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Comparação da desinfecção endodôntica de canais radiculares de dentes decíduos utilizando sistemas rotatório e reciprocante: Estudo *in vitro*

Comparison of endodontic disinfection of primary teeth root canals using rotary and reciprocating system: An in vitro study

Comparación de la desinfección endodóntica en los conductos radiculares de dientes primarios mediante sistemas rotatorio y reciprocante: Estudio *in vitro*

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Lis de Amorim Fonseca
ORCID: https://orcid.org/0000-0003-2758-6227
São Leopoldo Mandic, Brazil
E-mail: lisfonseca@gmail.com
Raphael Amorim Cangussu
ORCID: https://orcid.org/0000-0002-2481-1399
São Leopoldo Mandic, Brazil
E-mail: cangussu1985@gmail.com
Arthur Soares de Oliveira
ORCID: https://orcid.org/0000-0002-6297-9977
Goethe Universitat, Germany
E-mail: arthursdo@gmail.com
Sergio Luiz Pinheiro
ORCID: https://orcid.org/0000-0001-7157-4923
Pontifícia Universidade Católica de Campinas, Brazil
E-mail: slpinho@puc-campinas.edu.br
Caleb Shitsuka
ORCID: https://orcid.org/0000-0002-9813-0457
Universidade Brasil, Brazil
E-mail: cashitsuka@gmail.com
Danilo Antônio Duarte
ORCID: https://orcid.org/0000-0002-2291-5434
São Leopoldo Mandic, Brazil
E-mail: danilo.ant.duarte@gmail.com

Resumo

Objetivo: Este estudo experimental *in vitro* objetivou comparar a desinfecção do sistema de canais radiculares de dentes decíduos, utilizando os sistemas rotatório e reciprocante. Metodologia: Quarenta e oito canais radiculares de vinte e quatro dentes molares decíduos foram contaminados com a cepa padrão de *Enterococcus faecalis* e foram divididos aleatoriamente em 4 grupos (n = 12). O Grupo PN compreendeu os canais radiculares preparados com o sistema rotatório ProTaper™ Next. O Grupo WOG foi definido pelo uso do sistema reciprocante WaveOne™ Gold. As limas dos dois sistemas foram processadas termomecanicamente. O Grupo PU utilizou o sistema ProTaper™ Universal, sem tratamento térmico, e o Grupo C (controle negativo) não recebeu tratamento. As amostras dos canais radiculares foram coletadas com pontas de papel estéreis antes e após a sua preparação, diluídas e distribuídas em placas com Agar de Infusão Cérebro e Coração (BHI). As colônias bacterianas foram contadas e os resultados foram analisados estatisticamente pelos testes de Wilcoxon e Kruskal-Wallis (Dunn). Resultados: Houve redução bacteriana significativa nos sistemas (p> 0,01). No entanto, não houve diferença significativa entre eles (p <0,05) (PN = 3,38; WOG = 3,85; PU = 3,26). Conclusão: Ambos os sistemas (rotatório e reciprocante) fornecem desinfecção no sistema de canais radiculares dos dentes molares decíduos.

Palavras-chave: Odontopediatria; Dente decíduo; Endodontia.

Abstract

Aim: This experimental study *in vitro* aimed to compare the disinfection of the primary teeth root canals system using the rotary and reciprocating file system. Methodology: Forty-eight root canals from twenty-four primary molar teeth were contaminated with the standard strain of *Enterococcus faecalis* and randomically splitted into 4 groups (n=12). The Group PN comprised the root canals prepared with the ProTaper™ Next rotary system. The Group WOG was defined by the usage of WaveOne™ Gold reciprocating system. The files from both systems were thermo mechanical processed. The Group PU used the ProTaper™ Universal system, with no thermic treatment, and the Group C (negative control) received no treatment. Samples from the root canals were collected with sterile paper points before and after its preparation, diluted and distributed in plates with Brain Heart Infusion (BHI) agar. The bacterial colonies were counted and the results were statistic analyzed by Wilcoxon and Kruskal-Wallis (Dunn) tests. Results: There was significant bacterial reduction using the systems (p>0,01). However, there was no significant difference among them (p<0,05)

(PN=3.38; WOG=3.85; PU=3.26). Conclusion: Both systems (rotary and reciprocating) provide disinfectionon the primary molar teeth root canals system.

