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COMPARATIVE ANALYSIS OF THE APICAL EXTRUSION OF DEBRIS CAUSED BY DIFFERENT MANUAL INSTRUMENTATION TECHNIQUES

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ABSTRACT

INTRODUCTION: The instrumentation stage in endodontic treatment is associated with the extrusion of debris to the periapex, which can lead to postoperative symptoms and delay in apical repair. The present study aimed to perform a comparative analysis of the apical extrusion of debris caused by two different manual instrumentation techniques. **METHODS:** Thirty permanent lower central incisors were randomly selected and distributed into two groups (n=15) according to the technique used: (T1) manual instrumentation with cervical preparation burs and stainless steel files, and (T2) manual instrumentation with M nickel-titanium files. The extruded debris were collected in tubes, weighed before and after instrumentation. Three consecutive weights were obtained for each tube and the average was calculated. **RESULTS:** The data were analyzed using the t-test, with p-values less than 0.05 considered significant. Both techniques caused apical extrusion of debris, being greater in group T1 (0.0011) than in T2 (0.0002), with a statistically significant difference. **CONCLUSION:** The manual instrumentation technique with cervical preparation burs and stainless steel files showed greater apical extrusion of debris than the manual instrumentation technique with M files.

Keywords: Endodontics. Manual instrumentation techniques. Apical extrusion. Postoperative period.

Registration CEP: 5.384.166

INTRODUCTION

The chemical-mechanical preparation in endodontic treatments aims for the cleaning and decontamination of the root canals, through the action of instruments and irrigants[1]. This step results in the extrusion of debris into the apical region, which can trigger an inflammatory reaction, alter the repair process, and cause postoperative pain[2].

The severity of this reaction depends on the amount of debris extruded, where several factors are determinants. They may be related to the internal dental anatomy concerning the curvature of the root, degree of atresia, and size of the apical foramen. Additionally, they are associated with the instrumentation technique, kinematics, alloy and cross-sectional shape of the instrument, as well as the mode of use and volume of irrigants during preparation[3,4,5].

The literature reports that every instrumentation technique, whether manual or automated, produces apical extrusion of debris[6]. However, it is more frequent and in greater quantity when using manual files[7]. Although there are many professionals currently performing automated preparations, there are still those who do not have electric motors, as well as numerous undergraduate students in Dentistry[8]. In this context, manual instrumentation is still widely practiced and needs to be executed as well as possible.

Manual instrumentation originated with the combination of cervical preparation burs and stainless steel instruments. Due to the rigidity of these instruments, they are prone to fractures, apical transportation, and/or deviations from the original root canal bed[9]. Given these limitations, manual nickel-titanium (NiTi) instruments have brought an improvement in the quality of preparations, as they are more resistant, flexible, adaptable to root anatomy, and have a simplified sequence[10].

To promote high-performance manual instrumentation accessible to those who do not have automated motors, Easy Bassi developed the new M files. Made with NiTi and featuring a heat treatment for shape memory control (CM), they exhibit improved mechanical behavior, flexibility, resistance to cyclic fatigue, and allow for pre-curvature[11].

Given these new NiTi manual instruments recently launched in the market, which advocate a simplified technique different from the conventional one using stainless steel instruments, additional studies are opportune, especially to evaluate their ability to extrude debris. This fact is of great relevance in the choice of a technique by the professional, aiming for a treatment that prioritizes tissue repair and provides the patient with a postoperative period free of symptoms.

Thus, the present study aimed to perform a comparative analysis of the apical extrusion of debris caused by two different manual instrumentation techniques. The null hypothesis was that there would be no difference in the amount of apically extruded debris between the tested groups.

METHODS

The present study was approved by the Research Ethics Committee of the Federal University of Goiás (Protocol No. 5.384.166). The sample size was calculated based on a pilot study. Considering a test power of 0.80 and a confidence level of 95%, the sample size was determined to be fifteen samples per experimental group (n = 15). The calculations were performed using the Statistical Package for the Social Sciences software, version 20 (SPSS).

Two hundred human lower central incisors extracted for periodontal or prosthetic purposes were selected from patients at the South American University Center UNIFASAM. After extraction, the teeth were cleaned with periodontal curettes, subjected to prophylaxis with pumice/water, and sterilized in an autoclave at a temperature of 121°C for 15 minutes. They were then stored in 0.1% thymol until the preparation of the samples.

