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ORIGINAL ARTICLE

Analysis of the ability of XP Clean and Easy Clean files to remove Calcium Hydroxide paste from simulated internal tooth resorptions

ABSTRACT

Aim: *This study compared the ability of instruments XP Clean and Easy Clean to remove the calcium hydroxide paste from simulated internal root resorptions.*
Methodology: *Thirty freshly extracted human lower incisors were sectioned through the long axis after biomechanical preparation with ProTaper files. On each half, a defect simulating an internal resorption was fabricated on the middle root canal third using a round bur. One week after insertion of calcium hydroxide paste, the teeth were divided into three groups according to the technique employed: G1-Conventional irrigation; G2-XP Clean and G3-Easy Clean. Each instrument was used in three cycles of 20 seconds, followed by renewal with 2 ml of irrigant. Thereafter, the specimens were analyzed on a stereoscopic magnifying glass to analyze the removal of dressing material.*
Results: *Similar performance was observed for both methods employed, even though the rates of absence of removal were higher for the group Easy Clean compared to the group XP Clean.*
Conclusions: *The XP Clean presented better results in removing the calcium hydroxide paste compared to Easy Clean, with statistically significant difference.*

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Introduction

Root resorption in the permanent dentition is a pathology that causes loss of hard tissue as a result of osteoclastic cell activity, and may be classified as internal or external according to its location. Internal resorption initiates inside the root canal, tends to be asymptomatic, and is usually caused by chronic infection or trauma (1).

The treatment of choice to arrest this destructive process is non-surgical endodontic therapy. However, the irregular configuration of internal resorption lesions poses a technical difficulty for complete debridement, thus it is recommended to use an intracanal antibacterial drug to enhance the disinfection of defects produced by root resorption (1-3).

The calcium hydroxide paste has been the drug of choice for this purpose, since it presents a dissolution effect on the tissue, allowing removal of the remaining dental pulp in the internal root defect after the calcium hydroxide paste is kept in situ for several weeks (1, 4). However, the literature describes difficulty in removing this material from the irregularities of resorption by conventional irrigation procedures, which represents a disadvantage, since calcium hydroxide remnants on the root canal walls may affect the penetration of endodontic sealers into the dentinal tubules and chemically react with the sealer, affecting its physical properties (2, 3). This encouraged the search for different techniques for activation of irrigants inside the root canal system, to improve the effectiveness of irrigation (5, 6).

One such device is the Easy Clean file, composed of plastic (acrylonitrile butadiene styrene) with size of 25/.04, used as an irrigation aid for completion of endodontic treatment. These files are pre-sterilized, designed for single use to maximize the removal of debris removal and agitate the irrigants, offering advantages concerning time and cost saving. This material also provides flexibility to the instruments, allowing their utilization to the working length even in the presence of curvatures (7, 8). According to Prado et al. (7) the Easy Clean presents a particular shape, similar to that of an "airplane wing", characterized by a central matrix associated with two delicate edges throughout the instrument. These characteristic format generates two mechanisms of action, one represented by the agitation of the irrigating solution, dispersing forces within the canal, and the second determined by direct contact of the instrument with the root canal walls whose friction allows mechanical removal of debris and adhered biofilms, without causing damage, such as the formation of deviations in the root canal path.

Another device available in the market is the XP-Endo Finisher file, indicated for use as final irrigation protocol to improve the effectiveness of root canal disinfection. It is a 0.25 mm diameter cylindrical rotary instrument fabricated with a special NiTi alloy that allows change in shape according to the temperature. At room temperature the file is straight; when subjected to body temperatures it assumes a spoon shape with 1.5 mm depth in the final 10 mm of length. According to the manufacturer, due to its increased flexibility and capacity of expansion to adapt to the root canal three-dimensionally, it allows removal of accumulated hard tissue debris, smear layer and calcium hydroxide paste from the root canal system, without damaging dentin or altering the original root canal shape (9-11).