Keywords: Pediatric Dentistry; Primary teeth; Endodontics.

Resumen

Objetivo: Este estudio experimental *in vitro* tuvo como objetivo comparar la desinfección del sistema de conductos radiculares de los dientes primarios, utilizando los sistemas rotativo y reciprocante. Metodología: Cuarenta y ocho conductos radiculares de veinticuatro dientes molares primarios se contaminaron con la cepa estándar de *Enterococcus faecalis* y se dividieron aleatoriamente en 4 grupos (n = 12). El Grupo PN comprendía los conductos radiculares preparados con el sistema rotativo ProTaper™ Next. El Grupo WOG se definió mediante el uso del sistema alternativo WaveOne™ Gold. Los archivos de los dos sistemas se procesaron termo-mecánicamente. El Grupo PU usó el sistema ProTaper™ Universal, sin tratamiento térmico, y el Grupo C (control negativo) no recibió tratamiento. Las muestras del conducto radicular se recogieron con puntas de papel estériles antes y después de su preparación, se diluyeron y se distribuyeron en placas con agar para Infusión Cerebro y Corazón (BHI). Se contaron las colonias bacterianas y los resultados se analizaron estadísticamente mediante las pruebas de Wilcoxon y Kruskal-Wallis (Dunn). Resultados: Hubo una reducción bacteriana significativa en los sistemas ($p> 0.01$). Sin embargo, no hubo diferencias significativas entre ellos ($p <0.05$) (PN = 3.38; WOG = 3.85; PU = 3.26). Conclusión: Ambos sistemas (rotativo y reciprocante) proporcionan desinfección en el sistema de conducto radicular de los dientes molares primarios.

Palabras clave: Odontología pediátrica; Diente primario; Endodoncia.

1. Introduction

Dental caries lesions and trauma on the primary teeth may result in undesirable outcomes, which lead to endodontic therapy. The endodontic treatment in primary teeth, particularly in molars, requires special cares due to limiting factors such as: complex root canals system, limited time to proper endodontic preparation and the child behavior during treatment (Moghaddam, Mehran & Zadeh, 2009; Musani et al., 2009; George et al., 2016).

A practical pulpectomy technique for the primary teeth should include fast procedures, short treatment time, minimal number of appointments, effective debridement without weakening the tooth structure or damaging the adjacent permanent tooth (George et al., 2016).

The endodontic preparation with stainless steel manual files is the traditional method, which can provide proper cleaning of the primary teeth root canals, leading to clinical success in treatments (Moghaddam, Mehran & Zadeh, 2009; Pinheiro et al., 2014; Ramezanali et al., 2015). However the usage of rotary instrumentation in the field of pediatric dentistry was able to shortening the treatment time and to reduce the fatigue of patient and professional. Furthermore, it was also possible to achieve a high quality biomechanical preparation, which results in uniform and more predictable obturations as well as high degree of cleanness (Pinheiro et al., 2012; Musale & Mujawar, 2014; Katge et al., 2014; Ramanazi et al., 2016; Deshpande, Joshi & Naik, 2017), due to the tapered shape, which leads to a better root filling (Barr, Kleier & Barr, 2000; George et al., 2016; Deshpande, Joshi & Naik, 2017). These aspects assure its usage in pediatric dentistry, since time is key to properly manage the child behavior during the procedure (George et al., 2016;).

The rotary files system ProTaper™ Universal is considered the standard system between the mechanical instruments and it has been used for a long time to endodontically treat the permanent dentition. In the pediatric dentistry, the literature and researches show that its usage is so efficient as in permanent teeth treatment, which leads to an even more simplified technique with the same disinfection standards, cleanness and shaping in less time when compared to the manual technique (Pinheiro et al., 2012; Musale & Mujawar, 2014; Katge et al., 2014; Pinheiro et al., 2014; Pinheiro et al., 2016).

