Review removal of gutta-percha with hand files, xylol and Reciproc

Mariel Beatriz Galiana[1], Graciela Mónica Gualdoni[2], Carlos Lugo de Langhe[3], Natalia Belén Montiel[4], Alina Pelaez[5]

DOI: 10.22592/ode2018n32a3

Abstract

Nonsurgical endodontic treatment is the first choice in case of endodontic failure. The first step of retreatment is root canal opening, which will enable the biomechanical preparation of the root canal with proper irrigation and disinfection. The obturation removal protocol includes manual files, solvents and Reciproc, a single-use reciprocating file. This review of the scientific literature addresses the specific characteristics of manufacture, kinematics and function of the instruments and chemical products used in this protocol. We found that the choice of manual files, xylol and Reciproc would allow for a simple, safe and effective opening of the root canal.

Keywords: obturation removal, gutta-percha, xylol, Reciproc.

1 School of Dentistry, Universidad Nacional del Nordeste, Corrientes, Argentina. ORCID: 00000002-2715-8524
2 School of Dentistry, Universidad Nacional del Nordeste, Corrientes, Argentina. ORCID: 00000001-8971-9588
3 School of Dentistry, Universidad Nacional del Nordeste, Corrientes, Argentina. ORCID: 00000003-4926-4456
4 School of Dentistry, Universidad Nacional del Nordeste, Corrientes, Argentina. ORCID: 00000003-3740-9726
5 School of Dentistry, Universidad Nacional del Nordeste, Corrientes, Argentina. ORCID: 0000-0002-2715-8524

Introduction

The system of root canals has a complex anatomy that must be chemically and mechanically prepared before obturation. Endodontic pathologies include inflammatory and infectious processes associated with bacteria, fungi and viruses, as well as a percentage of post-operative endodontic failures [1-3]. During endodontic treatment, various clinical factors influence the success or failure of endodontic therapy [4-5].

Endodontic failure is the clinical situation that fails to restore normal tooth function, as determined by signs and symptoms, although there may not be radiographic signs of rarefaction [6-7]. Endodontic failure occurs primarily due to infectious causes and procedural errors, where the technical and clinical biomechanical preparation protocols have not been followed [8-9]. In a primary endodontic infection, strict anaerobes are the prevailing bacteria. In endodontic failures, we find between one and six species, where facultative anaerobes prevail, such as *Enterococcus faecalis (EF)*, responsible for 80 to 90% of these failures [9-10]. However, the current trend is to minimize the importance of *EF* and to emphasize that it is part of biofilm, which is one of the most significant mechanisms to evade the host's defense system [9]. According to Jhajharia et al., biofilm is a set of cells and microcolonies included in a matrix of exopolysaccharides, with channels that carry substrates, waste products and molecules [11]. Biofilm must be removed to control the infection [12].

Retreatment is a nonsurgical therapeutic option for an endodontic failure [13-14]. *Nonsurgical endodontic retreatment is performed to remove material from the root canal space in order to correct deficiencies or repair pathological or iatrogenic defects, followed by cleaning, shaping and three-dimensional obturation* [6,9,15].

When removing filling material, dentin debris, microorganisms, microorganisms or irrigation solution by-products may be extruded from the root canal area to the periradicular tissues, causing an inflammatory reaction known as *flare-up* [16-17]. This reaction causes postoperative pain and edema and delays periapical healing. Therefore, the instrumental or system used must cause the least periapical extrusion possible. The success rate of endodontically treated teeth ranges between 62% and 96%. However, this percentage is lower for retreatments [18]. Nonsurgical endodontic retreatment is necessary when microbial infection persists for initial treatments with deficient preparation, untreated canals, underfilling, crown filtration due to lack of marginal seal, deficient irrigation protocols, altered biosafety circuits, among other causes [13-14].

Gutta-percha (GP) has been used in endodontic therapy as filling material for over 100 years and remains the material of choice today [13]. Gutta-percha is biocompatible and has dimensional stability; its properties have made it the gold standard of endodontic fillings. However, its removal is not always satisfactory, which causes operational difficulties and biological problems [11,19-20]. Several studies have reported that gutta-percha is not fully removed from root canals regardless of the type of instrument used (manual, rotary, alternating), and the use or non-use of solvents and additional technologies like dental microscope and ultrasonic tips [15,19-20]. The procedures to remove gutta-percha require additional mechanical preparation and therefore could modify the anatomy of the root canal [21]. The methodology to be used in retreatment should focus on the anatomical differences of the complex system of root canals, with isthmus, angles and marked radius of curvature, which may lead to operation accidents, such as perforation, deviations, steps, instrument fracture; this would compromise the tooth's chemical-mechanical preparation and prognosis [12,21].

