

Effectiveness of Different Final Irrigation Protocols in Removing Debris in Flattened Root Canals

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This study evaluated *in vitro* the capacity of debris removal from the apical third of flattened root canals, using different final irrigation protocols. Thirty human mandibular central incisors with a mesiodistal flattened root were prepared using rotary instrumentation by Endo-Flare 25.12 and Hero 642 30.06, 35.02, 40.02 files, irrigated with 2 mL of 1% NaOCl after each file. The specimens were randomly distributed into 5 groups according to the final irrigation of root canals: Group I: 10 mL of distilled water (control), Group II: 10 mL of 1% NaOCl for 8 min, Group III: 2 mL of 1% NaOCl for 2 min (repeated 4 times), Group IV: 10 mL of 2.5% NaOCl for 8 min, and Group V: 10 mL of 2.5% NaOCl for 2 min (repeated 4 times). The apical thirds of the specimens were subjected to histological processing and 6- μ m cross-sections were obtained and stained with hematoxylin-eosin. The specimens were examined under optical microscopy at $\times 40$ magnification and the images were subjected to morphometric analysis using the Scion image-analysis software. The total area of root canal and the area with debris were measured in square millimeters. Analysis of variance showed no statistically significant difference ($p > 0.05$) among the groups GI (2.39 ± 3.59), GII (2.91 ± 2.21), GIII (0.73 ± 1.36), GIV (0.95 ± 0.84) and GV (0.51 ± 0.22). In conclusion, the final irrigation protocols evaluated in this study using the Luer syringe presented similar performance in the removal of debris from the apical third of flattened root canals.

Key Words: Endodontics, instrumentation, methods, sodium hypochlorite.

INTRODUCTION

Biomechanical preparation is the stage of endodontic treatment that aims at cleaning, disinfecting and shaping the root canals in order to eliminate bacteria and their irritating products, degenerated pulp tissue and contaminated dentin (1,2), thereby, creating an adequate surgical space for filling the root canal system.

The use of nickel-titanium instruments during biomechanical preparation creates an apical stop with a larger diameter and minimum apical transportation, when compared with the stainless steel instruments. Thus, a larger amount of pulp tissue, contaminated dentin and microorganisms are removed. Furthermore, wider apical preparation facilitates the disinfection process because a

larger volume of irrigant solution can act in this region (3). However, nickel-titanium instruments are not effective for cleaning flattened root canals, or those in which the canal shape does not allow instrumentation (4,5). In these situations, irrigant solutions may assume fundamental importance in biomechanical preparation (6).

Among these solutions advised for biomechanical preparation, sodium hypochlorite, at different concentrations, is the most used due to its properties of clarification, organic tissue dissolution, saponification, transformation of amines into chloramines, deodorization and antimicrobial action (7,8).

In addition to the physicochemical properties inherent to each irrigant solution, constant renewal of the solution during canal preparation by various irrigation-

aspiration cycles, avoids saturation, precipitation of particles, and favors the removal of debris in suspension inside the root canal (9). On this respect, some methods have been used for irrigating root canal systems such as the Luer-Lock syringe and irrigation needles of different calibers (10), the Quantec-E system, in which irrigation occurs concomitantly with rotary instrumentation (11), the NiviTip Fx system (12), the ultrasound irrigation system (13,14) and the electrochemical activation of cationic or anionic solutions (15).

Other factors related to irrigation can influence the effectiveness of cleaning the root canal system, such as the volume and pressure of the solution inside the canal (16), the caliber and penetration depth of the irrigation needle (17,18), the time that the solution remains inside the root canal (19), the contact area and heating promoted by solution that might increase the organic tissue dissolution (8).

Due to the limitations of instrumentation methods and the difficulty of completely cleaning root canals, it is necessary to develop alternative procedures to optimize the cleaning process. Therefore, the aim of this study was to assess *in vitro* by histologic and morphometric analysis, the capacity of debris removal from apical third of flattened root canals using different final irrigation protocols with the Luer-Lock syringe.

MATERIAL AND METHODS

Thirty human mandibular central incisors extracted for periodontal reasons were used in this study. All teeth had a mesiodistal flattened root with a single canal, confirmed by radiographic exam. The teeth showed completely formed roots and apical foramen with standard diameter of a size 15 file K-file (Dentsply-Maillefer, Ballaigues, Switzerland), and were maintained in 0.1% thymol solution at 4°C before use.

