

ORIGINAL RESEARCH

Morphometrical analysis of cleaning capacity of a hybrid instrumentation in mesial flattened root canals

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Abstract

The cleaning capacity of hybrid and rotary instrumentation techniques in mesial flattened canals of mandibular first molars was evaluated by morphometrical analysis in this study. Twenty human mandibular first molars were randomly assigned into two groups, according to instrumentation technique, as follows: group 1, instrumentation with ProTaper Starter Kit (Dentsply/Maillefer) rotary system; group 2, manual instrumentation using K files (Dentsply/Maillefer) by crown-down technique in middle and apical thirds, cervical preparation with Gates-Glidden #1 and #2 (Dentsply/Maillefer) burs, and to finalise the preparation, ProTaper F2 and F3 rotary files. Serial transverse cross-sections (5 µm) of the apical third, stained with hematoxylin and eosin, were analysed at 100× original magnification. The images were submitted to morphometrical analysis with an integration grid to determine the percentage of root canal area with debris. Statistical analysis (*t*-Student, $P < 0.05$) showed significant difference between the techniques ($P < 0.05$), although neither completely cleaned the root canal.

Introduction

The main objective of biomechanical preparation, gradually increasing the instruments diameter and constant irrigation, is cleaning, disinfection and shaping of the root canal in order to promote easy and adequate filling (1,2).

For several decades, manual instrumentation has been widely used in endodontic treatment and it is very efficient in broad canals and in cases of canals that are flattened to an accentuated extent, but it has not been shown to be efficient in debriding curved canals (3–5). As access to the root canal system is limited and the anatomy complex, microorganisms may remain in the dentinal tubules and in other irregular spaces. When these microorganisms find a supporting environment, they can proliferate and reinfect the root canal system (6,7).

For these reasons, motor-driven nickel-titanium instruments (Ni-Ti) were developed, which are flexible and

have great cutting efficiency, indicated for debriding these canals (8,9). As is the case with manual instruments, rotary instruments also have limitations, such as fracture because of kinetics, design and lack of knowledge of the technique used, added to the fact that the instruments only broaden root canals (10). Considering that the majority of canals have a flattened anatomy, no matter how thin or small the rotary instrument diameters may be, their action on these flattened areas is unlikely to occur, preventing them from being adequately cleaned and shaped (10–12).

Although there are many techniques for root canal preparation, all of them have a single objective: sufficient enlargement of the root canal to produce adequate canal debridement and obturation (10–12).

Recently, ProTaper instruments (Dentsply/Maillefer, Ballaigues, Switzerland) were introduced into the market, and are differentiated from the other instruments

sold at present by the variations in taper they present. The ProTaper Starter Kit set is composed of three instruments called 'Shaping' (Sx, S1 and S2) and 'Finishing' (F1, F2 and F3) and they are shorter when compared with instruments of the other systems. They have coloured rings on their handles, standardised by ISO system, which identify the instrument and direct the operator to use them in the sequence proposed by the manufacturer (13).

It has been shown that cleaning narrow, curved and flattened root canals is not always easily accomplished, indicating that anatomic variations are also an important factor to be considered (14,15). Given the limitations of instrumentation methods, manual and rotatory, it is necessary to develop protocols that clean the whole endodontic space, with a technique that gives emphasis in the main advantages of the two techniques.

Thus, the aim of this study was to evaluate histologically the cleaning capacity of a hybrid (manual/rotatory) instrumentation technique, comparatively to ProTaper Starter Kit rotary instrumentation in mesial flattened root canals of first mandibular molars.

Materials and methods

Twenty extracted human mandibular first molars were used in this study, in accordance with the ethical standards of the responsible Committee on Human Experimentation of this institution, within which the work was undertaken and that it conforms to the provisions of the Declaration of Helsinki. The teeth were chosen considering their external root anatomy, prioritising teeth with similar root lengths. The teeth were disinfected by placing them in a chloramine solution (0.5%) at a temperature of 4°C for 48 h and then washing them under running water for 24 h. After this, their crowns were sectioned in the lingual-vestibular direction at the amelo-cement junction, using a double-faced diamond disk coupled to a low-speed handpiece (Dabi Atlante, Ribeirão Preto, SP, Brazil) and obtaining a mesial-root remainder of 10 mm long.