Therefore, considering these variabilities, the methodology must be selected according to the clinical case, the technique and instruments that will allow us to remove the restorative material without causing unnecessary wear on the tooth. The use of manual, rotary or alternating systems is usually preceded by softening the filling material with different solvents or heat [22]. All retreatments leave gutta-percha and sealant debris on the root canals after re-instrumentation. Although it is not possible to fully remove the filling material, it is necessary to remove as much debris as possible to help clean and disinfect the root canal [17]. The aim of this review is to report a series of in vitro studies of nonsurgical retreatment with manual files, xylol and Reciproc, with a focus on current concepts and the importance of the right diagnosis and treatment.

Method

The literature search was conducted from March to May of 2017 in the databases EBSCO Host (Dentistry & Oral Sciences Source) Medline, SCIELO. The inclusion criteria considered papers published in the 2009-2017 period, in peer-reviewed and full-text journals, in English, Spanish, and Portuguese, which included issues related to retreatment in terms of root canal obturation removal in vivo and in vitro.

We selected the papers that include the following topics: filling removal techniques, comparison of Reciproc and manual files, xylol solvents. The papers selected were filtered using the following keywords: endodontic retreatment, root canal obturation removal, Reciproc, manual files, gutta-percha solvents, xylol. Out of 115 academic publications, we selected 50 papers as relevant to the topic.

Development

Retreatment is very important within endodontics, and root canal obturation removal is an essential first step. In a study conducted by Nagi et al. [23] in 2014, surveys were distributed among dentists to determine the protocols followed in cases of retreatment. The results showed that only 45% of them used rotary instruments and only 15% used some kind of solvent. There were no unanimous criteria regarding the diagnostic causes in decision-making in an endodontic retreatment to determine the necessary indication and methodology. The causes listed for root canal obturation removal included lack of coronal seal, extrusion of the filling material, canal not located, underfilled canal, fractured instruments. As for removal methodology, the instruments chosen were: Gates Glidden (GG) burs, ultrasound, manual files, rotary instruments, System B, touch and heat [23]. Some clinicians use solvents to soften the gutta-percha before using rotary or manual instruments. However, it is well known that all solvents are toxic to periapical tissues and should be used with caution [22]. The literature includes numerous studies on removing gutta-percha; however, there is no standardized universal protocol for this operation [23]. Some of the solvents used in endodontic obturation removal: xylol, xylene or dimethylbenzene, $C_6H_4(CH_3)_{2,\ \text{which is}}$ a benzene derivative. Its main property is that it helps soften the material inside the canal by dissolution. It is used in total obturation removals, acting only in the middle and cervical thirds of the canal. Solvents are generally toxic and irritating to periapical tissues. Xylol dissolves slowly, allowing for the controlled removal of gutta-percha [13]. Therefore, it is recommended to use a single drop to avoid harming the patient [17,24]. Xylol softens the guttapercha and decreases the potential resistance of the material to its removal [22,25].

The use of solvents decreases the application of excessive force, operation accidents (such as root perforation, straightening of root canals or modification of the original shape of the root canal). Additionally, it reduces working time and facilitates the insertion of instruments, making this stage of the surgery safer [19,22, 26]. Although Xylol was the most effective solution when removing filling material used jointly with rotary or oscillating instruments, most dentists do not use solvents due to their toxic action [27]. In a study conducted by Caetano et al. [25], xylol effectively removed the filling material compared to other solvents and used jointly with passive ultrasonic irrigation (PUI). After using mechanized instruments, it improves the removal of filling materials in anatomically complex teeth.

The risks of obturation removal increase with curved canals, which usually occur in molars. This entails a high level of difficulty and a time-consuming removal process [6]. Therefore, advances in endodontics and the emergence of new systems could be an excellent additional resource for a fast, safe and effective retreatment [11]. Ramos et al. [28] showed that solvents had greater dissolution power in the first five minutes of action and that the xylol used as control group showed greater dissolution power when removing gutta-percha cones compared to other solvents

Using manual files in an obturation removal protocol is justified as there is a decrease in the resistance the gutta-percha may offer to rotary instruments. Studies show that manual files remove gutta-percha mass more efficiently and reduce the number of operation accidents [29]. The use of Hedstrom files after softening the gutta-percha prepares the ground for the use of rotary instruments; in the cervical third. Studies have shown that Hedstrom files are slower in removing the filling, but they achieve better cleaning of the root canal [29]. Adventure et al. [30] determined that removal times are reduced when manual files are combined with the use of xylol. Other studies have shown different results regarding the effectiveness of H files for removal compared with rotary systems [31].

K and H files were more effective in removing the gutta-percha compared with ProTaper and REndo in curved channels. However, Khalilac et al. [32] found no significant differences between rotary and manual instruments for removal procedures .

The advent of alternating systems with a single instrument has simplified retreatment and decreased the time needed: removal with reciprocating instruments is faster, thus reducing the stress of the patient and the operator [17,19,33].