Conventional access was performed using a size 10 K-file (Dentsply-Maillefer), which was introduced into each canal until it appeared at the apical foramen. The working length was determined by subtracting 1 mm from this measurement. The teeth were prepared by the crown-down technique, using rotary instrumentation (Endo Plus electric motor; Driller, São Paulo, SP, Brazil) with Endo-Flare (25.12) and Hero (642 30.06, 35.02, 40.02) files (Micro-Méga, Besançon, France). Initially, the cervical third from the root canal was prepared with Endo-Flare 25.12 file, followed by irrigation with 2 mL

of 1% NaOCl. After enlargement of the cervical third, the middle third was instrumented with 30.06 file of Hero 642 system and the apical with 35.02 and 40.02 files. Irrigation with 2 mL of 1% NaOCl was performed after each file, using a Luer Lock syringe (Omega, São Paulo, SP, Brazil).

The specimens were randomly distributed into 5 groups according to the volume, concentration and irrigation time of the NaOCl solution used in the final irrigation: Group I: 10 mL of distilled water (control); Group II: 10 mL of 1% NaOCl, which remained into root canals for 8 min; Group III: 2 mL of 1% NaOCl, which remained into root canals for 2 min (the procedure was repeated 4 times, totalizing 8 min). In Group IV, it was used 10 mL of 2.5% NaOCl, which remained into root canals for 8 min; and in Group V, 10 mL of 2.5% NaOCl, remaining into root canals for 2 min (the procedure was repeated 4 times, totalizing 8 min).

For the irrigation procedure, 27-gauge needles (Becton Dickinson, Juiz de Fora, MG, Brazil) attached to 10 mL Luer-Lock syringes (Omega) were used. In order to remove the solutions, the teeth were washed with 2 mL of saline solution followed by drying of the canals with absorbent paper points (Dentsply Ind. e Com. Ltda., Petrópolis, RJ, Brazil).

After biomechanical preparation, the specimens were immersed in 10% buffered formalin for 24 h, decalcified in 10% trichloroacetic acid for 10 days and afterward, washed in water for 12 h. The apical thirds of each root were sectioned and removed, subjected to routine histological processing and embedded in paraffin. Serial 6- μ m-thick cross-sections were obtained from paraffin-embedded blocks and stained with hematoxylin-eosin. Five cross-sections were randomly obtained from each apical third (30 sections for each group). For the morphometric analysis, the histological slides were examined with an optical microscope at $\times 40$ magnification, which was coupled to a computer where the images were recorded with the Adobe Premier 5.1 software (Adobe Systems Incorporated, San Jose, CA, USA). Using Scion image-analysis software for Windows (beta 4.02 version; Scion Corporation, Frederick, MD, USA), the total canal area and the area with debris were measured in square millimeters. In each cross-section, the percentage of debris in the root canal after biomechanical preparation was calculated using the 2 measurements, total canal area and area with debris. The amount of debris in each specimen was obtained by mean percentage of 10 histological slides. For statistical

analysis, the results were subjected to analysis of variance, considering a 5% significance level.

RESULTS

The morphometric analysis revealed a smaller percentage of debris (mean \pm standard deviation) in the root canals from Group V (0.51 ± 0.22), followed by Group III (0.73 ± 1.36), Group IV (0.95 ± 0.84), Group II (2.91 ± 2.21) and Group I (3.41 ± 3.59). However, the comparative analysis between Group I (control) and Groups II, III, IV and V did not show statistically significant difference ($p=0.055$).

DISCUSSION

New instruments and techniques for root canal irrigation have been developed and tested in order to achieve the absence of debris and smear layer after biomechanical preparation. However, it is difficult to completely clean root canals, especially when dealing with accentuated flattened apical regions (4,5).

In this study, the results did not show significant difference among the final irrigation protocols with the Luer-Lock syringe for debris removal from the apical third of flattened root canals. Factors related to the physical and mechanical action of biomechanical preparation should be considered to understand these findings. The first refers to the volume of the solution used during irrigation, which was the same for all groups. According to Scelza et al. (7), the volume is more important than the type of the solution, due to the mechanical action created by the flux and reflux of the solution inside the canal, removing debris left in suspension after biomechanical procedures. The second factor concerns the caliber of the irrigation needle (27 gauge), which was also the same for all groups, thereby, providing the same pressure, irrigation time and hydrodynamic flux of the solution inside the canals. Boutsoukis et al. (16) reported that needles with thinner diameters require more force to dispense the solution, which results in an increase in its pressure inside the root canal, thus, favoring the debridement of the region. Indeed, some authors verified that the efficacy of the irrigant solution depends on the action of the irrigation needle, being greater when 1 mm from working length were used compared with 5 mm (18).

