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Article

Evaluation of apical debris extrusion and patency file in continuous and reciprocating rotary endodontic systems.

Evaluación de la extrusión de residuos apicales y permeabilidad apical en sistemas endodónticos rotativos continuos y recíprocos.

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Abstract: The aim of the study was to quantify and compare apical debris extrusion in two systems of continuous and reciprocating rotary instrumentation with, and without, the use of a patency file. An experimental study was carried out in 120 mesial roots of lower first molars, which were randomized in the following 4 groups: Group A. Reciproc (VDW) R25 without a patency file, Group B Mtwo (VDW) without a patency file, Group C Reciproc (VDW) R25 with a patency file and Group D Mtwo with a patency file. Groups A, B and C presented statistically significant differences in comparison to group D, Mtwo with the use of a patency file (p<0.008 to 95% reliability). In conclusion, the greater amount of debris extruded through the apex occurred in roots instrumented with the reciprocating rotary system; this difference was statistically significant in relation to teeth treated with the Mtwo continuous rotary system with the use of a patency file.

Keywords: Root canal preparation; dental instruments; dental high-speed equipment; molar; root canal therapy; debris extrusion.

Resumen: El objetivo del estudio fue cuantificar y comparar la extrusión de residuos apicales en dos sistemas de instrumentación endodónticos rotativos, continuo y recíproco, con y sin el uso de una lima de pasaje apical. Se realizó un estudio experimental en 120 raíces mesiales de primeros molares inferiores, que se aleatorizaron en los siguientes 4 grupos: Grupo A. Reciproc (VDW) R25 sin lima de pasaje apical, Grupo B Mtwo (VDW) sin lima de pasaje apical, Grupo C Reciproc (VDW) R25 con lima de pasaje apical y Grupo D Mtwo con lima de pasaje apical. Los grupos A, B y C presentaron diferencias estadísticamente significativas en comparación con el grupo D, Mtwo con el uso de una lima de pasaje apical (p<0.008 a 95% de confiabilidad). En conclusión, la mayor cantidad de residuos extruidos a través del ápice ocurrió en raíces preparadas con el sistema rotativo recíproco; Esta diferencia fue estadísticamente significativa en relación a los dientes tratados con el sistema rotativo continuo Mtwo con el uso de una lima de pasaje apical.

Palabras Clave: *Preparación del conducto radicular; instrumentos dentales; equipo dental de alta velocidad; diente molar; tratamiento del conducto radicular; extrusión de residuos.*

INTRODUCTION.

Success in root-canal treatment relies on the proper cleaning, disinfection, shaping and filling of the entire root canal system (RCS), in order to keep the tooth functional and create an environment conducive to periapical tissue health and healing.[1-3] While part of the literature suggests that instrumentation should finish 1mm shorter than the radiographic length of the RCS, there is evidence of bacteria present inside the apical foramen of teeth with necrotic pulp and/or apical lesions.[4,5] Apical extrusion of debris during chemical and mechanical root canal preparation (CMP) is one of the most common problems during endodontic therapy.[6]

All irritant agents must be released from the root canal by the CMP, and removed towards the coronal access of the root canal, thus avoiding damage to the underlying tissues.[1,6] However, it has been shown that the CMP can produce extrusion of bacteria and dentinal or chemical debris into the periapical tissue, regardless of the technique applied and of the maintenance of an adequate working length (WL) throughout the procedure.[2,6-8]

Evidence suggests that all CMP techniques and instruments produce some apical extrusion, even when the CMP does not access or modifies the apical foramen.[1,9-11]

When the apical foramen is part of the CMP, there is a higher probability of apical debris extrusion and subsequent inflammatory reactions or infection.[12]

Some studies suggest that the use of a patency file in most rotary instrumentation systems, helps to eliminate accumulated debris in the apical third of the root canal, thus helping to maintain a stable WL.[4] Furthermore, Hasheminia *et al.,*[13] showed that the use of a patency file was also helpful in preventing errors during CMP, such as apical transportation or loss of the physiological anatomy of the root canal. However, controversy continues about the use of this instrument, and is namely associated with its significance in debris extrusion and irritation of periapical tissues.