A finishing file recently introduced in Brazilian market, XP-Clean, has a similar design to XP-Endo Finisher yet without changing in shape according to the temperature variation. The XP-Clean is an asymmetrically shaped file made of nickel titanium alloy with thermal treatment of surface and triangular cross section, its tip is compatible with a file number 25 and taper 0.02. The speed of use recommended by the manufacturer is 800 to 900 rpm with a torque up to 1N, and it should penetrate 1mm below the working length in straight root canal and 2 to 3mm below curved root canals. This instrument is indicated for after the completion of the biomechanical preparation in order to achieve the same mechanisms described for Easy Clean, that is, promoting a swirling of the irrigating

Figure 1. Lower incisor divided into two parts.

solution inside the root canal at the same time that its stem comes into mechanical contact with the internal walls providing a double cleaning action (11).
Thus, this study compared the ability of XP Clean and Easy Clean instruments to remove the calcium hydroxide paste from gaps inside the root canal simulating internal tooth resorption.

Materials and Methods

This study was conducted on 30 single-rooted human lower incisors freshly extracted at the Discipline of Oral and Maxillofacial Surgery of the Dental School of Unipar, Campus Sede, Umuarama, according to the reasons observed during the diagnosis and treatment plan previously elaborated with the assistance of a supervising professor, accepted by the patient, earlier submitted and approved by the Institutional Review Board (CEPEH), Paranaense University, Umuarama Campus, under protocol 99834118.9.0000.0109.
After extraction, the teeth were washed in running water and their surface was scraped in order to remove any type of residue, then they were radiographed in the mesio-distal direction to prove the existence of only one root canal and then they were kept in a flask with formalin until accomplishment of the procedures, which were carried out by a single operator so that there was a standardization in the execution of each step described below.
A perpendicular section was performed through the tooth long axis using stainless steel discs, removing the coronal portion to standardize a 15 mm remnant from the root apex. Next, exploration was performed with Kerr hand files n. 8, 10 and 15 to achieve patency of the apical foramen.
ProTaper rotary files (Dentsply Sirona, Ballaigues, Switzerland) were used for biomechanical preparation, with crosshead and torque defined according to the manufacturer's recommendations. The first instrument of the system, the SX file, had its penetration limit set at 10 mm to restrict its action to the cervical and middle thirds, while the other instruments, from file S1 to F3, were introduced at the standardized working length of 15 mm. Throughout the preparation, irrigation was performed with 2 ml of 1% sodium hypochlorite to remove debris after utilization of each instrument.
After instrumentation, the teeth were inserted into anesthetic tubes with putty silicone (Zetaplus, Zhermack, Badia Polesine, Rovigo, Italy). After setting of the impression material, the roots were removed from the mold and longitudinal grooves were fabricated in the buccal and lingual surfaces using a diamond disc connected to a low-speed adapter coupled to a straight handpiece under copious irrigation with water, avoiding penetration into the root canal. The roots were then separated into two halves using a chisel and hammer (Figure 1).
With the aid of a digital caliper, a mark was made on the middle third of each section at a distance of 7 mm from the most coronal portion of the tooth (Figure 2A), ensuring that the cavity simulating an internal root resorption was fabricated at the same site in both dental segments. The grindings made with a round diamond bur 1014 (KG Sorensen, Cotia, São Paulo, Brasil) had 0.5 mm depth and 1.6 mm diameter (Figure 2B). The two halves of the tooth were reconnected and repositioned in the mold previously made, and a McSpadden condenser (Dentsply Sirona, Ballaigues, Switzerland) adapted to a

Figure 2.
A) Determination of the middle third using a digital pachymeter.
B) Grinding with diamond burs simulating internal root resorption.

handpiece rotating in counterclockwise direction was used to apply a paste containing calcium hydroxide and iodoform, at a 3: 1 ratio, with sufficient saline as vehicle to achieve a pasty mixture. The complete filling of spaces was checked by images obtained by a radiographic sensor (Figure 3).

