Filling displacement after apicectomy with different instruments: A scanning electron microscopic study

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ABSTRACT

Objective: To evaluate the displacement of the filling in root canals after apical root resection using various instruments. **Methods:** Sixty extracted human canines had their crowns removed at the cement-enamel junction, were instrumented and filled 1 mm short of the apex and randomly assigned to six groups, according to the instruments used for apical root resection 3 mm from the apex. The displacement of the filling during the resection procedure was evaluated under a scanning electron microscope by measuring the gap formed between the root canal wall and the material. **Results:** Statistical analysis between groups was performed (Tukey-Kramer's test), revealing that gaps between the filling material and dentinal walls were smaller in the group where Zekrya surgical burs were used, compared to the other tested instruments ($p<0.05$). **Conclusions:** Apical root resection using Zekrya surgical burs promotes less displacement of the filling when compared to the other tested instruments.

Keywords: Apicectomy. Apical surgery. Filling displacement. Filling space. Filling. Root resection.

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Introduction

The main goals of an endodontic treatment is cleaning, disinfecting and shaping the root canal.[1] However, these primary objectives are not always achieved, even with the use of biologically compatible techniques and materials. Together with this condition, it is frequent the presence of ledges, perforations, fractured instruments, posts or cores that may not be removed, calcifications or even anatomic alterations that lead the clinician to solve such problems by periapical surgery. Apicectomy with or without retrograde filling is one of the most indicated surgical procedures when conventional endodontic procedures fail.[2,3,4]

During the apicectomy, 2 to 3 mm of the apical portion of the root must be removed, by means of mechanical and manual instruments, ultrasonics or laser.[2,3,5-8] Apparently, the regularity of the apical surface after apicectomy is related to the repair process.[9,10] The deposition of newly formed cement over the resected surface is preceded by a dentin remodelling, and repair is favoured by a smooth and regular dentinal surface. Another important aspect is to determine if the instruments used for root resection will displace the root filling, thus creating voids that may lead the surgical procedure to failure. This situation may occur mainly with the classical indication of using tapered fissure burs, such as the 700 series.

The aim of this study was to evaluate quantitatively under the scanning electron microscope the gaps between the filling material and dentin walls created by different instruments used for root resection.

Material and methods

For the present experiment, sixty extracted human canines stored in 10% formalin solution and with no apparent defects in the roots were selected. The crowns were removed at the cement-enamel junction, the root canals were explored with a #10 K-file to the apical foramen and the working length was established as 1 mm short of this measurement. The canals were instrumented using the step-back technique, with a #60 master apical file. Irrigation was performed with 1 ml of 2.5% sodium hypochlorite between each file, and after shaping the canals they received 5 ml of 17% EDTA and a final irrigation with 5 ml of 2.5% sodium hypochlorite. The canals were dried with paper points and filled with gutta-percha and Grossman's sealer (Endofill®, Dentsply, Petrópolis, Brazil) using Tagger's hybrid filling technique. Proximal and buccolingual x-rays were obtained from the specimens to evaluate the quality of the filling, and if any voids were present, the sample was replaced.

The excess of filling was removed from the cervical portion of the root 1 mm apically from the cement-enamel junction, and Cimpat® (Septodont, Saint Maur des Fosses, France) was placed to seal this space. Specimens were kept in 0.9% saline solution at 37°C for one week for complete set of the filling material.

The specimens were randomly assigned to six groups, according to the instruments used for root resection. Group I had the roots resected with a tapered carbide fissure bur (#700, S. S. White, Rio de Janeiro, RJ, Brazil), attached to a low-speed engine. Group II was prepared with a #2082 diamond bur (KG Sorensen, Barueri, SP, Brazil) on a high-speed handpiece, while Group III had the root resection performed with a Zekrya bur (Maillefer, Ballaigues, Switzerland) on a high-speed handpiece. Groups IV, V and VI had the roots resected with #700 burs and the surfaces were refined either with a Shofu point (Shofu Inc., Kyoto, Japan), a #31-32 periodontal file (Neumar, São Paulo, SP, Brazil) or a 12-blade high-speed bur (S. S. White, Rio de Janeiro, RJ, Brazil), respectively. All roots were resected 3 mm from the apex at a 90° angle, with constant irrigation by saline solution. The position of the burs during the beginning and ending of the resection was recorded for each root by marks on their surfaces, which were observed during the specimen evaluation.