Conventional access was performed and a #10 K type file (Dentsply/Maillefer, Ballaigues, Switzerland) was introduced into the canal until it appeared at the apical foramen. The working length was established by subtracting 0.5 mm from this measurement. The roots were randomly separated into two groups of 10 roots each. Because each mesial root has two canals, 20 samples for each group ($n = 20$) were used.

In roots of group 1, instrumentation was performed with Ni-Ti rotary files of the brand ProTaper Starter Kit (Dentsply/Maillefer, Ballaigues, Switzerland), according to the manufacturer's recommendations. These special

files, six in number, were used following the order: Sx, S1, S2, F1, F2 and F3.

In group 2, the middle and apical third were manually debrided with K files #15, #20 and #25 by the crown-down technique (Dentsply/Maillefer, Ballaigues, Switzerland). Cervical preparation was performed with Gates-Glidden #1 and #2 (Dentsply/Maillefer, Ballaigues, Switzerland) burs and to finalise the preparation, ProTaper F2 and F3 rotary files were used, both at the real working length for finishing. During instrumentation of both groups, 1 mL of 2.5% NaOCl solution was used for irrigation at each change of instrument.

After biomechanical preparation, the apical third of each root was sectioned and removed for histological processing. The specimens were immersed in 10% buffered formalin and stored for 12 h in the same solution until histological processing. All specimens were then washed, decalcified in 10% glycoacetic acid and embedded in paraffin. Serial transverse cross-sections (5 µm) were stained with hematoxylin and eosin. The cross-sections were examined with an optic microscope (Nikon, Tokyo, Japan) (100×) coupled to a computer where the images were recorded and analysed by a software (Image Tool, The University of Texas, Health Science Center in San Antonio, San Antonio, TX, USA). A grid with 300 (20 × 15) points was placed over these images to evaluate the total canal area and tile area with debris (Fig. 1). The percentage of debris in the root canal after biomechanical preparation was calculated and the values obtained were submitted to statistical analysis (*t*-Student, $P < 0.05$).

Results

The experimental data of this study consisted of 60 numerical values corresponding to the percentage of debris that still remained in the hollow passage of the canal after instrumentation (Figs 2,3).

These values were calculated by the factorial product of 10 roots with two canals and six cuts for each one, totaling 60 samples for each group. In each of the samples, the squares with debris were counted and divided by the total number (clean and dirty) of squares, which were transformed into percentage (100×).

The values obtained showed that the hybrid technique (13.14%) presented greater capacity to clean the apical third of root canal systems when compared with the rotary technique (18.44%), with statistically significant difference ($P < 0.05$) (Table 1 and Fig. 4).

Discussion

Biomechanical preparation is the key to successful endodontic treatment. Its objective is to clean the root canal

