**Quality of root-end preparations using ultrasonic CVD diamond retrotips**


| | |
|---|---|
| Journal: | *International Endodontic Journal* |
| Manuscript ID: | IEJ-05-00010 |
| Manuscript Category: | Original Scientific Article |
| Date Submitted by the Author: | 10-May-2005 |
| Keywords: | Cavity, Chemical Vapour Deposition, Synthetic Diamond, Root canal, Ultrasound |
| | |

# Quality of root-end preparations using ultrasonic CVD diamond retrotips

AR Benetti, MM Menezes, MC Valera, VJ Trava-Airoldi, EJ Corat

São José dos Campos School of Dentistry – UNESP

Avenida Engenheiro Francisco José Longo, 777

Jardim São Dimas, São José dos Campos / SP 12245-000 - Brazil



Keywords: Cavity, Chemical Vapour Deposition, Synthetic Diamond, Root canal, Ultrasound

Running title: Preparations with CVD diamond

Corresponding author:

Ana Raquel Benetti anaraquel@rocketmail.com

Rua Gustavo Maciel, 29-40 apto. 303A

Jardim Estoril IV, Bauru / SP 17016-200 – Brazil

Phone: 55 (014) 8112-4393

## Abstract

**Aim** The purpose of this study was to evaluate the quality of root-end preparations using ultrasonic CVD (chemical vapour deposited) diamond tips. **Methodology** Fifty bovine incisors had their roots sectioned at the level of the cementoenamel junction and pulp tissue was removed. Roots were submitted to apicoectomy at a 90º angle using a cylindrical carbide bur. All roots were immersed in 0.004% methylene blue dye for 48 hours. Colored root-ends were photographed and prepared with four different ultrasonic devices during 1.5min. Root-end preparations in control groups were performed with conventional diamond burs in high-speed turbine. After the preparations were finished, roots were immersed in dye for a second time. Root-ends were photographed and scored for the number and type of cracks and for the regularity of the preparation. Data were submitted to Kruskal-Wallis and Dunn test ($\alpha$=0.05). **Results** No significant differences were observed for the number (p=0.2236) or the type of cracks (p=0.1279), but significant values were found for the regularity of the root-end preparations (p=0.0004). Control group was identified as the most regular preparations. **Conclusions** Ultrasonic CVD diamond tips produced more conservative root-end cavities with minimum cracks.



## Introduction

Root-end preparation and retrograde filling are commonly performed during periapical surgery when conventional endodontic therapy fails, especially if a prosthetic rehabilitation is indicated (Nicholls 1962). According to Arens et al. (1998), an ideal root-end preparation should be parallel to the long axis of the root, 3mm deep, centered in the root throughout its depth. A 45º apicoectomy of the root is often necessary when such preparations are performed with conventional handpieces because of the improper inclination of the instruments and tips and the difficult access to the area. In these situations, root-end preparations are most likely to be off-center.

Ultrasonic retrotips, on the other hand, have been designed to provide superior control for the operator during instrumentation, increased ability to remain centered in the canal, and minimum risk of perforation of the root when compared with handpieces, thus promoting more adequate root-end preparations (Carr 1992, Wuchenich et al. 1994, Engel & Steiman 1995).

Adversely, ultrasonic root-end preparation has produced multiple microcracks when compared to the conventional handpiece and bur (Gutman & Harrison 1991, Abedi et al. 1995). Apparently, higher ultrasonic power settings have produced more cracking than low power settings (Saunders et al. 1994, Abedi et al. 1995, Layton et al. 1996, Rainwater et al. 2000, Navarre & Steiman 2002). Therefore, the higher the number of microcracks, more microleakage is to be expected (Saunders et al. 1994, Abedi et al. 1995).

The hypothetical causes of cracking are the impact of the instrument against the cavosurface margin and the heat developed by ultrasonic energy (Brent et al. 1999). However, new technologies have developed to overcome this problem. Recently, diamond-coated ultrasonic surgical instruments have been introduced in hopes of minimizing dentinal fractures through their ability to abrade dentine more quickly (Brent et al. 1999, Navarre & Steiman 2002). Since diamond abrasion minimizes the time the instrument is in contact with the root end, it seems possible that it may prevent or minimize the occurrence of cracking, thus producing faster and more efficient root-end preparations.