The reciprocating, alternating or oscillatory movement, represented by Reciproc (VDW, Munich, Germany) is a system with a single-use single file [34]. The axial and reciprocating movement appears in 1928 with a contra-angle with reciprocating movement presented in Austria. The axial alternative movement dates back to 1958 with Racer, and rotational reciprocity with Giromatic by Micromega in France. Since that time, there have been numerous systems to achieve the reciprocity motion, with some doubts and concerns [35-36]. In 1985, Roane et al. [37] presented the technique with balanced instruments used in rotational reciprocity for curved canals. They were the first to use the clockwise - counterclockwise system with unequal degree of rotation in both directions. The canal's curvature is one of the factors that interferes with the appropriate preparation of the root canal.

With this new technique and numerous reports that showed good results when preparing narrow and curved canals, handheld instruments using rotation or reciprocity movements are presented in the United States: M4 by Sybron Endo, Endo-Eze by Ultradent Products, and Endo-Express Essential

by Dental System. In 2008, Yared introduced an ATR engine (ATR, Pistoia, Italy) to power ProTaper F2 (Tulsa Dentsply, Tulsa), and an ISO manual instrument size 08. He stated that it was possible to completely shape and clean the root canals with these two instruments: the F2 clockwise (CW) and counterclockwise (CCW). As clockwise rotation is greater than counterclockwise rotation, the instrument can enter apically. However, this instrument tended to break because of cyclic stress, and it was necessary to seal the canal before applying the technique. However, it opened up a promising path for reciprocating motion [17,35,38-39].

In 2010, Denstplay launches the VDW Reciproc System (VDW, Munich, Germany) and two files operated with oscillatory movements like Reciproc and Wave appear, thus revolutionizing the endodontics industry based on the concepts developed by Roane and Yared [35,38-39]. Reciproc appears as a retreatment option because of its specific characteristics and the scientific evidence that supports it. It includes nickel-titanium instruments with M-Wire alloy, which are more resistant to cyclic fatigue, torsional fatigue, have greater flexibility, and lower extrusion of debris than conventional alloys and continuous systems. It has a more effective performance than other reciprocating systems like WaveOne while maintaining the centrality of the root canal [13,17,39-41].

One of the main advantages of reciprocating systems compared to other systems is the greater resistance to cyclic and torsional fatigue [12,20,42,43]. One of the causes of fractures is cyclic fatigue, which is induced by alternate cycles of tension and compression on the alloy. This happens in the area of greatest curvature of the root canal, when there is a turn. It takes place in three phases: first stage with cracks; second stage with propagation of these cracks and microcracks; third stage, an overload area that ends with material breakage [20].

Endodontic instruments can also fracture by torsion, when the tip of the instrument locks on the canal, and the instrument keeps turning and exceeds the elasticity limit characteristic of the alloy, it is deformed and then the instrument fractures [12,20,42,43].

The main advantage is that working time is four times lower than with traditional NiTi systems. Reciproc (VDW, Munich, Germany) has three single-use files: R25 (25 / .08), R40 (40 / .06) and R50 (50 / .05) 5. The R25 instrument has a 8% taper on the first 3 mm, which is reduced to 4.3%; the R40 has a 6% taper on the first 3 mm, reduced to 4% at the end of the instrument. R50 has a reduced 5% taper on the first 3 mm, which is reduced slightly to 4%. These instruments manufactured with M-Wire alloy receive surface thermal treatment applied to the nickel-titanium alloy (M-Wire alloys, 56% Ni and 44% Ti), which makes the instrument more flexible [12]. They have an S-shaped section, two cutting blades and a continuous taper in the first 3 mm on the file, followed by a decline in the taper [17,38,41]. The instruments are used with a lateral brushing motion against the canal walls to remove residual material [15,42]. They work with reciprocal motion with a 150° clockwise rotation and a movement shorter than 30° clockwise. The alternating motion reduces the stress on the instrument and has a cutting and release action [38,51]. However, in the alternating motion, the angles of the alternate left and right rotations are significantly lower than the angles at which a Reciproc instrument fractures [45]. According to studies, Reciproc has less apical extrusion than manual files. These instruments are centered in the root canal and create a greater area of contact between instruments and the gutta-percha, allowing for better removal [35,45]. It is important to preserve the safety of the procedure. The reciprocating system

presents a lateral asymmetric oscillatory motion that does not exceed the elastic limit of the files used, decreasing the risk of fracture by following the dynamics of balanced forces and maintaining the root canal focused by decreasing the percentage of apical transportation [35]. The benefits of the reciprocating system are shorter working time and faster process of learning the technique, simplicity as a single instrument is used the procedure has fewer steps. One movement is counterclockwise as it interlocks and cuts the dentin, and the other is clockwise and decouples the dentin. This movement relieves stress on the instrument and increases resistance to cyclic and torsional fatigue [12].