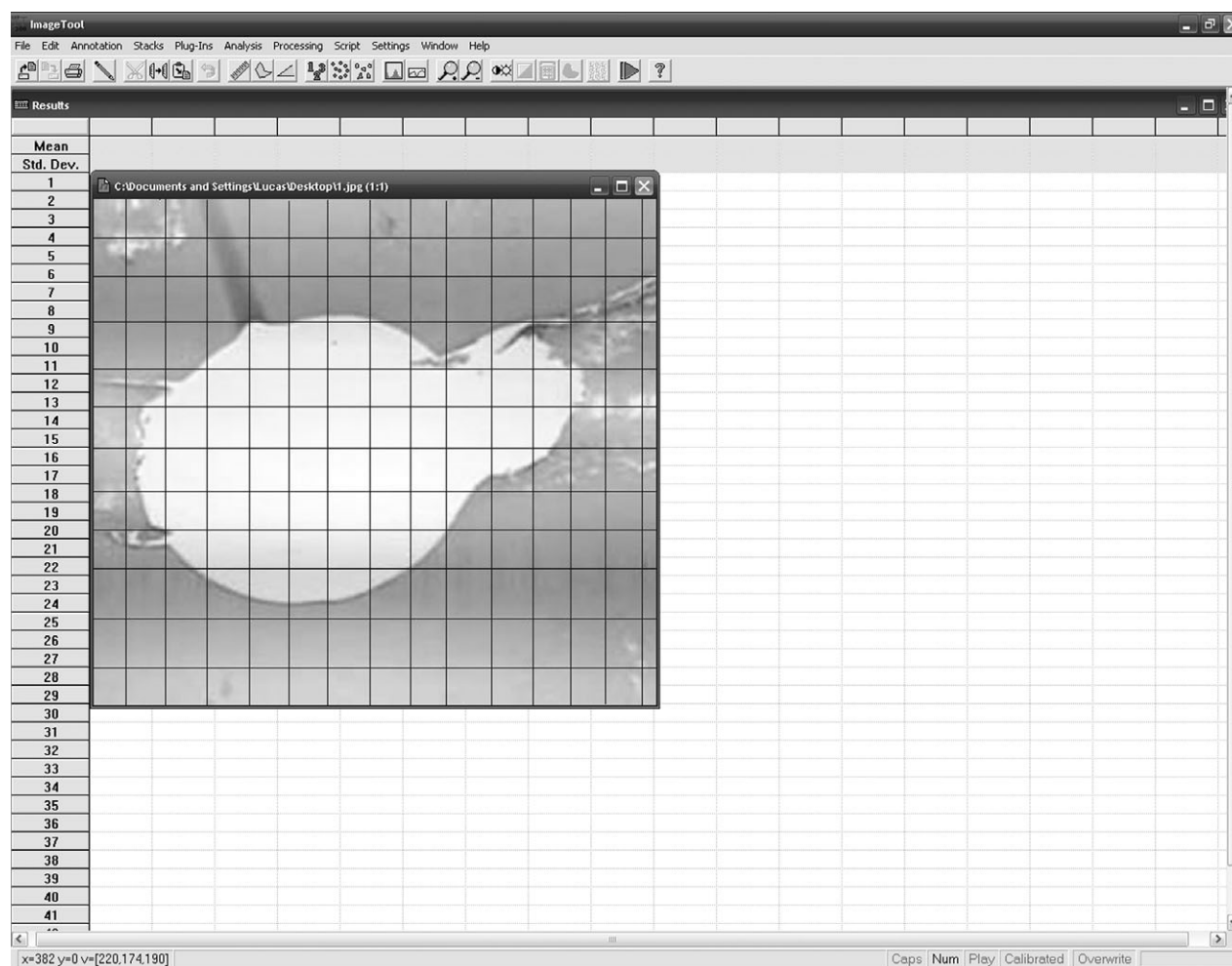


Figure 1 Image in the computer after superimposition of integration grid.

and its ramifications as thoroughly as possible, creating ideal conditions for tissue regeneration and health. Variations in internal anatomy can interfere with root canal therapy because root canals are not cylindrical, they are flattened. Thus, tissue remnants can persist in isthmus, re-entrances and ramifications making instrumentation more difficult (15).

The success of root canal treatment depends fundamentally on cleaning, shaping, disinfecting and sealing the root canal. Cleaning occurs simultaneously with biomechanical preparation, elimination of bacteria, their sub-products, degenerated pulp tissue and contaminated dentin, creating a surgical space that permits proper sealing. This process occurs by the action of the instruments on the root canal walls, the chemical properties of the irrigating solutions and irrigation-aspiration (9).

The most commonly used methods of evaluating the cleaning of the root canal are a scanning electron micro-

scope (16), optical microscope (3) and section analysis, before and after instrumentation (17). These evaluate quantitatively and qualitatively remaining layer and debris in the root canal system.