Among the latest technologies developed, chemically deposited diamond particles in metallic stems have suggested promising results. These retrotips are obtained during a process called chemical vapour deposition (CVD), which allows the chemical deposition during the vapour phase of a single layer of diamond crystals over metallic stems. This fabrication mechanism results in long-lasting diamond tips and maximizes the contact of the diamond crystals with the tooth surface (Valera et al. 1996), thus improving the quality of the preparations when compared to conventional diamond tips. Therefore, the purpose of this in vitro study was to investigate the quality of ultrasonic root-end preparations using CVD diamond retrotips.



## Material and methods

This study was conducted in accordance with the Committee of Ethics in Research (protocol #002/2003-PH/CEP). Fifty bovine incisors recently extracted were immersed in 10% formalin during 24 hours. Remaining periodontal tissues were removed and crowns were sectioned at the cementoenamel junction so pulp tissue could be removed. Standardization of apical foramen was preceded with manual instrumentation and 1% sodium hypochlorite until reaching the diameter equivalent to a #60 K-file manual endodontic instrument (Dentsply-Maillefer, Ballaigues, Swiss).

Apicoectomies were performed 2mm away from the apex, perpendicularly to the long axis of the roots. Sections were determined using high-speed carbide burs and abundant irrigation. Roots were immersed in 0.004% methylene blue dye during 48 hours (Layton et al. 1996).

All sectioned and colored root surfaces were examined in a stereomicroscope (Carl Zeiss, Jena, Germany) at 20x magnification. Additionally, photographs were taken using a camera attached to the stereomicroscope for comparison after treatment.

Roots were divided in four groups (Table 1). Root-end preparations were performed during 1.5 min using four different ultrasonic devices, regulated for endodontic purposes. Minimal manual pressure and abundant irrigation were present. All preparations in the experimental groups used the CVD retrotip (Clorovale Diamantes, São José dos Campos, São Paulo, Brazil). Preparations of control group were performed with a high-speed handpiece and conventional round diamond tip (#1011 KG Sorensen, Barueri, São Paulo, Brazil).

After root-end preparations, 17% EDTA solution was applied during 3 min to remove the smear layer. Roots were rinsed thoroughly with 0.5% sodium hypochlorite solution and were immersed again in the dye during 48 hours.

Root-end surfaces were re-examined in the stereomicroscope and new photographs were taken. These photographs were compared with the previous pictures obtained prior to ultrasonic preparation. Two independent examiners scored the photographs according to the number and type of microcrack and according to the regularity of the root-end preparation.

According to the number of microcracks:

- Score 0: no cracks
- Score 1: 1-2 cracks

- Score 2: 3-4 cracks
- Score 3: 5 or more cracks

The type of crack was determined as:

- Intracanal cracks – those that originate within the canal and extend into the dentin.
- Extracanal cracks – those that originate on the root surface and extend into the dentin.
- Communicating cracks – those that extend from the root surface to the canal.
- Dentinary – those limited to the dentin, not reaching the canal or the external surface of the root.

Regarding the regularity of the root-end preparations, roots could be classified as:

- Regular – when the contour was evenly shaped;
- Irregular – when the contour did not present a smooth pattern or shape.

*Statistical methods*

Data were submitted to Kruskal-Wallis test. Dunn multiple comparison test ($\alpha$=0.05) was run for the variable in which significant differences were evident.

## Results

Table 2 gathers the percentage frequency of the number and type of cracks and regularity of preparations observed after instrumentation using ultrasonic CVD diamond retrotips. Kruskal-Wallis test was performed at 95%

confidence interval and 5% level of significance. No significant differences were observed between groups for number (Kw=5.6885; p=0.2236) and type (Kw=7.1558; p=0.1279) of microcracks. Significant differences were detected between groups for the regularity of preparation (Kw=20.7308; p=0.0004). Dunn multiple comparison test ($\alpha$=0.05) identified group 5 (control) as the most regular preparations. Groups 2 (Jet Sonic Four) and 3 (Enac) held an intermediary position while most irregular preparations were observed in groups 1 (Profi I AS Ceramic) and 4 (Laxys Easy).