The kinematics is as follows: introduce the instrument in the canal with pecking motion, which must not exceed 3 mm; after three movements, the instrument is removed and cleaned. According to the manufacturers, the use of Reciproc does not entail prior preparation of the root canal with manual files, though this was done in some experimental works [35,38]. De Deus et al. showed that it was possible to prepare 80% of the moderate to severely curved canals without a manual instrument. Additionally, in 67% of cases, Reciproc could enter the narrow canals which a K N°10 file cannot enter [35].

De Deus et al. [42] determined that the number of cycles until the fracture of the instrument, distinguishing between continuous and alternating rotation, is on average 160 cycles at 250 rpm and 120 cycles at 400 rpm in the rotary system. According to its kinematics, the instrument rotates clockwise and counterclockwise in the opposite direction with a difference of 120º between the two movements. Every three cycles, the instrument fully rotates. In this way, there are 10 alternating motion cycles every second, equivalent to 300 rpm. The end result is that the instrument moves apically, applying light pressure. This is one of the reasons for the reduced cyclic fatigue and reduced working time with alternating motion [46].

Reciproc is effective in narrow and curved root canals, with calcifications and retreatment, given its flexibility because of the M-wire alloy, cutting action, cross-sectional design of instruments in the shape of an S, resistance to bending and cyclic fatigue. This allows the operator to reduce the strength of instrumentation, the number of accidents, and to promote patient cooperation, with the advantage of using a single instrument to shape the entire canal [38-39]. It was faster than other systems when removing filling from root canals. Besides extending the instrument's service life, it allows practitioners to move apically, with unequal movements and cutting and release action [38].

We have not found a standardized obturation removal protocol in the literature; the options in terms of systems, instruments, chemicals and techniques are numerous and varied [23]. Decisionmaking for obturation removal from the root canal is essential as it will determine the effective resolution of the endodontic retreatment. The dentist and the specialist in endodontics should be able to choose the methodology, the instruments, and the solvents according to the physical and chemical properties included in the literature as scientific evidence. We suggest applying the following methodology for removal as we consider it safe, fast and effective.

Discussion

Within endodontics, retreatment includes the anatomy of the root canal, its physiology, signs and symptoms, the prevailing microbiology in this particular ecological environment, the diagnosis that will allow for the right indication, the professional's expertise, the instruments, solvents, and methodology to apply. If each of these steps is selected appropriately, the evolution and success of the

new treatment will be enhanced [18,47]. In a comparative study with other solvents, Ferreira [48] concluded that xylol was the most effective solvent for gutta-percha cones, followed by orange oil and eucalyptol oil. Jointly with Hedstrom files, it facilitates the insertion of the instrument and paves the way for the rotary instrument selected. This is consistent with the results of Rodig et al., who in 2012 also found that Hedstrom files are effective in curved canals [34].

Reciproc is an alternating system that is a possible choice for endodontic retreatment given its specific characteristics: cross-section, resistance to cyclic and torsional fatigue, decrease in debris extrusion, conservation of root canal shape, centralized action within the canal [20,46]. Furthermore, another study concluded that mechanized systems cannot replace manual instrumentation, and that in comparison to other systems, it was not associated with iatrogenic errors [47]. Gomes et al. [40] evaluated the effectiveness and the duration of obturation removal from a root canal with ProTaper and Reciproc with Passive Ultrasonic Irrigation (PUI), which was conducted with sodium hypochlorite for one minute. There were no significant differences regarding the obturation removal percentage from the root canal. Gutta-percha remains were evaluated and quantified with scanning electron microscopy. Removal duration was lower in the group with Reciproc and PUI. Additionally, Marfici et al. [49] compared the effectiveness of Reciproc (VDW GmbH) and ProFile (Dentsply Maillefer) in removing gutta-percha from straight and curved root canals in vitro, which were filled through cold lateral compaction and GuttaMaster. Neither of the two systems completely removed the filling material from the root canals. The experimental studies that prove this lack of removal power are in vitro studies that use photographs, microcomputed tomography, etc. [35,50]. Other studies showed superior mechanical properties compared to a sequence NiTi rotary system, and it is more effective than rotary files when removing filling materials in straight canals [15,34].

In a clinical case reported by Bartols [38], the filling in a tooth was successfully removed with Reciproc 25: there were positive results clinically and radiographically. In turn, Gupta [45] has related two clinical cases where he removes canal filling with Reciproc R25, inserting 2/3 of the length of the tooth and irrigating with 5.25% sodium hypochlorite. Gupta uses eucalyptol as a solvent and enters the coronal third with heat. In a clinical evaluation, Chen et al [51-52] evaluated Reciproc in one of the groups. The average removal time was lower in this group in comparison with other systems. They also stressed that it could preserve the curvature of the canals.

There is ample scientific evidence regarding removal time. It is stated that Reciproc is indeed faster compared with other reciprocating and continuous systems according to several studies [15,17,34], as opposed to Silva et al., who found that WaveOne achieves the shortest working time [16]. In another study, Reciproc R50 file was considered effective to remove the root canal filling and was the quickest method compared with manual techniques [15].