There is a possible correlation between reciprocating instrumentation systems and debris extrusion through the apical foramen.[7,9,14,15] This could be associated with the motion, similar to that of manual files in balanced force movements or with instrument design. With these experiments, we want to determine the effect of the patency file in the apical extrusion of debris, using two different rotary instrumentation systems, and how the instrument movement affects the debris extrusion or displacement.

MATERIALS AND METHODS.

These experiments were performed in 120 adult teeth (mandible, first molars), previously extracted for caries and/or advanced periodontal disease, and retrieved before disposal. The selected teeth had a fully formed apex and curvature between 0º to 10º, according to the Schneider method (1971). Exclusion criteria were: radicular caries, fractures, cracks, external or internal resorptions, calcifications and endodontic filling, which was confirmed with periapical radiographs, taken in the bucco-lingual and mesio-distal direction.

Teeth were sectioned with a high speed diamond burr under refrigeration in order to use only the mesial root. The crowns were sectioned in a straight angle to obtain a 13mm root with stable reference points. All traces of dental biofilm and tartar were removed from the sample using a dental scaler. Samples were immersed in 5% sodium hypochlorite solution for 30 minutes, and then stored in saline solution at room temperature.

Root length was determined by introducing a 10K file (Dentsply-Sirona, Ballaigues, Switzerland) in the canal until it was visualized through the apical foramen, using a 3.5X dental loupe; WL was 1mm less than the root length and Patency length was 0.5mm less than the root length.

The sample obtained (n=120) was randomly divided into 4 groups.

Group A: Reciproc without the use of a patency file (n=30).

Group B: Mtwo without the use of a patency file (n=30).

Group C: Reciproc using a patency file (n=30).

Group D: Mtwo using a patency file (n=30).

Each root was fixed in a test tube with silicone putty, simulating the experimental model designed by Myers and Montgomery for this type of studies.[10,12,16] Tubes were previously labeled and weighed on a precision scale. These measurements were registered as Prior Weight.

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Instrumentation/Chemical and Mechanical Preparation (CMP)

Instrumentation of each sample was performed with an X-Smart Plus endodontic motor (Dentsply-Sirona, Ballaigues, Switzerland), according to manufacturer's instructions.[17-19]

Distilled water was used for irrigation at -3mm WL in Monoject 3mL syringes and 27G needles. The different groups of samples were prepared in the following scheme:

Group A: Reciproc System R25 to WL, without a patency file.

Group B: Mtwo System basic sequence of four instruments (10/.04, 15/.05, 20/.06, 25/.06), without a patency file.

Group C: Reciproc System R25 to WL, between each R25 file forward motion, a K 10 patency file, was used at 0.5mm over the WL.

Group D: Mtwo System basic sequence of four instruments (10/.04, 15/.05, 20/.06, 25/.06). Between the steps of each instrument, a K 10 patency file was used at 0.5mm over the WL.

Instrumentation of each root was considered completed after achieving WL three times, with the last file of the proper sequence. In groups (C) and (D) apical patency was performed by introducing the K 10 file three times at the length indicated above.

After CMP, each sample was removed from their fixed test tube, and the apical root area washed with 2mL distilled water, in order to retrieve debris adhered to the root surface, and these residues were collected in a test tube.

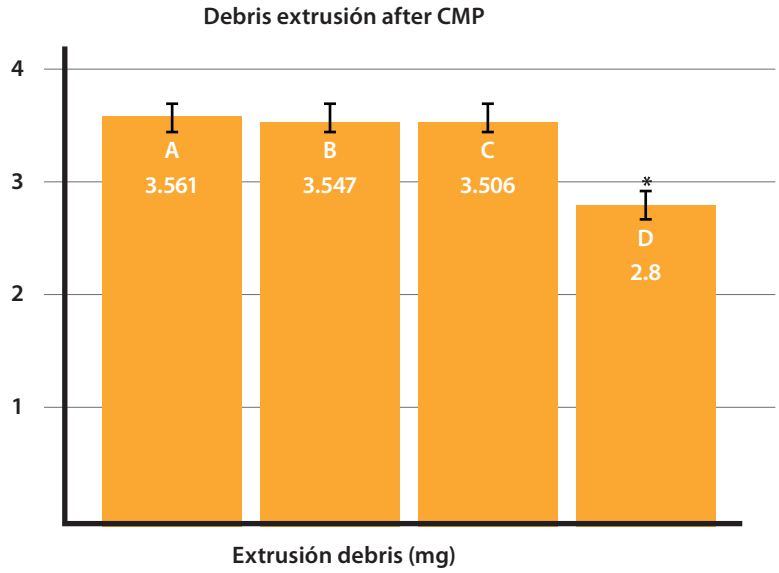
Then the liquid with the residues were semi-permeably sealed and the distilled water evaporated at 70°C, but preventing the contamination of the sample with external debris. Subsequently, the test tube content was weighed and these measurements registered as Post-Instrumentation Weight.