## Discussion

Ultrasonic root-end preparations have produced microcraks in the dental structure (Gutman & Harrison 1991, Abedi et al. 1995). Immersion of root-ends in methylene blue dye was determined to facilitate visual detection of cracks, as demonstrated by Cambruzzi et al. (1985). Therefore, this paper adopted similar methodologies to Layton et al. (1996) and Navarre & Steiman (2002). Since cracks and fractures may be detected right after apicoectomy (Rainwater et al. 2000), two evaluations were carried out: immediately after apicoectomy and after ultrasonic root-end preparation.

No significant differences were detected for the number and type of microcraks between experimental groups and control, prior to or after instrumentation, regardless of the brand of ultrasonic device used for instrumentation. These results corroborate with findings from Beling et al. (1997), who did not detect differences for number and type of cracks after apicoectomy or after low-power ultrasonic root-end preparations. Navarre &

Steiman (2002), comparing instruments coated with zinc nitrate to stainless steel points, obtained similar data. Brent et al. (1999) did not identify cracks on the root-end surfaces after ultrasonic instrumentation with diamond coated tips.

Considering the results of this paper and others (Beling et al. 1997, Brent et al. 1999, Navarre & Steiman 2002), perhaps ultrasound itself is not the main responsible for microcrack formation during instrumentation. Although previous papers demonstrate higher incidence of cracks after ultrasonic preparations when compared to rotary instrumentation, Navarre & Steiman (2002) pointed out that most of earlier ultrasonic instruments consisted of smooth stainless steel points. After testing different methods for root-end preparation, Khabbaz et al. (2004) concluded that cracks do not correlate directly with the surface area of the root-end but rather with the type of retrotip used to prepare the root-end cavity. Therefore, it is possible that instruments with lower cutting ability could induce higher stress in dentine and, consequently, produce more cracks.

Since CVD diamond retrotips present a long-lasting cutting ability (Valera et al. 1996), this aspect is not a concern. Additionally, the higher the power of the ultrasonic device, the higher the number of resulting cracks (Layton et al. 1996). Indeed, scanning electron microscopy revealed that significant differences for both the number of cracks and the marginal quality of preparation were found between full power and half power of the ultrasonic device when using a stainless steel tip (Taschieri et al. 2004). For these reasons, high cutting ability of retrotips and appropriate power settings for the ultrasonic device should be considered.

In addition to the small number of cracks produced, CVD diamond ultrasonic tips resulted in more conservative preparations. Khabbaz et al. (2004) also detected more conservative root-end cavities after ultrasonic instrumentation. Furthermore, ultrasonic instrumentation follows the direction of the root canal (Wuchenich et al. 1994, Mehlhaff et al. 1997). Engel & Steiman (1995) and Mehlhaff et al. (1997) highlight that these advantages should be considered in preparations in isthmus areas, which are more likely to perforation. Ultrasonic instrumentation still save time and provide easy access to the root-end surfaces (Engel & Steiman 1995), producing cleaner and well-centered root-end cavities when compared to rotary instrumentation (Wuchenich et al. 1994, Gorman et al. 1995, Khabbaz et al. 2004).

Regularity of preparations still seems to depend on the ultrasonic device used. Even regulating all devices for endodontic purposes, power settings were probably slight different from one manufacturer to another. Thus, it is suggested to increase the preparation time during instrumentation in groups that irregular contouring was observed.

Considering such arguments, CVD diamond ultrasonic tips may be considered as a promising technology. When used at proper power settings, result in minimum crack formation, thus as favorable instruments for root-end preparations.

## Conclusion

CVD diamond retrotips produce minimum cracks and may be considered a safe alternative for root-end preparations.

## References

Abedi HR, Van Mierlo BL, Wilder-Smith P, Torabinejad M (1995) Effects of ultrasonic root-end cavity preparation on the root apex. Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology **80**, 207-13.

Arens DE, Torabinejad M, Chivian N, Rubinstein R (1998) Practical lessons in endodontic surgery. Chicago: Quintessence Publishing Company.

Brent PD, Morgan LA, Marshall JG, Baumgartner JC (1999) Evaluation of diamond-coated ultrasonic instruments for root-end preparation. Journal of Endodontics **25**, 672-5.

Cambruzzi JV, Marshall FJ (1985) Methylene blue dye: an aid to endodontic surgery. Journal of Endodontics **11**, 311-4.