Furthermore, other recent studies have shown that alternating instruments reduce obturation removal time efficiently and that Reciproc and WaveOne removed 93 % and 94% of the filling material in curved canals [53]. In contrast to the studies mentioned, other reports showed no significant differences between reciprocating instruments and ProTaper Universal retreatment instruments [34,41]. This is consistent with Ramazanni [39], whose results show that Reciproc required the shortest time to prepare the root canal on average due to its alternating movement, and that there was no significant difference between Reciproc and K manual files [39].

Another factor to analyze is Reciproc's resistance to fracture because of cyclic or torsional fatigue. Numerous studies show that Reciproc was more resistant compared to other continuous and alternating systems. The difference, grouped as per mean time of fracture, was longer for the Reciproc system compared to WaveOne by 45.6 seconds [14]. Other studies also found that Reciproc had better resistance to flexural fatigue because of its cross section, to the angles and speed of reciprocation [35]. The fracture could result from flexural or torsional fatigue. Several studies support the resistance of Reciproc [14,17,42-43,45] and agree it has greater cyclic fatigue. Contrary to the results obtained by Ozyurek et al. [14], they compared the resistance to cyclic fatigue of WaveOne, WaveOne Gold and Reciproc, and concluded that WaveOne Gold showed greater resistance to cyclic fatigue. In a study conducted by Topcuoglu et al. [54] Reciproc presented greater resistance to cyclic fatigue than WaveOne in apical curvatures, but not in the cervical third. Pedulla, in his study [55] on the cyclic fatigue resistance of the new Hyflex OneFile, concluded that it was significantly more resistant than Reciproc and WaveOne, and that there were no significant differences between Reciproc and WaveOne.

As for torsional resistance, relevant studies have determined that reciprocating files have better resistance, while others conclude that there were no significant differences between Reciproc and WaveOne [14,17,45]. In this clinical case we irrigated the root canal with 5.25% sodium hypochlorite. In this review we have found several studies that tested the effect of sodium hypochlorite on the resistance to cyclic fatigue and fracture in relation to sodium hypochlorite used to irrigate in most endodontic treatments. Resistance to cyclic fatigue was not affected by immersion in NaOC, and Reciproc showed greater resistance to cyclic fatigue and to fracture compared with other alternating systems after immersion in sodium hypochlorite, which unlike in this work, had a 1% concentration [14,17,55].

According to scientific evidence, in most in vitro procedures, obturation cannot be fully removed from root canals and there always remains some filling material regardless of the technique chosen. This has been studied by Ríos et al. [41], who evaluated the effectiveness of two Reciproc alternating systems—VDW, Munich, Germany—and WaveOne—Dentsply Maillefer, Ballaigues, Switzerland—compared with a nickel-titanium rotating system created specifically for root canal obturation removal: (NiTi) ProTaper Universal, Retreatment—Dentsply Maillefer. No statistically significant difference was found between the groups. This is consistent with Martins et al. [50], who evaluated the effectiveness of ProTaper Next (Dentsply Maillefer, Ballaigues, Switzerland) and Reciproc (VDW, Munich, Germany) in removing root canal filling material with sonic or ultrasonic irrigation as additional cleaning methods. All the teeth were analyzed using micro-computed tomography; none of the retreatments fully removes it and there were no significant differences between the groups.

Regarding preservation and preparation of curved canals, De-Deus et al. [42] showed Reciproc could be used to prepare canals with moderate or severe curves in 80% of cases without prior insertion, and also that these instruments could reach the full length in 67% of cases, where a K file N° 10 could not be inserted . This is consistent with the manufacturer's instructions for the minimal preparation of the root canal before using rotary material. Yared agreed with the manufacturer's instructions in the preparation of the root canal before using the material, while other studies on the modification of the shape of the curved canals [52] found no significant differences between Reciproc and other sys-

tems, thus being consistent with this study. Regarding apical extrusion, studies concluded that Reciproc caused minor apical extrusion compared with WaveOne, while De-Deus states that no significant differences were found in the debris extruded apically, having tested both reciprocating systems [14,42]. Silva et al. [17], in an in vitro study of 60 lower premolars, tested these three systems: ProTaper Universal, ProTaper System Next, Reciproc and WaveOne; ProTaper Universal generates more apical debris. The other groups showed no statistically significant differences. The reciprocating systems extruded less material that rotary systems. In contrast to previous studies, in vitro experimental studies used, as samples, lower premolars treated with Reciproc and different SAF (Self Adjusting File) systems, ProTaper Universal and One Shape. WaveOne and One Shape agreed that Reciproc produced more extruded debris apically [17]. The least apically extruded remains were produced with alternating systems (Reciproc R40 and WaveOne) and not with retreatment systems (ProTaper Universal). Reciproc was associated with less debris extrusion in comparison with the NiTi continuous rotary instruments (ProTaper Universal Retreatment and Mtwo Retreatment systems) and manual files [11].