The specimens were kept in oven at 37 °C and 100% humidity for a period of one week. After this period, the lower incisors were divided into three groups with 10 teeth each and the calcium hydroxide paste was removed by the following protocol:

- Group 1: a 6 ml irrigation cycle with saline was performed using a 25X4 disposable needle calibrated at 15 mm with a duration of 60 seconds.
- Group 2: (Figure 4A) three application cycles were performed using the XP Clean file (MK Life, Porto Alegre, Rio Grande do Sul, Brazil) calibrated at 15 mm in a rotary movement driven by the Elements motor (KerrHawe SA, Bioggio, Switzerland) with a speed of 800 rpm and torque of 1 Ncm with duration of 20 seconds each, followed by irrigation with 2 ml of saline.
- Group 3: (Figure 4B) three application cycles of the Easy Clean file (Easy Equipamentos Odontológicos, Belo Horizonte, Minas Gerais, Brazil) calibrated at 15 mm were performed in reciprocating movements, activated through the Reciproc Direct contra-angle (VDW GmbH, Munich, Germany) coupled to the Elements motor (KerrHawe SA, Bioggio, Switzerland) with a speed of 20,000 rpm and torque of 1 Ncm with an angle of 150º counterclockwise and 30º clockwise for 20 seconds each, followed by irrigation with 2 ml of saline.

In all groups, concomitantly with utilization of the instrument to be tested, a back and forth movement was applied to produce greater turbidity of the irrigant inside the canal, thus enhancing the action of dressing removal.

Immediately after dressing removal, the teeth were removed from the molds and

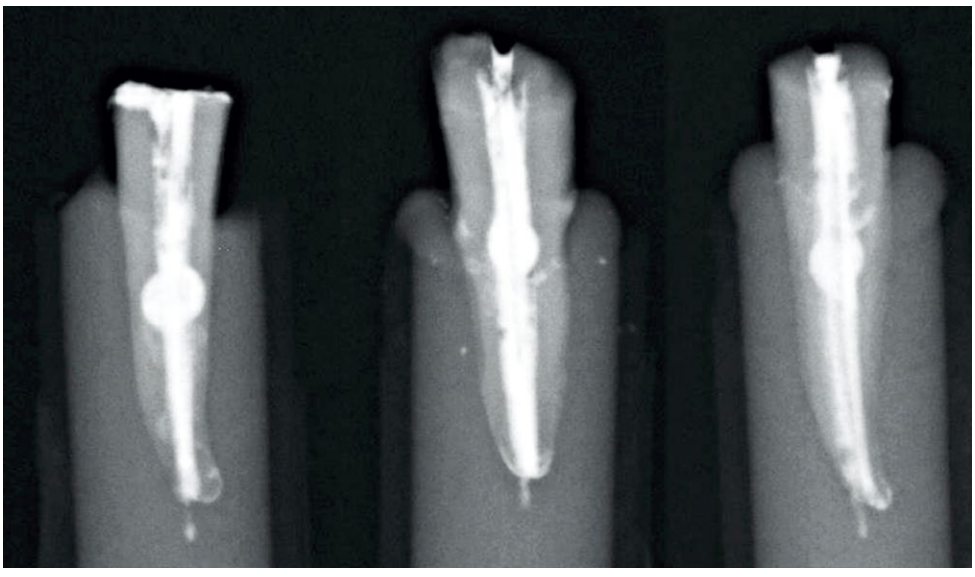

Figure 3.
Digital radiographic images to analyze the filling with calcium hydroxide paste throughout the root canal extent and in the simulated lesion.