The engine-driven files have been evolving and show a cross sectional design and cutting flutes that provide major debris removal during instrumentation, better preparations, tapered shaping, higher centralization and less risk of deviation. Improvements on the Nickel Titanium (NiTi) alloy also have been develop to create instruments that combine better flexibility, durability and safety during its use (George et al., 2016; Ramanazi et al., 2016).

Endodontic instruments designed for reciprocating system introduced the concept of single file treatment, optimizing the treatment time. Its use in primary teeth endodontic therapy has been studied and leads to cleaning and shaping efficiency and preservation of the original root shape in cases of curved canals. It has been also related to a reduced working time (Katge et al., 2014; Pinheiro et al., 2016; Prabhakar et al., 2016; Ramanazi et al., 2016).

Recently, the ProTaper™ Next systems (Rotary preparation) and the WaveOne™ Gold system (Reciprocating) represent an evolution of its predecessors and, according to the manufacturer, improvements in the NiTi alloy manufacturing technology are applied, with specific thermo mechanical processing to produce the M-Wire alloy, in order to provide more flexibility and cyclic fatigue resistance (George et al., 2016). In the WaveOne™ Gold files, in a post-manufacturing procedure, the alloy is treated with heat and then slowly cooled down to improve the strength and flexibility (Webber, 2015). They also present metallurgical advances, which leads to qualification in the diameter tip of the instruments and its tapering, and shifting the cross section to improve flexibility, safety and cutting efficiency maintenance in the root canals preparation (Elemam et al., 2015; Webber, 2015)

In light of this knowledge, it is appropriate to study the usage of these new rotary systems in the endodontic treatment of primary teeth. Moreover, it is appropriate to assess the microbial reduction capacity and provide guidance in the proper instruments selection by the professional, decreasing endodontic failures and reducing the working time. Thus this paper aimed to compare *in vitro* the disinfection achieved by root canals instrumentation of primary teeth with the ProTaper™ Next and ProTaper™ Universal rotary systems, with and without thermo mechanical processing alloys, and with the WaveOne™ Gold reciprocating system, with thermal treatment, through the plates method. The null hypothesis is that there is no difference in the capacity of disinfecting the root canals system in primary teeth between the different systems.

2. Methods

The study is approved by the Brazilian Local Ethical Committee (Centro de Pesquisas Odontológicas São Leopoldo Mandic SS No.: 1.921.738, Campinas, São Paulo, Brazil) and attests conformity with the Declaration of Helsinki (DoH). The teeth used in the study were donated under a signed consent form.

Forty-eight canals from twenty-four primary molars freshly extracted were selected for this study. The inclusion criteria were at least two-tirds of root present, absence of pathologic root resorption (internal or external), absence of furcation perforation, moderate root curvature (10º-20º) (Schneider, 1971) and root canal diameter matching the k-file #10. Twelve samples were added to each group based on the ANOVA test to sample calculation. The minimum difference between treatment means was 0.04, the standard error was 0.03, the amount of treatments was 3, statistical power was 0.80 and alpha was 0.05.The pulp chamber opening was performed by a high-speed round diamond bur (FG 1014 from KG Sorensen Ind. e Com. Ltda., São Paulo, Brazil), finished by a flat end tapered diamond bur (FG 3082 from KG Sorensen Ind. e Com. Ltda., São Paulo, Brazil) to remove the dentin excess from the root canal entrances. The crowns were flatten by a double-sided diamond disc (KG Sorensen, Barueri, SP, Brazil) in order to obtain a standard working length of 12 mm. This working length was defined by a visual method, placing a manual k-file #10 (Dentsply Maillefer Instruments, Ballaigues, Switzerland) into the root canal until the file tip be visible through the apical foramen. The instrument was removed and the working length was determined using an endodontic ruler, decreasing 1 mm from the whole-length. In order to obtain the root canals system contamination, an initial preparation was performed until the usage of a manual k-file #15 (Dentsply Maillefer Instruments, Ballaigues, Switzerland) in the determined working length. On the outer surfaces of the roots were applied two layers of an epoxy adhesive (Brascola Ltda., Taboão da Serra, SP, Brazil) to avoid the irrigation solution leakage. Then the roots were inserted vertically in polystyrene micro titer plates (Kasvi Imp. e Dist. de Prod. para Laboratórios Ltda., Paraná, Brazil) filled by condensation silicone (Silon2 APS – 3M, Saint Paul, MN, USA) for fixation. It was also applied a thin layer of cyanoacrylate (Loctite Super Bonder, Henkel Ltda., São Paulo, Brazil) to provide better stability for the instrumenting phase (Machado et al., 2013).

