Evaluation of Apical Cavity Preparation With a New Type of Ultrasonic Diamond Tip

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Abstract

This study evaluated the time, occurrence of fracture, and quality of apical cavity preparation with three different ultrasonic diamond tips: Satelec, Trinity, and a new type, CVD (chemical vapor deposition), using scanning electron microscopy (SEM) analysis. Thirty human single-rooted premolars were selected, submitted to apicectomy, and prepared with ultrasonic tips; impressions were then obtained. The presence of fractures was evaluated on the impressions, and the quality of preparation was evaluated by SEM analysis of teeth and scoring by two examiners. The group prepared with the CVD tips exhibited the shorter preparation time and did not present fractures. There was no statistically significant difference in the quality of preparation for the three tips. The three brands of ultrasonic tips produced adequate grinding without altering the morphology of the apical foramen. *(J Endod 2007;33:484–487)*

Key Words

Preparation time, root-end cavity, ultrasonic retrotip

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Surgical endodontic treatment is an option for teeth with apical periodontitis and may be indicated for teeth previously submitted to unsuccessful endodontic treatment and teeth with a strong possibility of failure by the nonsurgical approach (1–3). This procedure comprises several steps, including retrograde obturation, which is performed after root sectioning by preparation of a cavity in the root canal. Accomplishment of apical cavity preparation with burs involves difficult access, leading to inadequate preparations. The advent of ultrasonic tips has enhanced this preparation, because of the availability of tips with different shapes and angulations (4), besides allowing maintenance of preparation in the long axis of the root canal, maintaining the morphology of the tooth apex. Apical cavity preparation with ultrasonic tips reduces the need for root sectioning, thus reducing the number of exposed dentinal tubuli and consequently the possibility of apical leakage (5, 6).

Utilization of ultrasonic diamond tips has been demonstrated to be fast, effective, and practical in the quality of apical preparation (7–10).

Recently, CVD (CVD-Vale, São José dos Campos, SP, Brazil) has presented a new tip: a thick layer of pure diamond forming a single stone covers the entire surface of the tip, different from Satelec tips.

The aim of this study was to evaluate the time requirements and features of apical cavity preparation performed with different ultrasonic diamond tips: Satelec (Satelec, Paris, France), Trinity (Trinity, São Paulo, SP, Brazil), and the new tip, CVD (CVD-Vale).

Materials and Methods

Thirty freshly extracted single-rooted premolars were selected and stored in 10% formalin solution until utilization. A single operator performed apical preparation.

For preparation, the teeth were positioned in a clamp with the apex turned upwards. The apices were sectioned at 3 mm from the apex with tapered bur 699 (K. G. Sorensen, São Paulo, SP, Brazil) under a light microscope (D. F. Vasconcelos, São Paulo, SP, Brazil) at 16× magnification and under thorough irrigation with saline solution; the cutting surface was then smoothed with a Bramante apical file.

After apicectomy, the teeth were checked to see the presence of any cracks and fractures by two examiners under a light microscope (D. F. Vasconcelos) at 16× magnification. Impressions were obtained from the apices with quadrifunctional poly-

TABLE 1. Time required for apical cavity preparation according to the ultrasonic tip employed

Satelec	Time (s)	Trinity	Time (s)	CVD	Time (s)
1	77.45	11	47.1	21	19.1
2	42.08	12	68.1	22	20.02
3	46.42	13	50.41	23	10.06
4	52.89	14	48.13	24	17.35
5	11.74	15	41.56	25	18.87
6	36.86	16	38.4	26	17.42
7	64.7	17	46.2	27	20.28
8	35.05	18	38.06	28	15.14
9	34.2	19	37.2	29	22.1
10	54.4	20	33.12	30	19.1
Mean	45.579	Mean	44.83	Mean	17.944

TABLE 2. Comparison of the time required among the ultrasonic tips, significance level 0.05

Comparison	Difference	Critical Value	Interpretation
CVD × Satelec	−26.635000	12.4920618	Significant
CVD × Trinity	−26.886000	12.4920618	Significant
Satelec × Trinity	−0.2510000	12.4920618	Nonsignificant

vinylsiloxane (Aquasil ULV, Dentsply DeTray, Konstanz, Germany). The impressions were sputter-coated with gold and analyzed by scanning electron microscopy (SEM).