Conclusions

The lack of a standardized protocol for obturation removal from root canals has justified this literature review. The first step to achieve success in retreatment is the appropriate removal of the filling from the canal, while preserving its shape, without displacing the apical foramen, with lower removal of apical debris, and shorter working time. This is essential to reduce the stress of both the operator and the patient. This is done to achieve adequate disinfection, reduce the possibility of iatrogenic procedures, selecting for this study the inclusion of manual files, solvents and Reciproc in the obturation removal protocol. As most of the studies have been conducted in vitro, it is difficult to extrapolate them to clinical practice, so further studies are necessary. The use of this protocol, endorsed by the current scientific evidence, in the clinical case hereby presented allowed for quick, safe and efficient removal. Therefore, we recommended its implementation as a simple protocol to be used in endodontic retreatments.

References

1. Chércoles-Ruiz A, Sánchez-Torres A, Gay Escoda C. Endodontic Retreatment, and Apical Surgery Versus Tooth Extraction and Implant Placement: A Systematic Review. J Endod. 2017; 43 (5): 679-686
2. Leonardo M. Endodoncia. Tratamiento de Conductos Radiculares. Principios técnicos y biológicos. Edit. Artes Médicas Ltda. 2009; 12: 9
3. Marroquín Peñaloza T, García Guerrero C. Guidelines for clinical diagnosis of pulp and periapical pathologies. Rev Fac Odontol Univ Antioq. 2015; 26 (2): 398-424.
4. Labrada M, Maya Cerón C. Influencia de la calidad de restauración coronal en el pronóstico de dientes tratados endodónticamente. Rev Cub de Estomatología. 2015; 52 (1): 47-62.
5. Rios M de A, Villela AM, Cunha RS, Velasco RC, De Martin AS, Kato AS, Bueno CE. Efficacy of 2 reciprocating systems compared with a rotary retreatment system for gutta-percha removal. J Endod. 2014; 40 (4): 543-6.
6. Klimentova Pipérkova T, Barzuna Ulloa M. Eliminación de interferencias intraconducto con su respectivo retratamiento: caso clínico. Rev Odon Vital. 2 (17): 49-58.
7. Meneses Guzmán J. Presencia de itsmos y su relación con el fracaso endodóntico: Literature review. Revi Odon Vit. 2011; 2 (15): 20-23.

8. Ensinas P, Cornejo N, Manguera. Análisis de la limpieza de las paredes dentinarias del conducto radicular y el tiempo de desobturación utilizando dos técnicas diferentes de retratamiento endodóntico. Rev Canal Abierto SECH. 2009; 19: 10-16.
9. Siqueira J, Rôças I. Present status and future directions in endodontic microbiology. Endodontic Topics. 2014; 30(1): 3-22.
10. Batra M, Bal C, Devi P, Kaur K. Role of intraradicular and periradicular microflora in endodontic failure cases, requiring endodontic retreatment in-vivo study. IJCDC. 2014; 4(2): 428-433.
11. Jhajharia K, Parolia A, Vikram Shetty K, Mehta L. Biofilm in endodontics: A review. J Int Soc Prevent Communit Dent. 2015; 5 (1): 1-12.
12. Alsilani R, Jadu F, Bogari D, Jan A, Alhazzazi T. Single file reciprocating systems: A systematic review and meta-analysis of the literature: Comparison of reciproc and WaveOne. J Int Soc Prevent Communit Dent. 2016; 6 (5): 402-409.
13. Mushtaq M, Farooq R, Ibrahim M, Khan FY. Dissolving efficacy of different organic solvents on gutta-percha and resilon root canal obturating materials at different immersion time intervals. J Conserv Dent. 2011; 15 (2): 141-145.
14. Altunbas D,Kütük b,Toyoglu G,Kustarci A, Er K. Reciproc versus Twisted file for root canal filling removal: assessment of apically extruded debris. J Istanb Univ Fac Dent. 2016; 50 (2): 31-37.
15. Zuolo AS, Mello JE Jr, Cunha RS, Zuolo ML, Bueno CES. Efficacy of reciprocating and rotary techniques for removing filling material during root canal retreatment. Int Endod J. 2013; 46 (10): 947-953.
16. Silva EJ, Carapiá MF, Lopes RM, Belladonna FG, Senna PM, Souza EM, De-Deus G. Comparison of apically extruded debris after large apical preparations by full-sequence rotary and single-file reciprocating systems. Int Endod J. 2016; 49 (7): 700-705.
17. de Sousa B, Tomás Cantilho, Castelo R. Uso dos sistemas reciprocantes Reciproc e Wave One In Endodontia: revisão de literatura. Dent. Press Endod. 2017, 7 (1): 50-59.
18. Cavenago BC, Ordinola-Zapata R, Duarte MAH, del Carpio-Perochena AE, Villas-Bôas MH, Marciano MA, Bramante CM, Moraes IG. Efficacy of xylene and passive ultrasonic irrigation on remaining root filling material during retreatment of anatomically complex teeth. Int Endod J. 2014; 47, 1078–1083
19. Zannettini P, Barletta F, de Mello Radhe N. In vitro comparison off different reciprocating systems used during endodontic retreatment. Aust Endod J. 2008; 34(3):80-85.
20. Soares C, Maia C, Vale F, Gade-Neto C, Carvalho L, Carvalho R, Oliveira H. Comparison of Endodontic Retreatment in the Teeth Obturated With Resilon or Gutta-Percha: A Review of Literature. Iran Endod J. 2015; 10 (4): 221-225.
21. Üstün Y, Topçuoğlu HS, Düzgün S, Kesim B. The effect of reciprocation versus rotational movement on the incidence of root defects during retreatment procedures. Int Endod J. 2016; 48 (10): 952-958.
22. Kaled G, Faria M, Heck A, de Aragao E, Morais S, de Souza R. Retratamiento endodóntico: análise comparativa da efetividade de remoção da obturação dos canais radiculares realizada por três métodos. RGO: Rev Gaucha Odontol. 2011; 59 (1): 103-108.
23. Nagi S, Khan F, Rahman M. Endodontic Retreatment. Pak Oral Dental J. 2014, 34(4): 722-725.
24. Aguirre Rodríguez, Magaly Janeth. Técnicas químico mecánicas con la utilización de xilol en un retratamiento endodóntico. Dissertation. Universidad de Guayaquil. Ecuador, 2014. In: http://repositorio.ug.edu.ec/handle/redug/5424#sthash.kOIp8slO.dpuf
25. Caetano C, do Prado M, de Almeida Gomes B, Rolim de Sousa E. Effectiveness of 2% chlorhexidine gel compared to two solvents commonly used in endodontic retreatment. Dent. Press Endod. 2012; 2 (4): 15-19.
26. Azar M, Khojastehpour L, Iranpour N. A Comparison of the Effectiveness of Chloroform in Dissolving Resilon and Gutta-Percha. J Dent (Tehran). 2011; 8(1):19-24.
27. Guedes O, Chaves G, Alencar A, Borges Á. Effect of gutta-percha solvents on fiberglass post bond strength to root canal dentin. J Oral Sci. 2014; 56 (2): 105-112.