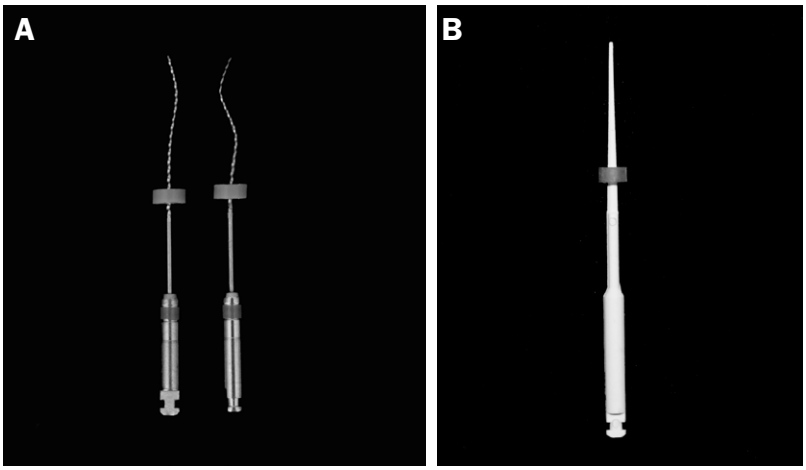

Figure 4.
A) XP Clean files.
B) Easy Clean file.

reopened to observe the simulated internal resorption in a 40x stereoscopic magnifying glass with 40x magnification. Three independent and previously calibrated examiners analyzed each root half and assigned one of the following scores according to the cleanliness of cavities:
-Score 0: indicating no removal of dressing (Figure 5A)
-Score 1: indicating partial removal of calcium hydroxide paste (Figure 5B)
-Score 2: indicating complete removal (Figure 5C)
The most frequent score for each simulated resorption was adopted in case of discrepancy between examiners.

Results

The specimens were analyzed according to the scores assigned by the three examiners. After conventional irrigation with 25x4 mm disposable needles, ten segments presented score 0; eight had score 1 and two segments had score 2. The files XP Clean achieved three segments with score 0; seven segments with score 1 and ten segments with scores 2. The Easy Clean files exhibited nine segments with score 0; ten segments with score 1 and one segment with score 2 (Table 1).
Table 2 presents the comparison of scores between groups. It evidences significant difference in scores between the techniques XP Clean and 25x4 mm needle (p value=0.003) and XP Clean and Easy Clean (p value=0.002), in which the XP Clean achieved higher percentage of score 2 (50.0%), while the techniques Easy Clean and 25x4 mm needle presented higher percentages of score 0 and 1. Also, figure 6 evidences that there was no significant difference in scores between the techniques Easy Clean and 25x4 mm needle (p value=1,000).

Discussion

Internal root resorption is a condition that affects permanent teeth affected by trauma or infections, in which demineralization of the pulp cavity contour produces an irregular anatomy that impairs the achievement of effective root canal cleaning and obturation (3, 10).
Currently, the most appropriate treatment for cases of internal root resorption is the application of a long-term dressing with calcium hydroxide paste after biomechanical preparation. However, complete removal of this paste before root canal filling is an obstacle, since the traditional manner to eliminate it is using a spray of irrigant applied using a syringe and needle (1, 12). This technique provides insufficient dressing

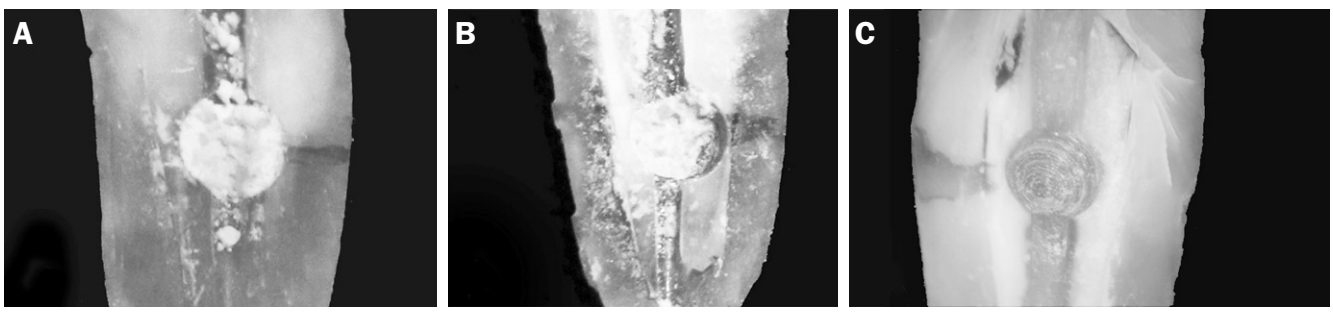

Figure 5.
A) Score 0: without removal of calcium hydroxide.
B) Score 1: partial removal of calcium hydroxide.
C) Score 2: total removal of calcium hydroxide.