Afterward, apical preparation was performed with the tips with the device Jetsonic Four (Gnatus, Ribeirão Preto, SP, Brazil), set at Endo mode and power 5, with irrigation with water. The specimens were securely fixed to an apparatus to facilitate handling and cavity preparation and were kept wet throughout the procedures.

Three groups with 10 teeth each were established, according to the tips employed:

Group 1: Tip S12 (Satelec)

Group 2: Tip TU-18 (Trinity)

Group 3: Tip 6.1107-6 (CVD-Vale)

Thus, three SEM analyses were performed for each root ($n = 10$): impression of roots after apicectomy without apical preparation; impression of roots after apicectomy with apical preparation; and roots after apicectomy with apical preparation.

The specimens were sputter-coated with gold (Hammer VI Sputtering System, Anatech Ltd., Alexandria, VA) and analyzed by SEM (JSM-T220A, Jeol, Tokyo, Japan).

All groups were evaluated as to the time required for preparation, presence of cracks and/or fractures, and quality of apical cavity preparation. The time required for preparation was considered from onset until 3 mm of depth was reached.

Analysis of the root surface as to the presence of cracks and/or fractures was performed by SEM analysis of the roots and of the impressions of roots after apicectomy and after cavity preparation.

The quality of apical cavity preparation was analyzed according to the following scores:

1. Smooth and regular cavities.
2. Smooth and regular cavities with presence of groove on one or two walls.
3. Irregular cavities with presence of groove on three walls.
4. Irregular cavities with presence of groove on four walls.

The characteristics of the ultrasonic diamond tips before and after utilization were also assessed.

These analyses were performed by two examiners on photomicrographs obtained with a Maiya photo camera (Jeol, Tokyo, Japan) connected to the scanning electron microscope at 35× and 50× magnification.

Results

Table 1 presents the time required to prepare the apical cavity with the different ultrasonic tips; CVD showed the lowest mean time. Table 2 demonstrates the comparison of the time required for preparation among ultrasonic tips by the Tukey test, at a significance level of 5%. There was a significant difference in the time required for preparation for the CVD tips.

Assessment of the impressions of apices after apicectomy and after apical cavity preparation did not reveal cracks or fractures in any specimen.

There was no statistically significant difference in the quality of apical preparation among the three ultrasonic tips as compared by the Miller test ($p = 0.05$).

Interexaminer agreement was also investigated using the Kendal coefficient, which showed good agreement. The quality of the ultrasonic tips was visually analyzed by SEM at the same magnification and of the same aspects, before and after utilization, to check any changes in the diamond covering.

Scanning electron microscopy analysis of the ultrasonic tips revealed the same features before and after 10 preparations with the CVD tip, without loss of diamond morphology; the Trinity tips exhibited little or no diamond loss; and the Satelec showed significant loss of diamond.

Discussion

Tsesis et al. (1) conducted a retrospective study to compare the outcomes of surgical endodontic treatment performed using traditional versus modern techniques. The complete healing rate for teeth treated with the modern technique (91.1%) was significantly higher compared to treatment by the traditional technique (44.2%). The modern technique included root-end resection with minimal or no bevel and retrograde preparation using ultrasonic retrotips with the aid of a dental operating microscope.

The advantages of using ultrasonic tips for apical cavity preparation in retrograde obturation compared to preparation with burs have been well demonstrated, including easier access to the cavities, lower risk of perforation, better retention of the retrograde obturation material, removal of necrotic tissue from the root canal, smaller exposure of dentinal tubuli, and lesser need for root sectioning (11–15).

Layton et al. (16) observed that the occurrence of microfractures during preparation is associated with the utilization of high power. Paz et al. (17) investigated the cutting efficiency of two ultrasonic units with two different tips (Satelec and Spartan) at maximum and medium

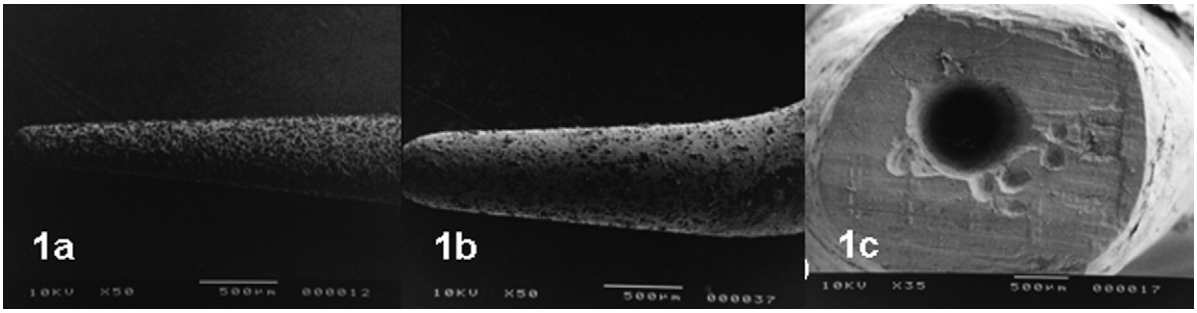

Figure 1. Satelec tip: (*A*) before utilization; (*B*) after utilization; (*C*) preparation with tips.