Finally, it is relevant to consider that biomechanical preparation with the Ni-Ti system allows a larger

surgical diameter with minimum deviation. According to Albrecht et al. (17), root canal preparation done with instruments of larger conicity in the cervical and middle region permits an effective flux and reflux of the solution in the apical region, allowing the needle to achieve deeper areas into the canal and favoring the debridement. These concepts were observed in the methodology of the present study, in which the teeth were prepared with the 25.12 EndoFlare instrument and the surgical diameter at the working length was equivalent to a size 40 instrument. Moreover, apical preparation in flattened canals with the 40.02-Hero instrument promotes a greater removal of dentin and debris (20), generally leaving only the "polar areas" or isthmus without instrumentation.

As regards the chemical action of the solution, it was observed that an increase in the concentration did not contribute to root canal cleaning in the final irrigation. This probably occurred because in this situation, the function of the solution would only be entrainment, since the water behaved in the same way as the NaOCl at 1% and at 2.5% in debris removal. It should be emphasized that during the rotary instrumentation, 2 mL of 1% NaOCl was used in every change of the instrument, allowing the chemical action of the solution.

According to Spanó et al. (8), the dissolution capacity of dental tissue by NaOCl is directly related to the mechanical agitation, volume, temperature and concentration of the solution, and with the amount of the solution remained in contact with the organic tissue. The chemical action of the NaOCl on the organic tissues occurs by the formation of hypochlorous acid, which reacts with the insoluble proteins, forming soluble products. This reaction can be accentuated by continuous flux and larger amount of solution, which would provide the effective removal of superficial debris and prolongation of the chemical activity of the solution (7,9). According to Baratto-Filho et al. (6), rotary instrumentation combined with NaOCl irrigation at different concentrations between each instrument evidenced greater debris removal for the 5% NaOCl solution when compared to the 0.5% solution, whereas in the present study, the increased concentration in the final irrigation did not contribute to canal cleaning. On the other hand, other authors observed that in the final irrigation, the NaOCl energized with ultrasound contributed to debris removal, in comparison to distilled water energized by ultrasound as well (13).

This study demonstrated the importance of

investigating the irrigation technique in root canal cleaning. Therefore, with optimization of instrumentation by rotary system, irrigation assumes an important role in removing suspended debris from the root canal system and areas where the instrument did not reach.

Based on the employed methodology and the obtained results, it may be concluded that there was no significant difference among the tested irrigation protocols with the Luer-Lock syringe in debris removal from the apical thirds of flattened root canals. Furthermore, none of the different final irrigation protocols were completely efficient in cleaning the apical portion of the canals. Sodium hypochlorite solutions at 1% and 2.5% present similar performance in removing debris from the apical third of the flattened canals.

RESUMO

Este estudo avaliou, *in vitro*, a capacidade de remoção de debris do terço apical de canais radiculares achatados, usando diferentes protocolos de irrigação final. Trinta incisivos centrais mandibulares humanos com a raiz médio-distal achatada foram preparados usando instrumento rotatório Endo-Flare 25.12 e limas Hero 642 30.06, 35.02, 40.02, irrigadas com 2ml de NaOCl 1% após cada lima. Os espécimes foram aleatoriamente distribuídos em cinco grupos de acordo com a irrigação final dos canais radiculares: Grupo I: 10 mL de água destilada (controle), Grupo II: 10 mL de NaOCl a 1% por 8 min, Grupo III: 2 mL de NaOCl a 1% por 2 min (repetidos 4 vezes), Grupo IV: 10 mL de NaOCl 2,5% por 8 min e Grupo V: 10 mL de NaOCl 2,5% por 2 min (repetido 4 vezes). Os terços apicais dos espécimes foram submetidos a processamento histológico de rotina e cortes transversais com 6 µm de espessura foram obtidos e corados com hematoxilina e eosina. Os espécimes foram analisados em microscopia óptica com aumento final de 40 X e as imagens submetidas à análise morfométrica com a utilização do software Scion Image. A análise de variância evidenciou não haver diferença estatística ($p > 0,05$) entre os grupos GI ($2,39 \pm 3,59$), GII ($2,91 \pm 2,21$), GIII ($0,73 \pm 1,36$), GIV ($0,95 \pm 0,84$) e GV ($0,51 \pm 0,22$). Conclui-se que os protocolos de irrigação final utilizando a seringa Luer apresentaram comportamentos semelhantes na remoção de debris do terço apical de canais radiculares achatados.

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