The test bodies were numbered and sterilized in ethylene oxide to be contaminated later on by *Enterococcus faecalis*ATCC 29212 (Labcenter, São Paulo, Brazil) inside the laboratory. Two roots were randomly selected and submerged into a recipient, which contained BHI broth (Difco, Michigan, USA), for 24 hours, in order to work as sterilization effectiveness control method.

The root canals were contaminated by 1 mL of the standard strain *E. faecalis*suspension and asterile manual k-file #10 (Dentsply Maillefer Instruments, Ballaigues, Switzerland) was used to equally disperse the bacterial suspension through the working length. The inoculated samples were cultivated under microaerophilic conditions (CO_2 incubation between 35-37ºC for 21 days). After the 21 days, the culture mediums were changed in order to keep viable the bacterial growth.

After incubation period, the inner material from the root canals was then collected by sterilized absorbent paper points (Dentsply Maillefer Instruments, Ballaigues, Switzerland), matching the same root canals diameter, for one minute, into the working length to analyze the contamination degree prior to the endodontic instrumentation. The paper points were immediately placed in polypropylene tubes (Eppendorf™, Hamburg, Germany), which contained 900 µL of sterilizes saline solution. These samples were mixed for 30 seconds on Vortex (AP56 Phoenix Luferco, São Paulo, Brazil) and then diluted (1:10), inoculated in agar BHI plates and incubated in a CO_2 incubator (35º-37ºC for 24 hours).

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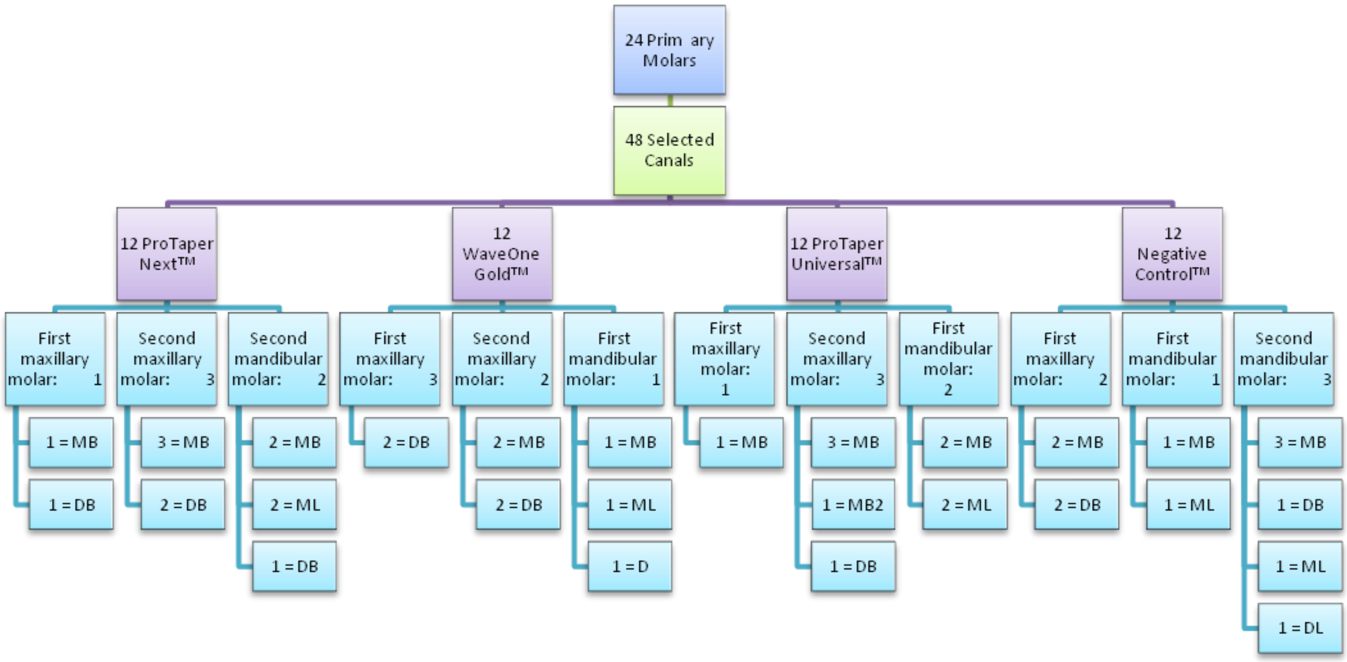
The management from the test bodies and the root canals preparations were performed in a laminar flow cabinet (Siqueira et al., 1999; Siqueira et al., 2002; Tewari et al., 2016) by a single operator.