These teeth were radiographed in the buccal-lingual and mesio-distal directions using a phosphor plate (Kavo Express, Joinville, Brazil), with an exposure time of 0.32 seconds at a distance of 10 cm. The obtained images were analyzed using the Cliniview software (Kavo, Joinville, Brazil). The inclusion criteria included teeth with a length between 18 and 20 mm, having a single root with a curvature less than 10° (measured by Schneider's method), containing a single root canal, a single fully formed foramen that allowed the insertion of a snug #15 K-File

(Dentsply/Maillefer, Ballaigues, Switzerland) up to the foramen. Thus, out of the 200 pre-selected teeth, only 30 met these criteria.

The teeth were measured with a digital caliper (Dutra Maquinas, São Paulo, Brazil) and their lengths standardized to 18 mm by grinding the incisal edge with a conical diamond bur 3072 (KG Sorensen, Cotia, Brazil). Subsequently, their coronal accesses were made with spherical diamond burs 1012 and conical burs with inactive tip 3081 (KG Sorensen, Cotia, Brazil), operated at high speed. Patency was achieved with a K-file #15 file at a length of 18 mm (Dentsply/Maillefer, Ballaigues, Switzerland) and its exit from the foramen was confirmed visually through an operative microscope (Alliance Microscopia, São Carlos, Brazil). From this measurement, the file was retracted 1 mm to establish a working length (WL) of 17 mm.

The samples were randomly distributed into two groups (n=15), for each technique to be tested:

- (T1) Manual instrumentation with burs and stainless steel files (Figure 1). Cervical and middle preparation was performed with Gates-Glidden burs numbers 1 and 2 (Dentsply/Maillefer, Ballaigues, Switzerland) at a length of 12 mm. Subsequently, apical preparation was carried out with stainless steel K-type files 15, 20, and 25 at the working length (WL) of 17 mm, followed by stepping up with files 30 at 16 mm, 35 at 15 mm, 40 at 14 mm, and 45 at 13 mm.

Fig. 1 - Instruments used in Group T1.

- (T2) Manual instrumentation with M nickel-titanium files (Figure 2). Cervical and middle preparation was performed with an Orifice Shapper 15.08 of the M files

(Easy Dental Equipment, Belo Horizonte, Brazil) at a length of 12 mm. Subsequently, apical preparation was carried out with M files 15.03, 20.03, 25.03, 25.05 at the working length (WL) of 17 mm.

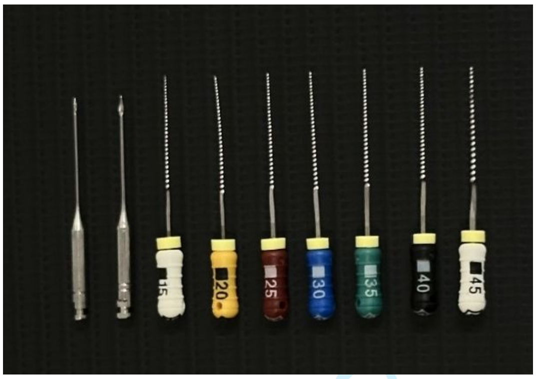

Fig. 2 - Instruments used in Group T2.

Each instrument, regardless of the technique, was used to prepare four canals. Irrigation was performed with a NaviTip 30G needle and syringe (Ultradent, South Jordan, UT), inserted as deeply as possible into the canal without resistance, not exceeding 15 mm. A total of 12ml of bidistilled water was used for each technique, divided by the number of instruments used.

All instrumentations were performed by a single operator, while the evaluation of debris was done by a second examiner, unaware of the experimental groups.

To collect the debris formed post-instrumentation, the Myers & Montgomery[13] method was used (Figure 3).