After one week stored in saline solution, specimens were prepared for observation under a scanning electron microscope (JEOL ISM T220A, Tokyo, Japan) at 75X magnification. The displacement of the filling during the resection procedure was evaluated by measuring the gap formed between the root canal wall and the material, recorded in micrometers. Statistical analysis between groups was performed using the Tukey-Kramer's test.

Results

Photomicrographs of the most representative specimens of each group are shown on Figures 1 to 6.

The statistical analysis revealed that roots resected

with Zekrya burs (Group III) presented less displacement of the filling when compared to Groups I and V ($p<0.05$). Groups I, II, IV and V presented statistically similar results ($p>0.05$). Figure 7 presents graphically the results obtained for the measurements of the displacement of the filling after root resection.

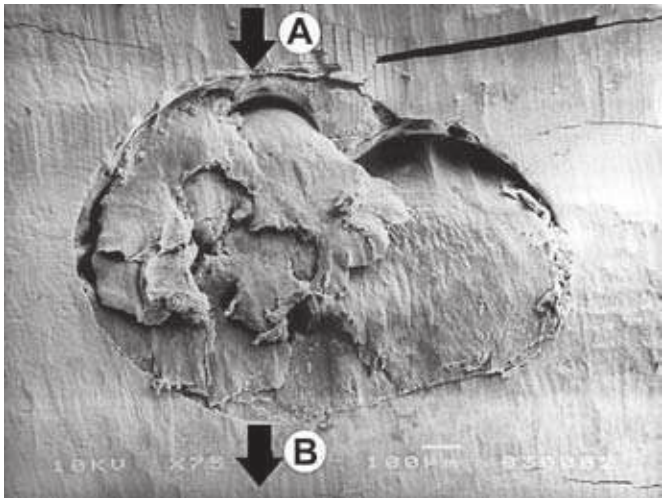

Figure 1. Photomicrograph (75X magnification) of the apical surface after resection with a #700 bur (Group I). **A**) Entry surface of the bur during the resection; **B**) exit surface of the bur after the resection.

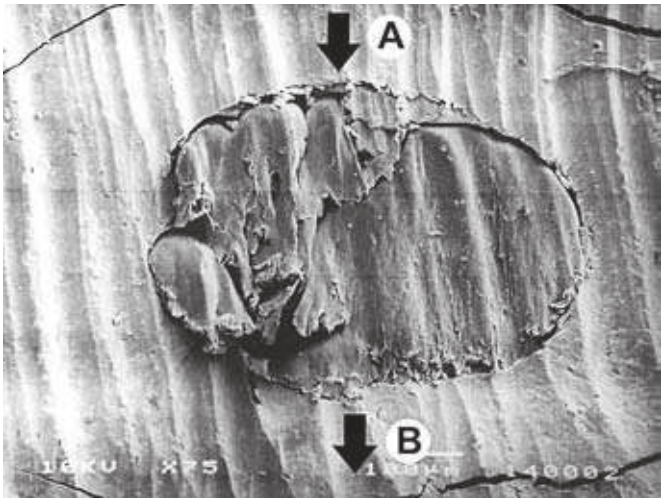

Figure 2. Photomicrograph (75X magnification) of the apical surface after resection with a #2082 diamond bur (Group II). **A**) Entry surface of the bur during the resection; **B**) exit surface of the bur after the resection.

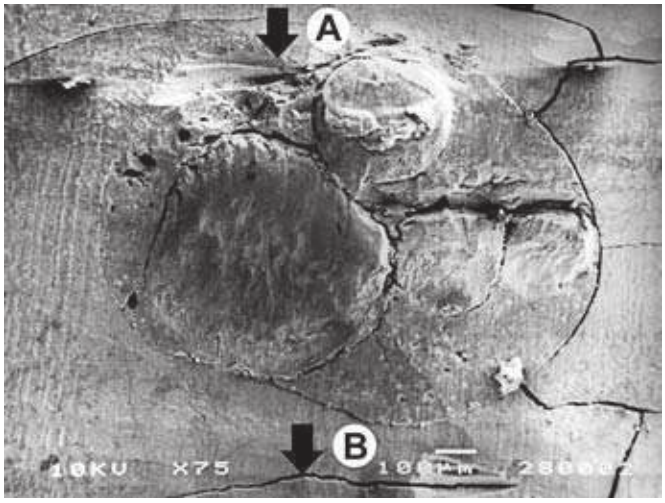

Figure 3. Photomicrograph (75X magnification) of the apical surface after resection with a Zekrya bur (Group III). **A**) Entry surface of the bur during the resection; **B**) exit surface of the bur after the resection.