Table 1

Scores assigned by the examiners to each segment in the study groups

Side 1	Side 2	Side 1	Side 2	Side 1	Side 2
1	0	2	1	0	0
1	2	2	1	2	1
0	0	2	2	0	0
1	1	2	2	0	0
0	0	1	2	1	1
0	1	2	1	1	1
0	1	0	0	0	0
0	2	1	0	0	1
0	1	2	1	1	1
0	1	2	1	1	1
Disposable needle		XP Clean		Easy Clean	

Table 2

Comparison of scores between groups

Tecnic	Disposable needle		XP Clean		Easy Clean	
	N	%	N	%	N	%
0	10	50,0%	3	15,0%	9	45,0%
1	8	40,0%	7	35,0%	10	50,0%
2	2	10,0%	10	50,0%	1	5,0%

Cochran Armitage Test (p-Value): Disposable needle x XP=0.003; Disposable needle x Easy=1,000; XP x Easy=0.002.

removal from the irregular resorption regions, as demonstrated in the present study by the achievement of higher percentages of scores indicating absence of cleaning, a similar result as that presented by Topçuoğlu, et al. (1), in which the control group presented the lowest removal of calcium hydroxide.

Thus, several instruments and techniques that can promote the activation of the irrigant have been proposed to enhance the removal of calcium hydroxide paste from the root canal system.

One of these systems, introduced in the Brazilian market, is the XP-Clean file, which was designed to perform a similar effect as that presented by the XP-Endo Finisher endodontic file. As there are few studies in the literature regarding the performance of XP-Clean, we evaluate it legitimate to consider the results presented by the XP-Endo Finisher file as a bibliographic reference to support this discussion. Vaz-Garcia et al. (11) compared the roughness and cyclic fatigue of XP-Endo Finisher and XP-Clean, concluding that the XP-Endo Finisher instruments performed better, showing less roughness and greater resistance to cyclic fatigue than XP Clean. Despite this finding, there was no fracture of any of XP Clean files used in this study; however, it was difficult to introduce them into the root canal due to their pre curvature. Lack of standardization between the files used was also observed, in which one had greater curvature than the other, which led to difference in performance between both, and it was possible to obtain greater removal of calcium hydroxide paste using the file with greater curvature.

Notwithstanding, the XP Clean files presented the best results in this study, reaching 50% of scores representing total removal of calcium hydroxide paste and 35% of scores scored as partial removal. Similar result was observed by Ulusoy et al. (10), who observed greater effectiveness of XP-Endo Finisher files compared to ultrasound inserts in removing organic tissues from the simulated internal root resorptions. Donnermeyer et al. (4) obtained significantly better results with the use of sonic and ultrasonic inserts to remove calcium hydroxide paste from grooves made in the apical portion of root canals. Easy Clean is another system available in the national market. In this study, the results obtained showed no difference when compared with conventional irrigation, reaching higher percentage of scores with partial removal (50%) or no elimination (45%). A recent study by Silva et al. (6), observed similar performance between Easy Clean and passive ultrasonic irrigation to remove calcium hydroxide paste inserted in simulated lateral canals in resin blocks, and none was able to completely remove the dressing. Conversely, Prado et al. (7) demonstrated improved cleaning capacity of QMix when using ultrasound inserts and Easy Clean compared to conventional irrigation over the same period. In the same study, the authors tested the effectiveness of Easy Clean file in removing smear layer by shaking the