The specimen were then randomly splitted into four groups of twelve root canals each, according to the type of instrumentation system to be used for endodontic treatment and to the definition of the control group, it can observed in Figure 1.

Figure 1. Samples distribution flowchart.



Source: Authors.

The root canals from group PN were prepared by the continuous rotation system ProTaper™ Next (Dentsply Maillefer Instruments, Ballaigues, Switzerland), featuring a thermomechanical processing to obtain the NiTi M-wire alloy. It was activated by the X-Smart Plus™ Endo Motor (Dentsply Maillefer Instruments, Ballaigues, Switzerland), according to the following protocol: X1 file sequentially use (taper 0.04, tip 17) followed by the X2 file (taper 0.06, tip 25) for the final shape, regarding the initial apical diameter from the root canals. The speed used was 300 rpm and the torque was 4 Ncm. It was used a reduction gear handpiece (16:1) with brushing motion until it reaches the working length in a passive way.

The root canals from group WOG were instrumented by the WaveOne™ Gold reciprocating system (Dentsply Maillefer Instruments, Ballaigues, Switzerland), presenting the NiTi M-wire alloy as well, activated by the same endodontic motor, set upped in reciprocating mode, following this protocol: Primary file insertion (taper 0.07, tip 25), selected according to the initial diameter of the root canals. The file was gently inserted at the cervical portion of the root canals and then removed. The file is now inserted again to reach the middle third and removed. Finally the same file is now inserted into the apical third to reach the working length. The brushing motion is always applied against the root canal walls.

In the group PU the rotary system ProTaper™ Universal (Dentsply Maillefer Instruments, Ballaigues, Switzerland) was used to prepare the root canals without the thermal preparation of the NiTi alloy. This system was also activated by the X-Smart Plus™ Endo Motor and followed these steps: S1 file sequential use (taper 0.11, tip 18) and S2 (taper 0.08, tip 20) to prepare the cervical and middle thirds with brushing motion. Then the F1 file (taper 0.07, tip 20) and F2 file (taper 0.08, tip 25) to the final shape and apical preparation with a pecking motion (insertion and removal). The speed was 300 rpm and the torque was 3 Ncm used for the S1 and S2 files and 2 Ncm for the F1 and F2 files.

The root canals from the Group C (negative control) were not endodontic prepared. Only sterilized saline solution was used for irrigation.

The root canals from groups PN, WOG and PU was irrigated individually with 9 mL of sterilized saline solution (ASFER, São Paulo, Brazil) during the preparation, just to consider the mechanical effect of disinfection of all the tested systems. After each file, the root canals were irrigated (PN group: 6 mL for X1 file until the middle third and 3 mL for the apical third after the X2 file; WOG group: 3 mL for Primary file in each third until reach the apical one; PU group: 2 mL for each file S1, S2, F1 and 3 mL for the apical third after the F2 file) by a 5 mL disposable plastic syringe (Injex Ind. Cirúrgicas Ltda., São Paulo, Brazil) attached with a Navitip 27G needle (Ultradent, South Jordan, UT, USA). In order to standardize the procedure, the needle wasinserted into the canals until the first part of the root curvature, followed by a patency k-file #10.

