A Comparative Study on the Frequency, Location, and Direction of Accessory Canals Filled With the Hydraulic Vertical Condensation and Continuous Wave of Condensation Techniques

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Abstract

The present study compared the frequency, location, and direction of accessory canals filled with two different filling techniques. Sixty-four mandibular first molars were accessed, prepared, and divided into two groups of 32 teeth each. The teeth from group A and group B were filled using the hydraulic vertical condensation technique and the continuous wave of condensation technique, respectively. The specimens were then decalcified, dehydrated, rendered transparent, and analyzed by three independent evaluators. There was no significant difference (*t* test, $p < 0.05$) between the two groups in relation to the total number of filled ramifications. Moreover, there was no significant difference among the three thirds of the roots in relation to the number of filled ramifications (analysis of variance, $p < 0.05$). The filled ramifications were more frequently detected toward lingual, buccal, distal-lingual, and distal-buccal directions. It was concluded that the two filling techniques are not different in relation to the frequency, location, and direction of the ramifications filled. *(J Endod 2009;35:397–400)*

Key Words

Accessory canals, gutta-percha, root canal filling, sealer

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The hermetic sealing of the root canal system consists in an important phase of the root canal treatment (1, 2). The internal anatomy and especially the complexity of the root canal system (RCS) must be considered during the therapy because many studies have shown a high prevalence of ramifications in the teeth analyzed (3–9). Several techniques and materials have been studied to improve the three-dimensional filling and provide an increase in the success rate of the endodontic treatment (1, 9–22). According to Schilder (1), the warm vertical condensation of gutta-percha offers a technique that produces a homogeneous and dimensionally stable mass of gutta-percha, allowing this material to penetrate the RCS ramifications. Some devices have been introduced to simplify the warm vertical condensation, such as the System B, which provided the continuous wave of condensation technique (10). The hydraulic vertical condensation technique, described by De Deus (11), is another technique that promotes the vertical condensation of the gutta-percha. According to the author, the gutta-percha is warmed at the canal's entrance, allowing the sealer to adapt throughout the main canal and to flow inside the accessory canals. Then, the vertical plugger must be carefully selected to fit in the canal and, consequently, avoid the reflux of sealer during the vertical condensation.

Therefore, the aim of the present study was to compare the ability of the hydraulic vertical condensation and continuous wave of condensation techniques to fill the root canal system. The frequency, location, and direction of accessory canals and isthmuses filled with these two techniques were investigated.

Materials and Methods

Sixty-four recently extracted human mandibular first molars were used for this study. They were stored in a 0.1% thymol solution until required and washed in running water for 24 hours to eliminate any trace of this substance. An endodontic access cavity was prepared in all teeth, and the root canals were prepared by using the segmented preparation technique described by Bassi (23). According to this technique, the coronal and medium thirds of the canals were prepared using a 35.10 NiTi rotary file (Miltex System; Miltex Inc, York, PA) mounted on an electric motor (Easy Endo, Belo Horizonte, Brazil) at 350 rpm, with brushing movements. Gates-Glidden drills 4 and 5 (Dentsply Maillefer Instruments SA, Ballaigues, Switzerland) were then used on the cervical orifice of root canals. After this phase, the working length was determined introducing a #10 file (HI-five, Miltex Inc) in the canal until it was visible at the apical foramen. The apical part of the canals was then prepared with the following sequence of files: 20.03, 15.05, 22.04, 25.04, and 20.06 (Miltex System). All NiTi files were used until the working length. Irrigation with 5.25% sodium hypochlorite was performed during all the instrumentation procedure. The smear layer was removed with two washes with a 10% citric acid solution during 30 seconds. The final irrigation was made with 5.25% sodium hypochlorite. The root canals were dried with FM paper points (Endopoints Ind e Comercio Ltda, Paraíba do Sul, Brazil).

Obturation Techniques

The teeth were then randomly divided into two groups of 32 teeth each. The teeth of group A were filled using the hydraulic vertical condensation technique described by De

Deus (11), and the teeth of group B were filled using the continuous wave of condensation technique. Medium gutta-percha cones (Endopoints Ind e Comercio Ltda) and Kerr Pulp Canal Sealer (SybronEndo; Sybron Dental Specialties Inc, Orange, CA) were used in both groups. In group A, the gutta-percha cones were fitted at 0.5 mm from the working length. The sealer was prepared according to the manufacturers' instructions and introduced into the canals using a #15 file. The selected gutta-percha cone was coated with sealer and placed in the canal. More than one cone was used depending of the canals' shape. A heated instrument was used to remove the coronal portion of the cones, and a vertical condensation plugger was used to adapt the remaining gutta-percha to the canal's entrance. A vertical condensation was applied to the superficial thermoplasticized mass of gutta-percha for 10 to 15 seconds. Once the obturation of the root canals was concluded, the chamber was cleaned with a small piece of cotton and alcohol to remove the excess of sealer. In group B, the gutta-percha cones were fitted at 1.0 mm from the working length. The sealer was also prepared according to the manufacturers' instructions and introduced into the canals using a #15 file. Then, the selected gutta-percha cone was coated with sealer and placed in the canal. The System B Heat-Source (Analytic Technologies, Redmond, EUA) was used to remove the coronal portion of the cone. A medium-size tip was placed on the System B Heat-Source with a silicone stopper set at 5 mm short of the working length. All the subsequent procedures were performed as described by Buchanan (10). The Obtura II system (Obtura Corporation, Fenton, MO) was used for the backfilling, with the application of gutta-percha in 4-mm increments. The temperature range of gutta-percha was 200°C when injected into the canal space. Once the obturation of the root canals was concluded, the chamber was cleaned with a small piece of cotton and alcohol to remove the excess of sealer. Both groups were filled by a unique graduate student who was proficient in both techniques.