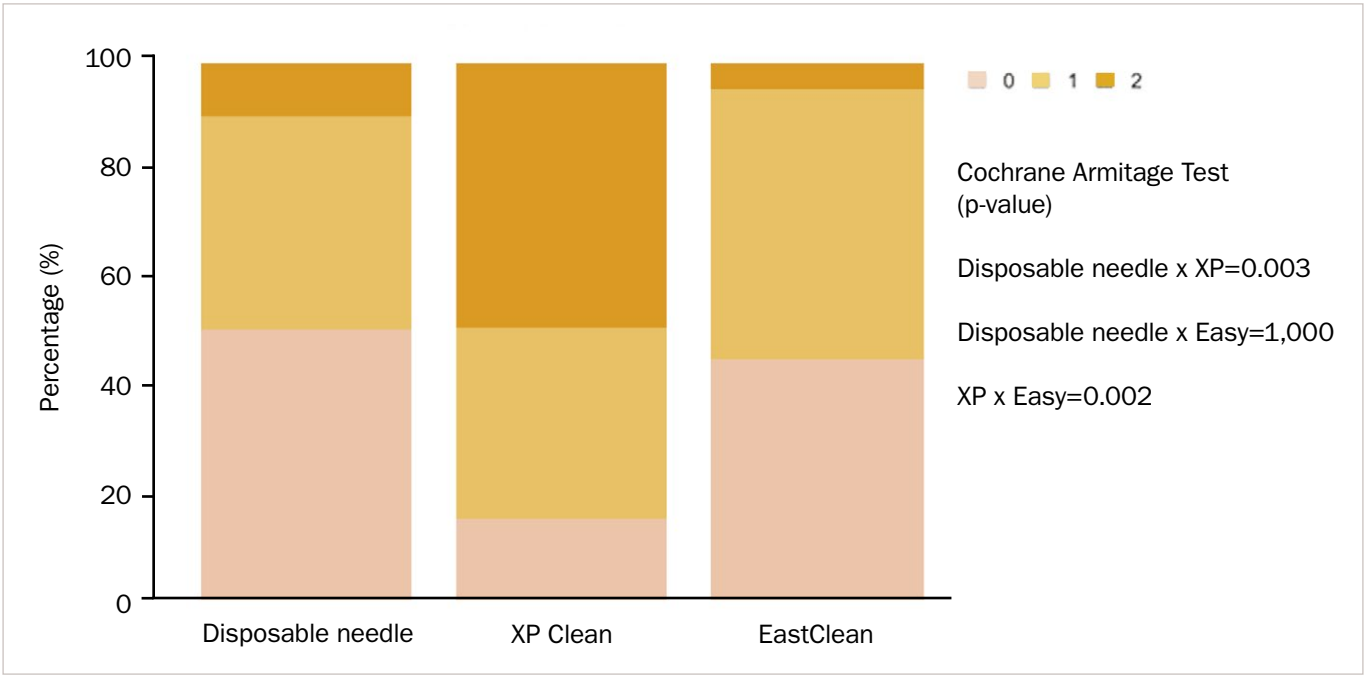

Figure 6.
Table of percentages of instruments employed.

QMix solution in rotational and reciprocating movements, without statistically significant difference between groups. Duque, et al. (13) compared the use of Easy Clean in continuous and reciprocating motion, besides other devices, to verify the effectiveness in removing debris from the root canals and isthmus through scanning electron microscopes obtained after the first, second and third activation of the irrigating solution in cuts made at three different levels, 2, 4 and 6 mm away from the root apex of 50 mesial roots of lower molars. The results showed that the activations of the irrigating solution provided a better cleaning of the canal and isthmus in relation to the conventional irrigation made with a Navitip 30G needle, in addition it was possible to verify that although Easy Clean in continuous rotation had lower percentages of remaining debris, there was no statistically significant difference compared to the use of Easy Clean in reciprocating rotation. Thus, this study used this device in reciprocating motion, as indicated by the manufacturer, and also considering a previous test which revealed that the rotation movement could cause greater instrument deformity.
This study used round diamond burs for preparation of simulated internal root resorption to create uniform and well-characterized cavities, allowing standardization of defects and thus equating the difficulty imposed on instruments to be analyzed (1). A similar approach was adopted regarding definition of the vehicle to be used to manipulate the calcium hydroxide paste, choosing saline to create more obstacle in dressing removal, since the resulting mixture presents drier consistency over time.