28. Ramos TIF, Câmara AC, Aguiar CM. Evaluation of Capacity of Essential Oils in Dissolving ProTaper Universal Gutta-Percha points. Acta Stomatol Croat. 2016; 50 (2): 128-133.
29. Patil S, Kidiyoor KH, Naik-Balaram D, Sawagave S, Shivanand S, Jituri, Sandeep R, Shetty D. Efficacy of Pro-taper Universal Rotary Re-treatment System, H-file and K-flex File in Gutta-Percha Removal from Root Canal: A Comparative In-Vitro Study. J Int Oral Health. 2016; 8 (1): 123-128.
30. Colaco A, Pai V. Comparative Evaluation of the Efficiency of Manual and Rotary Gutta-percha Removal Techniques. J Endod. 2015; 41 (11): 1871-1874.
31. Ünal G, Kaya B, Taç A, Keçeci A. A comparison of the efficacy of conventional and new retreatment instruments to remove gutta-percha in curved root canals: an ex vivo study. Int Endod J. 2009; 42 (4): 344-350.
32. Khalilak Z, Vatanpour M, Dadresanfar B, Moshkelgosha P, Nourbakhsh H. In Vitro Comparison of Gutta-Percha Removal with H-File and ProTaper with or without Chloroform. Iran Endod J. 2013; 8 (1): 6-9.
33. Martinho F, Freitas L, Nascimento G, Fernandes A, Leite F, Camoes L, et.al Endodontic retreatment clinical comparison of reciprocating systems versus rotary system in disinfecting root canals. Clin Oral Investig. 2015; 19 (6): 1411-1417.
34. Rodig T, Reicherts P, Konietschke F, Dullin C, HahnW, H€ulsmann M. Efficacy of reciprocating and rotary NiTi instruments for retreatment of curved root canals assessed by micro-CT. Int Endod J. 2014; 47 (10): 942-948.
35. Yared G, Alasmar Ramli G. Single file reciprocation: A literature review. ENDO. Endodontic Practice Today 2017; 7 (3): 171-178.
36. Luz Segundo A, Silva V, Pereira R, Nunes E. Uso do Reciproc em pré-molar inferior com dupla curvatura: relato de caso. Dent. Press Endod. 2015; 5 (3): 49-55.
37. Roane JB, Sabala CL, Duncanson MG. The "balanced force" concept for instrumentation of curved canals. J Endodont. 1985; 11 (5): 203-19.
38. Bartols A. Clinical experiences with Reciproc. Endodontic Practice Today. 2013; 7(3):179.187.
39. Ramazani N, Mohammadi A, Amirabadi F, Ramazani M, Ehsani F. In vitro investigation of the cleaning efficacy, shaping ability, preparation time and file deformation of continuous rotary, reciprocating rotary and manual instrumentations in primary molars. J Dent Res Dent Clin Dent Prospects. 2016;10(1):49-56.
40. Gomes NN, de Carvalho GM, Sponchiado Junior EC, Garcia LFR, Marques AAF, de Carvalho FMA. Filling Material Removal with Reciprocating and Rotary Systems Associated with Passive Ultrasonic Irrigation. Eur Endod J. 2017; 2:6
41. Rios M, Villela A, Cunha R, Velasco R, De Martin A, Bueno C, et al. Efficacy of 2 Reciprocating Systems Compared with a Rotary Retreatment System for Gutta-percha Removal. J Endodont. 2014; 40 (4): 543-546.
42. De Deus G, Silva E, Vieira V, Belladonna F, Elias C, PlotinoG, Grande N. Blue Thermomechanical Treatment Optimizes Fatigue Resistance and Flexibility of the Reciproc Files. J Endod. 2017; 43 (3): 462-466.
43. Plotino G, Ahmed H, Grande N, Cohen S, Bukiet F. Current Assessment of Reciprocation in Endodontic Preparation: A Comprehensive Review—Part II: Properties and Effectiveness. J Endod. 2015; 41 (12): 1939-1950.
44. Kokak M, Kokak S, Türker S, S Aglam B. Cleaning efficacy of reciprocal and rotary systems in the removal of root canal filling material. J Conserv Dent. 2016; 19 (2): 184-188.
45. Gupta R, Dhingra A, Aggarwal N. Endodontic Retreatment using Reciproc Single File System. Guident. 2014; 8 (1):46-50.
46. Matos Maia Filho E, de Castro Rizzi C, Bandeca Coelho M, Freitas Santos S, Mayanne Oliveira Costa L, Nunes Carvalho C, Alves Soares J. Shaping Ability of Reciproc, UnicOne, and Protaper Universal in Simulated Root Canals. Scientific World Journal 2015. http://doi.org/10.1155/2015/690854