Sample Decalcification and Analysis

After 24 hours, the filled teeth were immersed in the 5% hydrochloric acid solution for approximately 4 days at room temperature for decalcification. The decalcifying solution was changed every 24 hours and agitated for 5 seconds twice a day. After the completion of the decalcifying process, the teeth were washed in running water for 12 hours to eliminate any trace of the acidic substance. The teeth were then dehydrated with different gradients of ethyl alcohol (75%, 85%, 96%, and 100%, respectively) by immersing them in each solution for 4 hours. After that, the teeth were rendered transparent in methyl salicylate and analyzed with a four times magnifier by three previously calibrated and independent evaluators. Each evaluator analyzed the frequency, location, and direction of the filled accessory canals and isthmuses. The identification of the teeth's group was not revealed to the evaluators, which characterized a blind study.

Statistical Analysis

A *t* test ($p < 0.05$) was used to compare both groups in relation to each type of ramification and in relation to the total number of filled ramifications and isthmuses. Analysis of variance ($p < 0.05$) was used to compare the number of filled accessory canals among the three thirds of the roots.

Results

Table 1 summarizes the frequency and location of the different types of ramifications filled in both groups. It was concluded that no statistical difference exists between the groups in relation to the total number of filled ramifications (*t* test, $p < 0.05$). Some type of ramification was filled in 87.5% of the teeth from group A and 90.62% of the teeth from group B (Figure 1). The number of apical deltas and the number of isthmuses in the apical third were significantly higher to the group B in comparison to the group A. However, no statistical difference was observed between the groups in relation to all the other types of ramifications. There was no significant difference among the three thirds of the roots in relation to the number of filled ramifications (analysis of variance, $p < 0.05$). The filled ramifications were more frequently detected toward lingual, buccal, distal-lingual, and distal-buccal directions (Table 2). There was no significant difference between the two groups in relation to the direction of filled ramifications.

TABLE 1. Frequency and Location of Filled Accessory Canals and Isthmuses

	Hydraulic compression (%)	Continuous wave of condensation (%)
Lateral canals		
1/3 C	3 (1.91)	3 (1.86)
1/3 M	16 (10.19)	9 (5.59)
Secondary canals	48 (30.57)	40(24.84)
Reticular canals		
1/3 C	10 (6.37)	13 (8.07)
1/3 M	16 (10.19)	15 (9.32)
1/3 A	9 (5.73)	9 (5.59)
Recurrent canals	3 (1.91)	2 (1.24)
Intercanal	0	4 (2.48)
Isthmuses		
1/3 C	23 (14.65)	22 (13.66)
1/3 M	19 (12.10)	20 (12.42)
1/3 A	7 (4.46)	13 (8.07)
Deltas	3 (1.91)	11 (6.83)
Total	157 (100.00)	161 (100.00)

Note: 1/3 C = coronal third, 1/3 M = medium third, 1/3 A = apical third.

Discussion

The method used in the present study renders the teeth transparent and therefore has been developed to investigate the internal anatomy of the root canal system (24). This method was used by De Deus, who analyzed the frequency, location, and direction of ramifications naturally present in 1,140 teeth (3). Some authors also used this method to investigate the occurrence of microleakage after root canal filling with different techniques (13–16, 25–27). Venturi et al (9, 14, 15, 17), Almeida et al (13), and Bertacci et al (28) studied the filling of lateral canals with different techniques and materials using this method. This present study was based on these studies to evaluate ramifications filled with two different filling techniques.

The rotary NiTi files were used to obtain an efficient and uniform shape of the root canals, with a continuous removal of debris (29). The use of these instruments improves the efficacy of endodontic shaping procedures (30) and may have resulted in a good preparation of the curved canals found in the mandibular molars used here (31). Consequently, after an efficient cleaning and shaping procedure, the ability to fill lateral canals may have been improved.

In the current study, both techniques showed the ability to fill a high number of ramifications, and approximately 90% of the teeth showed filled accessory canals. This percentage is higher than that observed by Venturi et al (9), who examined 222 human teeth after obturation with Schilder's technique and found filled lateral canals in 65.5% of the specimens. Those authors included mandibular and maxillary incisors, canines, premolars, and molars in their study, which characterizes a different type of sample in relation to the present study. Almeida et al (13) showed that 88% of the artificial lateral canals created in human teeth were filled using the lateral condensation technique with five different sealers. However, that result is not comparable