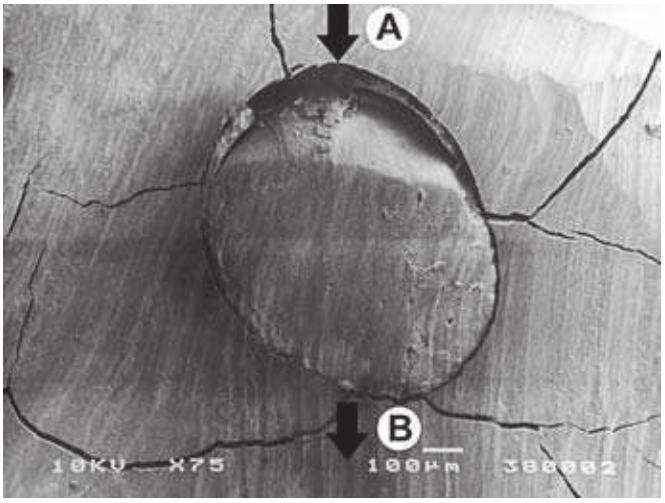

Figure 4. Photomicrograph (75X magnification) of the apical surface after resection with a #700 bur refined with a Shofu point (Group IV). **A**) Entry surface of the bur during the resection; **B**) exit surface of the bur after the resection.

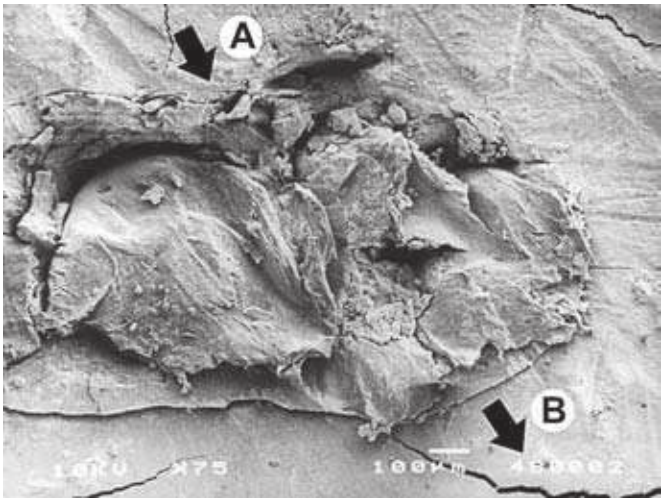

Figure 5. Photomicrograph (75X magnification) of the apical surface after resection with a #700 bur refined with a #31-32 periodontal file (Group V). **A**) Entry surface of the bur during the resection; **B**) exit surface of the bur after the resection.

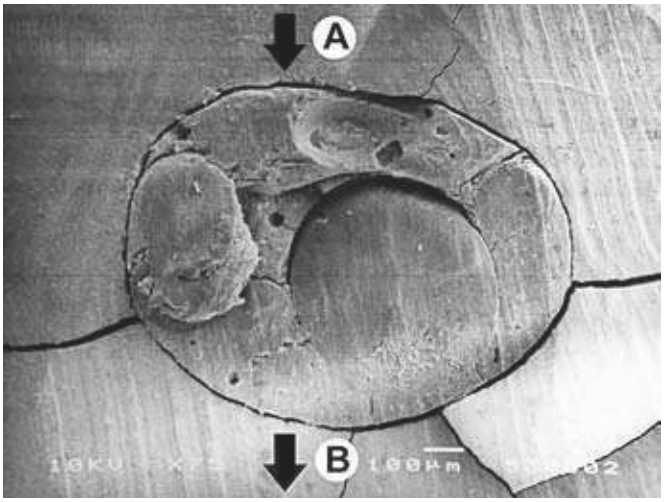

Figure 6. Photomicrograph (75X magnification) of the apical surface after resection with a #700 bur refined with a 12-blade, high-speed bur (Group VI). **A**) Entry surface of the bur during the resection; **B**) exit surface of the bur after the resection.