After endodontic preparation and irrigation, the bacterial samples were finally collected by sterilized paper points (#25) insertion in each canal until the working length (matching diameter) to analyze the decontamination degree achieved. The paper points were left in contact with the root walls for exact one minute. The collected samples were analyzed following the same protocol used before the endodontic preparation.

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After incubation period, the bacterial colonies formation was counted and the results were analyzed by a computer software (Biostat 4.0). The results obtained in UFC/mL were converted in log_{10} and tested for normality by the Shapiro-Wilk test. The sample data was not normal. The results were then submitted to the Wilcoxon and Kruskal-Wallis (Dunn) non-parametric tests.

3. Results

Table 1 show all endodontic systems analyzed presented significant microbial reduction ($p<0.01$).

Table 1. Median (M) and Interquartile deviation (ID) from microbial counting before and after instrumentation with ProTaper™ Next, WaveOne™ Gold and ProTaper™ Universal (log_{10}).

		PN	WOG	PU
M (ID)	B	5.74 (0.68)^{A}	5.43 (0.68)^{A}	5.90 (0.69)^{A}
	A	3.38 (0.92)^{B}	3.85(1.16)^{B}	3.26 (0.53)^{B}
(p)		0.0007	0.0010	0.0007

PN: ProTaper Next; WOG: WaveOne Gold; PU: ProTaper Universal; B: Microbial counting before instrumentation; A: Microbial counting after instrumentation; different alphabet letters, statistical significant differences. Wilcoxon test results. Source: Authors.

There was no significant difference in microbial reduction obtained after instrumenting the root canals between the groups PN, WOG and PU. In the control group (C), which was performed only mechanical irrigation, all the analyzed systems presented higher microbial reduction ($p<0.05$), it can be observed in Table 2.

Table 2. Median (M) and Interquartile deviation (ID) from microbial counting after instrumentation with ProTaper™ Next, WaveOne™ Gold and ProTaper™ Universal (log_{10}).

		C	PN	WOG	PU
M (ID)	A	4.59 (0.39)^{A}	3.38 (0.92)^{B}	3.85(1.16)^{B}	3.26 (0.53)^{B}
(p)		<0.05			

C: Contro group; PN: ProTaper Next; WOG: WaveOne Gold; PU: ProTaper Universal; A: Microbial counting after instrumentation; different alphabet letters, statistical significant differences. Kruskal-Wallis (Dunn) test results. Source: Authors.

4. Discussion

The present study showed that all endodontic systems analyzed achieved significant microbial reduction, considering the colonies forming units (CFU/mL) obtained from the collected samples before and after instrumentation, and that these results were statistically equivalent between the groups and significantly higher than the control group, rejecting the null hypothesis. The bacterial analysis was selected for this study to ensure a better predictability on the root canals disinfection. Thus, a standard strain of *Enterococcus faecalis* was chosen to contaminate the primary root canals in this experiment. This choice was based on its high virulence, prevalence after endodontic treatment, capability of recolonization in nutritionally deprived settings, ability to penetrate dentin tubules and bind to collagen molecules and its high prevalence in cases of endodontic retreatment. Besides, the same strain was used prior in other studies (Pinheiro et al., 2012; Machado et al., 2013; Pinheiro et al., 2014; Neves et al., 2016; Pinheiro et al., 2016; Tewari et al., 2016).