In the present study, histological analysis was used to evaluate the cleaning achieved by hybrid and rotary instrumentation. The morphometrical analysis was used to quantify the remaining debris in the root canal as recommended by Barbizam *et al.* (3) and Passarinho-Neto *et al.* (18), and the percentage of root canal area with debris of these studies was similar to the results of the present study.

Methods for cleaning and shaping the root canal have been reported over the last century; however, recent technological developments, such as Ni-Ti alloy (3,19) used in rotary file systems, have improved endodontic therapy. Most studies have reported that the canal shape was maintained by rotary Ni-Ti files (17,20,21), with the

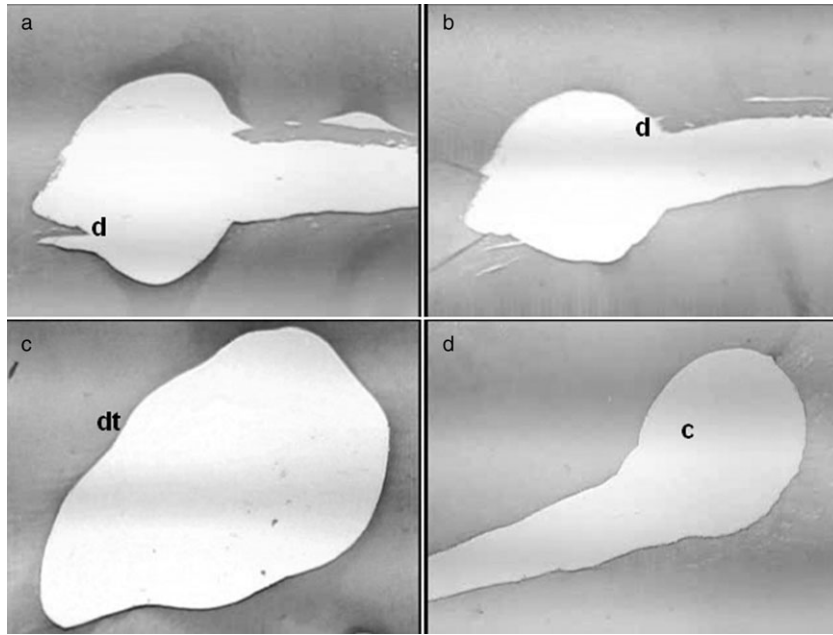


Figure 2 Photomicrographs referent to the sections of samples of group 1 (rotary instrumentation) (100x). (a) Debris in the light of the canal (d); (b) debris in the isthmus region (d); (c) dentin (dt); and (D) light of canal (c).