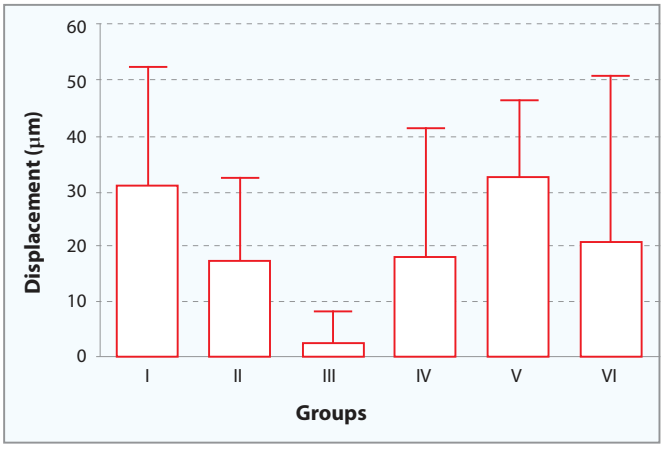

Figure 7. Graph showing the mean values and standard deviation of the gaps due to displacement of filling after apical root resection with different instruments.

Discussion

According to previous studies, a higher resection angle during apicectomies avoids unnecessary exposition of dentinal tubules, which could allow the infiltration of periapical fluids and the passage of microorganisms to and from uncovered dentin.[9,11,12]

In the present study, apical resection was performed at a 90° angle, which was also recommended by other authors.[5,11,13,14,15] Gilheany et al[16] reported that there was a significant increase in leakage as the resection angle increased.

A resection located 3 mm from the apex, used in the present study, is accordingly to previous authors.[17-21]

There are few studies on the effects of the bur on the resected dentinal surface and the eventual consequences on the filling, which are both poorly addressed by research.[3]

The #700 bur is one of the most indicated instruments for apical root resection,[3,18,19,20,22] and the use of this bur attached to a low-speed handpiece enhances visualization and control during the resection in a proximal direction.[17] The association of a #700 bur with other instruments was suggested by previous authors, and also tested in the present experiment.[6,23]

Diamond burs are advocated by other authors as the instrument of choice during apical root resection.[3,13,24] The Zekrya surgical bur is indicated by the manufacturer for root hemisection and amputation; it was included in the present experiment for being recommended by some authors.[7]

The resected specimens were observed under the scanning electron microscope, which was also used by previous authors with good results.[7,15,18] The microscopy artefacts, represented by cracks surrounding the canal in most of the samples, were also evidenced by other authors.[13]

During root resection, the action of the instrument on the filling may compromise apical seal, which may

lead to an unsuccessful outcome of the surgical procedure.[19,27] Despite most authors support the necessity of retrograde filling after apicectomy, some find higher success rates in cases where this filling was not performed.[26]

Interface infiltration between the retrofilling material and dentinal walls is the main cause of failure in endodontic surgery.[27] However, despite most authors relate interface infiltration with retrofilling materials, root canals treated with the conventional technique also present successful outcomes.[13] This seems to correspond to the findings of previous studies, where teeth with canals filled with gutta-percha and sealer submitted to apicectomy revealed absence of infiltration.[22]

The present study revealed that root resection using #700 burs in low-speed handpieces causes more displacement of the filling at the side where resection began, producing a gap which is more pronounced in this area and creating a "combed" pattern in the gutta-percha. Apical resection with Zekrya burs caused less displacement of the filling (2.67±8.43 μm) when compared to Groups I and V (31.20±20.86 μm and 32.53±13.73 μm), being similar to Groups II and IV (17.46±14.81 μm and 18.26±22.93 μm, respectively). A similar finding is reported by Nedderman et al,[15] who found that a non-fissure bur promotes the least displacement of the filling. The use of such burs in high-speed handpieces apparently favours the maintenance of the filling in place, maybe due to the efficiency in cutting both dental tissue and the filling material.

Conclusions

The results of the present study demonstrated that apical root resection using Zekrya surgical burs promotes the least displacement of the filling when compared to the other tested instruments.

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