Among the several study methods of endodontic disinfection efficiency, the plate culture method is widely used and provides similar post-instrumentation quantitative results when compared with other methods, as the PCR (Alves et al., 2012). In this study, the paper points were used to collected the bacterial samples before and after the procedures (instrumentation and irrigation) according to other studies (Musani et al., 2009; Pinheiro et al., 2012; Machado et al., 2013; Pinheiro et al., 2014; Krokidis et al., 2016; Neves et al., 2016; Pinheiro et al., 2016; Tewari et al., 2016) and it is proven to be a simple and easy method. Although there might have some limitations from the microbial collect, due to the paper points could not scrape the infected root canal and also could not reach the anatomic variations properly, this method proved to be valid to achieve this study goal. The aim was to analyze the bacterial load reduction after endodontic treatment, as suggested by Yun *et al.* (2017).

In experimental studies it is possible to create controlled situations in order to observe isolated factors. This was demonstrated in this study by the mechanical disinfection ability of the analyzed systems. Since no irrigation solution with antimicrobial capacity was used, the post-instrumentation bacterial reduction can be credited to the combined mechanical effect of instrumentation and irrigation with saline solution, as described by Siqueira *et al.* (1999), resulting in a significant decrease in microbial counting when compared to the control group, which only counted on the mechanical effect of irrigation with saline solution, with no antibacterial activity.

The significant bacterial reduction observed in the tests groups is related to the motion applied and the unique file designs. Its higher flexibility without compromising the cutting efficiency allows proper cleaning in curved canals. Furthermore, the higher tapering of these instruments results in a higher contaminated dentin removal and higher bacterial elimination. The continuous rotation motion effect contributes to an effective bacteria and debris removal out of the canals (Katge et al., 2014; Krokidis et al., 2016; Pinheiro et al., 2016; Tewari et al., 2016; Topçuoğlu, Topçuoğlu & Akpek et al., 2016).

The hand endodontic technique using stainless steel manual files to prepare the primary dentition is the one traditionally used and it has the capability to provide adequate cleanness (Moghaddam, Mehran & Zadeh, 2009; Ramezanali et al., 2015; Pinheiro et al., 2016). However, these instruments present lower flexibility, which leads to rectification of curved canals, deformations, apical transportation, perforations and deviations (Gergi et al., 2010). The outcomes are an increased working time (Pinheiro et al., 2012; Makarem, Ravandeh & Ebrahimi, 2014) and a higher debris and dentin shavings extrusion beyond the apex limits due to the cinematic movements applied and to the shape of the instruments. These factors are of a great concern in the primary dentition due to its larger apical anatomy (Sowmya et al., 2014; Topçuoğlu, Topçuoğlu & Akpek, 2016; Gungor & Kustarci, 2016). In the present study, no manual files were used either to be compared nor in the control group, given the well-established evidence of mechanical disinfection in primary tooth canals (Pinheiro et al., 2012; Musale & Mujawar, 2014; Pinheiro et al., 2014; Katge et al., 2014; Pinheiro et al., 2016).

Regarding the widening provided by the systems used in this study, it was shown that the difference between the files tapering was not able to influence its mechanical disinfection capacity, as well as the amount of files used for each system. According to Neves *et al.* (2016) findings, this can change the operative time in permanent teeth. The preparation with ProTaper^{TM} Next used two instruments e was finished with the X2 file (25/0.06), the WaveOne^{TM} Gold used only the Primary file (25/0.07) and the ProTaper^{TM} Universal used four instruments for preparation, finishing with the F2 file (25/0.08). These differences may have been balanced by the reciprocating motion (WaveOne^{TM} Gold file), or by the swaggering effect from the ProTaper^{TM} Next, and to the specific heat treatments that improve their performances. Thus, the mechanical disinfection capacity might seen to be related to variations on the apical preparation size according to the initial diameter (Siqueira et al., 1999; Card et al., 2002), standardized in this study.

Still regarding the modeling procedures, the smaller tapering provided in ProTaper^{TM} Next and in the WaveOne^{TM} Gold systems would be more favorable to preserve the root dentine, which is important in the field of pediatric dentistry, maintaining significant endodontic disinfection and avoiding offsets preparations. The use of ProTaper^{TM} Next system provides a higher taper finishing file and it can clinically result in a weaker dental structure of primary teeth, increased risk of apical transportation and more working time due to the longer sequence of instrumentation required, without any advantages when compared to the other systems.