Figure 2. Trinity tip: (*A*) before utilization; (*B*) after utilization; (*C*) preparation with tips.

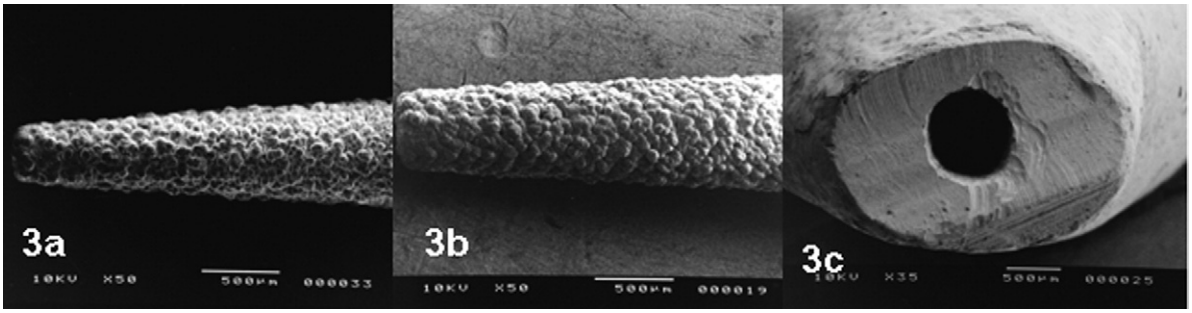

Figure 3. CVD tip: (*A*) before utilization; (*B*) after utilization; (*C*) preparation with tips.

power. All experimental variables (ultrasonic unit, power setting, and tip) were found to affect the cutting efficiency. The Satelec ultrasonic unit and the Satelec tip were more effective for dentin removal than the Spartan ultrasonic unit. Although the tips were of different brands, the characteristics of the diamond were similar. In the present study, the tips represented different methods of manufacture.

The utilization of impressions for SEM analysis has been advocated (18, 19). Therefore, low power was employed and analysis of cracks was performed on impressions, eliminating the risk of appearance of cracks in the teeth because of utilization of high vacuum and sputter-coating for SEM analysis. Utilization of diamond burs has also been related to the appearance of cracks.

No differences have been found in the occurrence of cracks between ultrasonic diamond tips or ultrasonic stainless steel tips (10, 19, 20). Diamond burs were selected for the present study because they allow faster preparation with better cavosurface angle, which is considered an advantage (12, 21), although others found disadvantages (22).

Both Satelec and Trinity tips present small-sized diamond crystals, as if they were embedded in a joining material (Figs. 1*A* and Figs. 2*A*). Both tips showed losses in the amount of diamond after utilization, which were greater for the Satelec tip (Figs. 1*B* and 2*B*).

The CVD tips, manufactured by chemical vapor deposition, present a new characteristic. This new technology deposits a thick layer of pure diamond, forming a single stone that covers the entire surface of the tip (Fig. 3*A*). The technique of manufacturing these tips may explain their maintenance of shape even after utilization (Fig. 3*B*) (23, 24).

The time required for apical cavity preparation was 45.57 seconds for the Satelec tip, 44.83 seconds for the Trinity tip, and 17.94 seconds for the CVD tip; the latter differed significantly from the other two. The diamond arrangement on the CVD tip may explain this difference.

Even though no significant differences were found as to the quality of preparations, a greater number of more regular preparations was observed for the Satelec and Trinity tips compared to the CVD tips. The good quality of preparation with the Satelec tips corroborate the findings of other authors (17, 25, 26), but no studies have been found in the literature on the Trinity and CVD tips.

Conclusions

Based on the present findings, the CVD tips allowed faster apical cavity preparation and did not present any change in their characteristics. No root fractures were present after cavity preparation with ultrasound.

The three tips provided regular apical cavity preparations, with no difference among them.

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