
2 = Complete flow of gutta-percha.

Statistical analysis was performed using χ^2 ($p \leq .05$) for gutta-percha in lateral grooves and dentin depressions at the different levels.

RESULTS

Group C had statistically better movement of gutta-percha into the 1-mm dentin depression than either group A ($p = 0.0005$) or group B ($p = 0.0025$) and better movement of gutta-percha into the 3-mm dentin depression than group A. Complete filling of the dentin depressions was seen at the 5-mm and 7-mm levels for all warm vertical compaction groups (Fig. 2).

The only significant difference in gutta-percha flow into the lateral grooves was seen in group C at 3 mm from WL ($p < 0.0001$). Group C demonstrated gutta-percha in the grooves, whereas groups A and B had no gutta-percha in the grooves. There was no gutta-percha in the lateral grooves at the 1 mm canal level in any of the three groups. Complete filling of the lateral grooves was seen at 5 mm and 7 mm from the WL for all warm vertical compaction groups.

No extrusion of gutta-percha was seen beyond the WL, even though a size-20 file was always extended past the apical constriction for patency.

The teeth that were filled by using lateral compaction showed no extrusion of gutta-percha into any of the dentin depressions or lateral grooves at any level. There was sealer seen at all levels in both dentin depressions and lateral grooves in all the groups and comparison teeth.

DISCUSSION

The purpose of this study was to evaluate the movement of gutta-percha into lateral grooves and depressions. The split-tooth model allowed comparisons to be made directly between the different System B levels of obturation and with lateral compaction.

No extrusion of gutta-percha was seen beyond the WL in this study. Similar findings were seen in a previous study when the System B continuous wave of condensation technique was used in plastic resin blocks (15).

Sealer was found to occupy space in all lateral grooves and dentin depressions at all levels. This agrees with other studies that have found lateral canals obturated primarily with sealer after vertical condensation (15, 16). Studies have shown that the quality of seal produced with injection-molded gutta-percha had no significant difference in leakage when compared with laterally condensed gutta-percha, provided sealer was used (17, 18). No leakage studies have been reported using the System B continuous wave of condensation technique to determine whether the seal is effective.

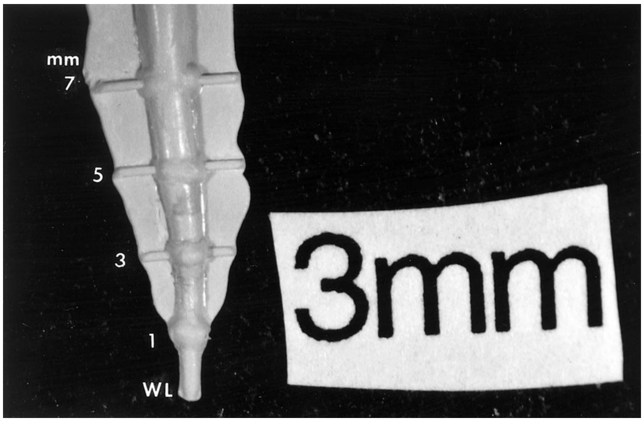

FIG 2. Gutta-percha replication of lateral grooves and depressions when the System B Fine heat plugger was inserted to a depth of 3 mm (group C) from the WL. Group A (not shown) had the System B Fine heat plugger inserted to a depth of 5 mm from the WL, and group B (not shown) had the System B Fine heat plugger inserted to a depth of 4 mm from the WL. Group C had statistically better movement of gutta-percha into the 1-mm dentin depression than either group A or group B and better movement of gutta-percha into the 3-mm dentin depression than group A. Group C also demonstrated statistically better movement of gutta-percha into the lateral grooves at 3 mm from the WL than either group A or group B.

In this study there were more voids in the Obtura II gutta-percha backfill with group C when compared with the other groups. This finding was surprising, because the Obtura II was used in the same manner for all the groups with one continuous backfill motion. Two possible reasons for voids are (a) the injection needle was not seated completely in the canal, and (b) there was entrapment of air. The Obtura II has been shown to have the same quality of seal when either a single or multiple incremental backfill is used with sealer (19).

The tooth was kept at a constant body temperature of 37°C by using an incubator between obturations and a heated water bath. Sealer was used in the canal with controlled compaction force to simulate the clinical situation. The compaction pressure was controlled to avoid excessive force, which has been believed to be a cause of vertical root fracture (20). The amount of force was limited to 2.5 kg, which is within the range of forces that are reported most commonly used by endodontists to laterally compact gutta-percha (13, 14). Although this study used vertical compaction rather than lateral compaction, 2.5 kg of force was chosen because no studies have been performed showing a safe vertical condensation force. It may have been possible to cause more gutta-percha to move into the dentin depressions and lateral grooves by using heavier force but that would not have simulated a clinical setting.

Because a split-tooth model was used, there was a tendency for the backfilling gutta-percha to flow into the interface between the two halves. This demonstrated the ability of the Obtura II gutta-percha to mold to the canal configurations within our model system.

When the two halves of the model were taken apart, the gutta-percha cones in the laterally condensed group tended to come apart even before the model was completely separated. The thermoplasticized groups held together very well. There was always a union between the gutta-percha at the point where the Obtura II backfill met the System B down-packed gutta-percha.

When using the continuous wave of condensation technique, it is recommended that the heat-carrying plugger be placed approximately 4 mm to 6 mm from the WL (10). This study suggests that there may be better gutta-percha replication of the canal by using the System B plugger to 3 mm from WL. In this study, a straight canal with a taper was created that allowed the plugger tip to reach within 3 mm from WL. With curved canals and narrow canals, it may not be possible to make a taper that will allow the plugger to extend to 3 mm from WL.

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