47. Rossi-Fedele G, Ahmed H. Assessment of Root Canal Filling Removal Effectiveness Using Micro–computed Tomography: A Systematic Review. J Endod. 2017; 43 (4): 520-526.
48. Ferreira Ramos T, Câmara A, Aguiar C. Procjena učinkovitosti eteričnih ulja u otapanju štapića od gutaperke u sustavu ProTaper Universal. Acta Stomatol Croat. 2017; 50 (2): 128-133.
49. Marfisi K, Mercade M, Plotino G, Clavel T, Duran-Sindreu F, Roig M. Efficacy of Reciproc and Profile Instruments in the Removal of Gutta-Percha from Straight and Curved Root Canals ex Vivo. J Oral Maxillofac Res. 2015; 6 (3): 1-8.
50. Martins M, Duarte M, Cavenago B, Kato A, da Silveira Bueno C. Effectiveness of the ProTaper Next and Reciproc Systems in Removing Root Canal Filling Material with Sonic or Ultrasonic Irrigation: A Micro–computed Tomographic Study. J Endod. 2017; 43 (3): 467-471.
51. Lu Y, Chen M, Qiao F, Wu L. Comparison of apical and coronal extrusions using reciprocating and rotary instrumentation systems. BMC Oral Health. 2015; 15:92. doi:10.1186/s12903-015-0081-z.
52. Çapar I, Arslan H. A review of instrumentation kinematics of engine-driven nickel-titanium instruments. Int Endodont J. 2016; 49 (2): 119-135.
53. Fruchi L de C, Ordinola-Zapata R, Cavenago BC, Hungaro Duarte MA, Bueno CE, De Martin AS. Efficacy of reciprocating instruments for removing filling material in curved canals obturated with a single-cone technique: a micro-computed tomographic analysis. J Endod. 2014 Jul;40(7):1000-4
54. Topçuoğlu HS, Zan R, Akpek F, Topçuoğlu G, Ulusan Ö, Aktı A, Düzgün S, Ağırnaslıgil M. Apically extruded debris during root canal preparation using Vortex Blue, K3XF, ProTaper Next and Reciproc instruments. Int Endod J. 2016 Dec;49(12):1183-1187
55. Pedulla E, Lo Savio F, Boninelli S, Plotino G, Grande NM, La Rosa G, et al. Torsional and Cyclic Fatigue Resistance of a New Nickel-Titanium Instrument Manufactured by Electrical Discharge Machining. J Endod. 2016;42:156–9.

Mariel Beatriz Galiana: marielgaliana@hotmail.com.ar

Received on: 30 Aug 2017 – Accepted on: 13 Jun 2018