Conclusions

Based on the present results, it was concluded that Easy Clean file and conventional irrigation were unable to remove calcium hydroxide paste from simulated internal root resorptions, while XP Clean file showed the best results, evidencing higher capacity in reaching the irregularities fabricated on the root canal walls, with statistically significant difference.

Clinical Relevance

It is important for the dental surgeon to know the result of the comparison of instruments that promote the activation of irrigating solutions such as XP Clean and Easy Clean in order to verify whether they are effectively capable of providing a bet-

ter cleaning of the root canal, allowing a more efficient removal satisfactory use of the calcium hydroxide paste used during the treatment of internal tooth resorption, especially close to the areas excavated in the dentin.

Conflict of Interest

The authors declare that there is no conflict of interest.

Acknowlegments

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References

1. *Topçuoğlu HS, Düzgün S, Ceyhanli KT, et al. Efficacy of different irrigation techniques in the removal of calcium hydroxide from a simulated internal root resorption cavity. Int Endod J. 2015; 48:309-16.*
2. *Arslan H, Akcay M, Capar ID, et al. An in vitro comparison of irrigation using photon-initiated photoacoustic streaming, ultrasonic, sonic and needle techniques in removing calcium hydroxide. Int Endod J. 2015; 48:246-51.*
3. *Küçükkaya Eren SK, Aksel H, Parashos P. A novel model for testing the efficiency of removal of calcium hydroxide from complex root canal anatomies. Aust Endod J. 2017; 43:5-10.*
4. *Lambrianidis T, Kosti E, Boutsioukis C, Mazinis M. Removal efficacy of various calcium hydroxide/chlorhexidine medicaments from the root canal. Int Endod J. 2006; 39:55-61.*
5. *Silva RM, Rezende GS, Lino IG, et al. Avaliação da eficiência de diferentes protocolos de irrigação na remoção de pasta de hidróxido de cálcio em canais laterais simulados. Revista Faipe, 2018; 8:1-10.*
6. *Donnermeyer D, Wyrsch H, Bürklein S, Schäfer E. Removal of calcium hydroxide from artificial grooves in straight root canals: Sonic activation using EDDY versus passive ultrasonic irrigation and XP Endo Finisher. J Endod. 2019; 45:322-6.*
7. *Prado MC, Leal F, Simão RA, et al. Effectiveness of a plastic endodontic file to remove smear layer in rotary or reciprocating motion. Int J of Clin Dent. 2017; 3:143-151.*
8. *Prado MC, Leal F, Simão RA, et al. The use of auxiliary devices during irrigation to increase the cleaning ability of a chelating agent. Restor Dent Endod. 2017; 42:105-10.*
9. *Keskin C, Sariyilmaz E, Sariyilmaz Ö. Efficacy of XP-endo Finisher file in removing calcium hydroxide from simulated internal resorption cavity. J Endod. 2017; 43:126-130.*
10. *Ulusoy Öi, Savur Ig, Alaçam T, Çelik B. The effectiveness of various irrigation protocols on organic tissue removal from simulated internal resorption defects. Int Endod J2018; 51:1030-6.*
11. *Vaz-Garcia ES, Vieira VTL, Petitet NPSF, et al. Mechanical properties of anatomic finishing files: XP Endo Finisher and XP-Clean. Braz Dent J. 2018; 29:208-13.*
12. *Kfir A, Blau-Venezia N, Goldberger T, et al. Efficacy of self-adjusting file, XP-endo finisher and passive ultrasonic irrigation on the removal of calcium hydroxide paste from an artificial standardized groove. Aust Endod J. 2018; 44:26-31.*
13. *Duque JA, Duarte MAH, Canali LCF, et al. Comparative effectiveness of new mechanical irrigant agitating devices for debris removal from the canal and isthmus of mesial roots of mandibular molars. J Endod. 2017; 43:326-31.*