Fig. 3 - Device used for debris collection

A hole in the tube cap was made to accommodate the tooth and the tooth/cap interface was sealed with Top Dam gingival barrier (FGM, Joinville, Brazil). A cut was made at the bottom of the Eppendorf, through which the debris generated during instrumentation passed. This assembly was placed in a hole, in a plastic lid attached to a larger glass bottle. Inside this bottle, an amber tube (receiving tube) was placed. Prior to use, this tube was identified and weighed three times consecutively on an analytical precision scale to obtain the initial weight of the empty tube. The root apex was suspended over this amber tube. A 27 G needle (Unoject DFL, Rio de Janeiro, Brazil) was placed along with the Eppendorf cap to balance the internal and external pressure. The larger glass bottle was wrapped in aluminum foil so that the operator could not see the apex during instrumentation.

Once instrumentation was completed, each tooth, separated from the receiving tube and with debris adhered to the root surface, had its root washed with 1 ml of distilled water into the receiving tube.

The receiving tubes were then stored in an incubator at 70 °C for five days, in order to evaporate the moisture before weighing the dry debris. An electronic scale (Shimadzu do Brasil, São Paulo, Brazil) with a precision of 0.0001 g was used to weigh the tubes containing the debris. Three consecutive weights were obtained for each tube, and the average value was calculated. The dry weight of the extracted material was calculated by subtracting the weight of the empty tube from the weight of the tube containing debris.

Since they fall into the A4 waste disposal group, the teeth were disposed of in accordance with the norms of the Anvisa/RDC 222 Resolution.

The means and standard deviations of the values of apically extruded debris were calculated using the t-test, with a significance level of 5% ($p<0.05$)

RESULTS

Table 1 shows the values of apically extruded debris by different manual instrumentation techniques. Both techniques resulted in apical extrusion of debris, with a higher amount in group T1 (0.0011) than in T2 (0.0002), with a statistically significant difference.

Table 1 – Number of specimens, means and standard deviations, minimum and maximum values of apically extruded debris by manual instrumentation techniques.

Technique	N	Mean and Standard Deviation	Minimum	Maximum
T1 Limas de aço inox	15	0.0011 ± 0.0002^{a}	0.0008	0.0017
T2 Limas M	15	0.0002 ± 0.0001^{b}	0.0001	0.0005

*Different letters indicate statistical differences ($p<0.05$)

DISCUSSION

Choosing an instrumentation technique that extrudes the least amount of apical debris improves the success rates of endodontic treatment[14]. In the present study, the null hypothesis was rejected, as there were significant differences between the two tested manual instrumentation techniques.

The pilot study was of utmost importance for the proper design of the research. The method of collecting and weighing extruded debris from Myers & Montgomery was used, which is the most widely used in the literature, with the modification of covering the transparent tube, so that the operator could only see the canal entrance during instrumentation, simulating the clinical setting and avoiding possible influences on the results[15,16,17,18,19,20,21].

Bidistilled water was used as an irrigant because it does not influence the final weight of the debris after evaporation, since sodium hypochlorite allows the formation of crystals and salt deposits, capable of increasing the mass of extracted

To control the greater extravasation of irrigant that could impact the results, the use of the 30G NaviTip irrigation needle was chosen. This needle has a tip diameter of 0.30 mm, which is less than the CT even after final apical preparation with a diameter of 0.25 mm, thus allowing space for the liquid to reflux and prevent accidental extravasation. Furthermore, this needle, being open at the tip, provides greater replacement of the irrigant with better cleaning of the apical region[25]

Two manual instrumentation techniques were selected. T1 is the conventional technique widely used over the years, advocating the use of cervical preparation burs and stainless steel files. T2 is the contemporary and more recent technique, advocating the use of NiTi files with CM heat treatment. A greater amount of apically extruded debris was observed in group T1 (0.0011) compared to T2 (0.0002). This result may be associated with the instrumentation technique, kinematics, alloy, and cross-section of the instruments[3,4,5].

In group T1, the stainless steel instruments were stepped up, as recommended in this technique and also to approximate the diameter of the prepared canal in group T2. However, this stepped technique requires the use of a greater number of files, which may have influenced the greater extrusion of debris. This fact has already been pointed out in previous studies, where a larger sequence of instruments during root canal preparation resulted in greater apical debris extrusion[15].