The findings are in agreement with previous studies, which reported no difference on the bacterial reduction level using different systems or preparation techniques, in permanent or primary teeth (Machado et al., 2013; Neves et al., 2016; Krokidis et al., 2016; Pinheiro et al., 2016). However, Tewari *et al.* (2016) reported higher cleaning related to the ProTaper^{TM} Next in permanent teeth in comparison to the manual NiTi files (Nitiflex and Hero Shaper) and to the Hyflex CM rotary system. This feature was related to its offset cross-sectional mass, which creates a swaggering effect motion, less contacting areas with dentin walls and higher debris removal out of the canals. In the present research, the special mechanical effect from the reciprocating movement provided by the WOG group, as well as the usage of multi-instruments with larger taper in the PU group, were possibly balanced with the described benefits.

The ProTaper^{TM} Next and WaveOne^{TM} Gold present great applicability in the pediatric dentistry due to the achieved results. Both systems were design to provide less contact from the files in the root canals, regarding their shifted cross-sectional optimized design, which increase the flexibility and push them against all the anatomic irregular walls (usually seen in primary dentition), in order to properly remove the debris out of the root canals through the spaces created between the file and dentin (Webber, 2015; Topçuoğlu, Topçuoğlu & Akpek, 2016; Krokidis et al., 2016). More comfort can be achieved during and after treatment by these aspects, regarding the higher risk of debris extrusion in the primary dentition due to the physiological root resorption (Topçuoğlu, Topçuoğlu & Akpek, 2016) as well as the greater preservation of the root and the underlying permanent germ.

Regarding the technique simplification, several studies showed that the protocols from the automated systems could be adapted to primary teeth endodontic treatment and a reduced amount of files are enough to provide proper cleaning and shaping (Musani et al., 2009; Pinheiro et al., 2012; Katge et al., 2014; Pinheiro et al., 2014; Pinheiro et al., 2016). In this study, the ProTaper™ Next and WaveOne™ Gold showed a consistent bacterial reduction requiring a smaller amount of files in comparison with the ProTaper™ Universal system, leading to useful and desirables possibilities in pediatric dentistry field, which demands precision and reduced operative time. Since there was no difference in contamination reduction by *Enterococcus faecalis* between the analyzed systems, the choice for single file systems, as the WaveOne™ Gold, may be more viable to the primary teeth endodontic therapy due to its advantages such as: simplified technique, short operative time, less risk of crossed infections during instrument management and safety in shaping procedures (Bürklein et al., 2012; Webber, 2015; Katge et al., 2014; Pinheiro et al., 2016; Prabhakar et al., 2016; Ramazani et al., 2016). All these features, related to multi-instrument systems, are of great importance for pediatric treatment and must be considered in order to obtain better approaches.

Within the limitations of an *in vitro* study, which could be difficult to turn into an *in vivo* study, it can contribute to present new materials and techniques before being used in the clinical practice. Thus, future clinical studies can be develop aiming to report aspects related to the trans- and postoperative comforting pediatric endodontic treatment, according to the physical and mechanical properties of the instruments, as well as the long term apical periodontitis case proservations in primary teeth.

5. Conclusion

It can be conclude that the ProTaper™ Next, the ProTaper™ Universal and reciprocating WaveOne™ Gold provide high disinfection capacity of the root canal systems in primary molars, being therefore considered effective methods to endodontic treatment in the pediatric dentistry. These outcomes may guide the professional in choosing instruments that improve the working time in endodontic preparations, which leads to an increased safety in children. The use of mechanized instruments to shape the root canals systems with a shorter sequence and smaller tapering showed to maintain the expected disinfection pattern.

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Percentage of contribution of each author in the manuscript

Lis de Amorim Fonseca - 20%

Raphael Amorim Cangussu - 20%

Arthur Soares de Oliveira - 20%

Sergio Luiz Pinheiro - 20%

Caleb Shitsuka - 5%

Danilo Antônio Duarte - 15%