Carr GB (1992) Advanced techniques and visual enhancement for endodontic surgery. Endodontics Report **7**, 6-9.

Engel TK, Steiman R (1995) Preliminary investigation of ultrasonic root end preparation. Journal of Endodontics **21**, 443-5.

Gorman MC, Steiman HR, Gartner AH (1995) Scanning electron microscopic evaluation of root-end preparations. Journal of Endodontics **21**, 113-7.

Gutman JL, Harrison JW (1991) Surgical endodontics. Boston: Blackwell Scientific Publications.

Khabbaz MG, Kerezoudis NP, Aroni E, Tsatsas V (2004) Evaluation of different methods for the root-end cavity preparation. Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology **98**, 237-42.

KL Beling, Marshall JG, Morgan LA, Baumgartner JC (1997) Evaluation for cracks associated with ultrasonic root-end preparation of gutta-percha filled canals. Journal of Endodontics **23**, 323-6.

Layton CA, Marshall JG, Morgan LA, Baumgartner JC (1996) Evaluation of cracks associated with ultrasonic root-end preparation. Journal of Endodontics **22**, 157-9.

Mehlhaff DS, Marshall JG, Baumgartner JC (1997) Comparison of ultrasonic and high-speed-bur root-end preparations using bilaterally matched teeth. Journal of Endodontics **23**, 448-52.

Navarre SW, Steiman R (2002) Root-end fracture during retropreparation: a comparison between zirconium nitride-coated and stainless steel microsurgical ultrasonic instruments. Journal of Endodontics **28**, 330-2.

Nicholls F (1962) Retrograde filling of the root canal. Oral Surgery **15**, 463-73.

Rainwater A, Jeansonne BG, Sarkar N (2000) Effects of ultrasonic root-end preparation on microcrack formation and leakage. Journal of Endodontics **26**, 72-5.

Saunders WP, Saunders EM, Gutman JL (1994) Ultrasonic root-end preparation, part 2: microleakage of EBA root-end fillings. International Endodontic Journal **27**, 325-9.

Taschieri S, Testori T, Francetti L, Del Fabbro M (2004) Effects of ultrasonic root end preparation on resected root surfaces: SEM evaluation. Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology **98**, 611-8.

Valera MC, Ribeiro JF, Trava-Airoldi VJ, Corat EJ, Pena AFV, Leite NF (1996) Pontas de diamante CVD. Revista Gaúcha de Odontologia **44**, 104-8.

Wuchenich G, Meadows D, Torabinejad M (1994) A comparison between two root-end preparation techniques in human cadavers. Journal of Endodontics **20**, 279-82.

Table 1 – Group division and ultrasonic devices used.

| *Group (n=10)* | *Ultrasonic device & brand* |
|---|---|
| 1 | Profi I AS Ceramic (Dabi Atlante, Ribeirão Preto, São Paulo, Brazil) |
| 2 | Jet Sonic Four Plus (Gnatus, Ribeirão Preto, São Paulo, Brazil) |
| 3 | Enac (Osada Electric Co. Ltda., Tokyo, Japan) |
| 4 | Laxys Easy (DMC, São Carlos, São Paulo, Brazil) |
| 5 | Control (high-speed and round diamond bur) |

Table 2 – Percentage frequency of the number of cracks, type of cracks, and regularity of the root-end preparations in the groups.

| Group | Number of cracks* | | | Type of cracks* | | | | Regularity** | |
|---|---|---|---|---|---|---|---|---|---|
| | Score 0 | Score 1 | Score 2 | Intracanal | Extracanal | Communicating | Dentinary | Regular | Irregular |
| 1 | 40% | 60% | 0% | 40% | 0% | 0% | 0% | 20%[C] | 80%[C] |
| 2 | 30% | 70% | 0% | 40% | 0% | 0% | 20% | 40%[B] | 60%[B] |
| 3 | 60% | 30% | 10% | 30% | 0% | 0% | 10% | 80%[B] | 20%[B] |
| 4 | 40% | 50% | 10% | 10% | 10% | 10% | 20% | 20%[C] | 80%[C] |
| 5 | 80% | 20% | 0% | 10% | 10% | 0% | 0% | 100%[A] | 0%[A] |

* No significant differences were detected for these variables.

** Different letters correspond to statistically different data.