The kinematics of the instruments may also be related to the distinct pattern of debris extrusion in the experimental groups. In T1, the stainless steel files were used with a forward widening movement, right turn, and pull. In T2, M files were used in a right rotational movement. This method of operation is innovative in manual instrumentation, simpler, quicker to execute, and simulates the movement imparted by automated motors to rotary instruments. There is evidence that continuous rotational movement causes less debris than reciprocating movement[18], which corroborates the results of the present study.

The alloy of the instruments also has an important correlation with the apical extrusion of debris. NiTi instruments with heat treatment have enhanced characteristics of greater flexibility, better centering during preparation, and less canal transportation, allowing for less debris extrusion19,21. This was verified in the present study, where in the T2 group of thermally treated NiTi M files, there was less debris extrusion than in the T1 group of stainless steel files.

The cross-sectional shape of the instrument is also an important parameter in determining debris extrusion. Depending on its geometry, there can be more space between the file and the canal wall, allowing for better coronal escape of dentinal debris20. However, in this study, the manual files of both groups T1 and T2 have the same quadrangular cross-section, which was not determinant in the difference of extruded debris.

Considering the damage caused by debris extrusion in the periapex, the search should always be for instrumentation techniques that are effective and respect the health of adjacent tissues as much as possible.

CONCLUSION

It is concluded that the manual instrumentation technique using cervical preparation burs and stainless steel files resulted in greater apical extrusion of debris compared to the manual instrumentation technique using M files.

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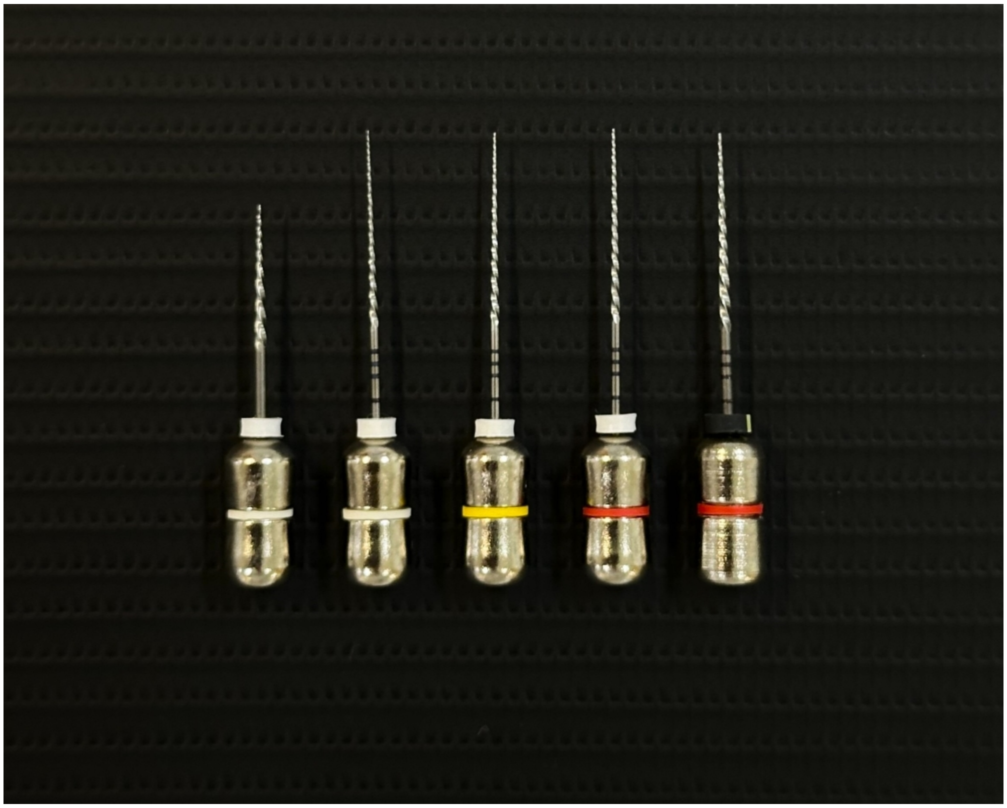

Fig. 1 - Instruments used in Group T1.

193x154mm (300 x 300 DPI)

Fig. 2 - Instruments used in Group T2.

176x128mm (300 x 300 DPI)

Fig. 3 - Device used for debris collection.

54x71mm (118 x 118 DPI)