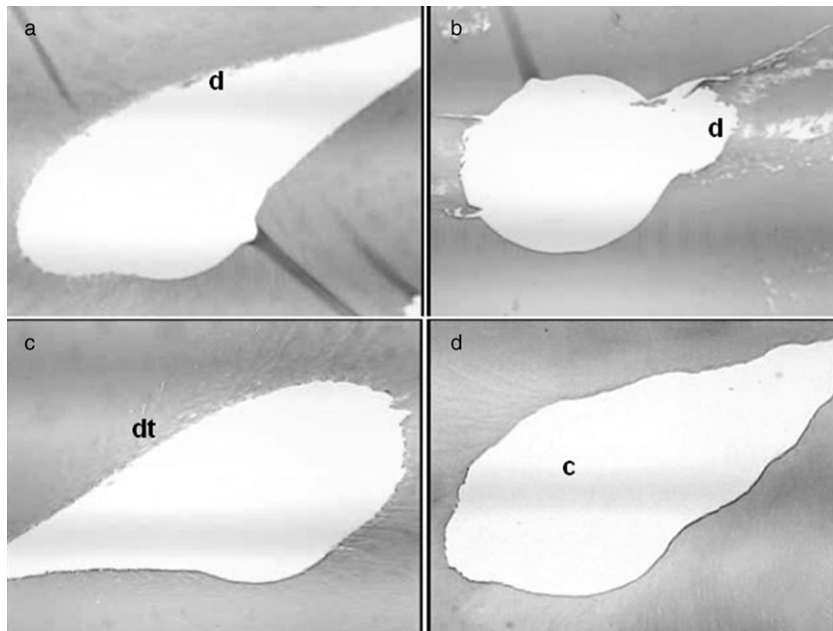


Figure 3 Photomicrographs referent to the sections of samples of group 2 (hybrid instrumentation) (100x). (a) Debris in the light of the canal (d); (b) debris in the isthmus region (d); (c) dentin (dt); and (d) light of canal (c).

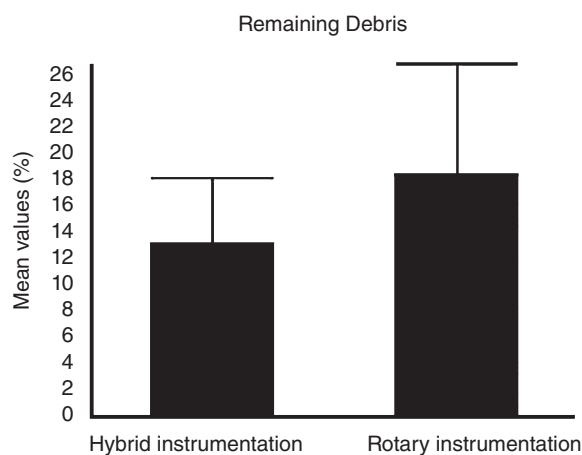
procedure being noticeably easier and faster than manual preparation (22). However, the action of these instruments in flattened areas is critical, being necessary the complementation with a manual technique (10–12).

Passarinho-Neto *et al.* (18) have reported that rotary instrumentation with Ni-Ti files associated with final irrigation of 1% NaOCl energised by ultrasound leads to better debris removal from the apical third of mesio-

Table 1 Mean values of remaining debris (percentage) and standard deviation for experimental groups

	Hybrid instrumentation	Rotary instrumentation
Mean values	13.14 ± 5.01 ^A	18.44 ± 8.38 ^B

Different letters mean statistically significant difference (*t*-Student, $P < 0.05$) = 5.22.

**Figure 4** Graphic representation of the percentage mean of debris after instrumentation.

distally flattened root canals. However, the present study did not evaluate the cleaning capacity of irrigating solutions, as in other reports (9,23). The biomechanical preparation leaves organic and inorganic debris into the root canal (24), and the results of this study are in agreement with others (25,26), showing that neither of the instrumentation techniques used completely cleaned the root canals. Moreover, Williamson *et al.* (27) described in their study that the duration of contact and the volume of NaOCl used as irrigant solution during rotatory instrumentation does not cleanse the canals completely.

Rotary instrumentation with Ni-Ti files has a limited area of action. Because of their superelasticity, it is known that they cannot be pressed against the root canal walls (10). Flattened root canal does not permit major enlargement without the risk of creating a lateral perforation (11–13). Various studies have reported that the utilisation of Ni-Ti instruments, by causing less transportation than stainless steel instruments at the middle and apical thirds, results in shaping at the apical third that closely resembles the original canal form (28). The literature also indicates that motor-driven Ni-Ti instruments create canal shapes that are more circular and homogeneous in form (17). Thus, a combination of manual and rotatory techniques for flattened root canals should also be considered.

The results of this study confirm previous research (15), showing that the amount of debris in the root canals, after instrumentation, is related to internal anatomic characteristics. The hybrid (manual/rotary) technique was more effective in cleaning mesial flattened root canals than the rotary technique (ProTaper Starter Kit), although neither completely cleaned the root canal.

Conclusion

In spite of the good results obtained for the hybrid technique, further studies should be conducted to investigate its real cleaning capacity in mesial flattened root canals, being varied the irrigation protocols.

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