The amount of debris produced was calculated as follows:

Prior Weight-Post-Instrumentation Weight = Extrusion weight

Extrusion weight data was collected and registered using an Excel spreadsheet and data analyzed using SSPS statistics software. Kruskal Wallis test was used for non-normal distribution of the sample, with 95% reliability. Bonferroni correction was applied to compensate the small magnitudes involved.

Figure 1. Apical Debris Extrusion after mechanical root canal preparation.



A: Reciproc Groups without Patency File. **B:** Mtwo without Patency File. **C:** Reciproc with Patency File. **D:** Mtwo with Patency File. ***:** Significant difference compared to all other groups ($p<0.008$, 95% reliability).

RESULTS.

In this study 120 mesial roots of lower molars were analyzed, distributed in 4 groups of 30 samples each, with the results. (Figure 1)

The results show that there is a difference in the performance of the different instruments, measured as the amount of debris extruded through the apex of the experimental root-canal samples. The Mtwo system (Group D) projected an average 2.8mg of debris through the apex of the sample, compared with the approximately 3.5mg of debris projected by the other systems. This difference was statistically significant (p<0.008 to 95% reliability) compared with all three groups (A-B-C). The comparisons between groups A-B-C showed no statistically significant differences (p>0.008).

DISCUSSION.

The objective of this study was to compare the amount of apical debris extrusion of two rotary instrumentation systems and the effect of the use of a patency file during CMP. Apical debris extrusion during initial endodontic treatment or retreatment can produce post-treatment complications. Several studies show that in all endodontic treatments there will be some degree of debris extrusion, which could trigger pain and inflammation.[1,5,8,20]

The use of distilled water for irrigation prevents the crystallization artifact produced by sodium hypochlorite, a preferred irrigation solution.[21] All methodologies used to measure apical debris extrusion, are based on a quantitative measurement of debris, irrigation material and/or bacteria, and many use the same methodology applied in this study.[1,7-9,14,15, 22,23]

Some studies however, have shown that there is no correlation between the incidence of post-treatment complications and the amount of apically extruded residues.[24] Tanalp *et al.,*[25] observed that the virulent bacterial factor has more relevance in the inflammatory response of the periapical tissues than the amount of extruded debris. Nevertheless, any reduction of the amount of debris, and eventually bacteria through the apical foramen, should be considered beneficial in order to prevent any post-treatment infections.

The limitation of the experimental model used in this study, is that there is no apical barrier to simulate the Periodontal Ligament (PL), which can play a protective role in a real clinical situation. The use of an apical barrier to simulate a PL has been suggested, but its implementation may alter the debris extrusion measurements. Although this experiment allows group comparison under identical conditions, it has certain limitations when transferring the results to an actual clinical setting.[1,7-9,22,26,27]

The results observed in this study indicate that there is significantly less extrusion when a continuous rotary system with patency file was used. Other studies that used the same methodology obtained comparable results; for example, an increase in cutting ability is generally associated with greater cleaning efficiency, but may also favor the projection of debris to the periapical tissue, when used in conjunction with a reciprocating movement. On the other hand, continuous rotary instruments may favor the removal of dentinal debris coronally, acting as a screw conveyor.[7-9,22] On the other hand, a study conducted by Dincer *et al.,*[23] found that reciprocating instrumentation extruded less debris than continuous instrumentation, but the files in this study were used for retreatment.

The use of the patency file is controversial: Camoes *et al.,*[28] demonstrated that the use of a patency file resulted in the extrusion of sodium hypochlorite in 100% of mesiobuccal roots studied.

However, Lambrianidis *et al.,*[29] associated the use of the patency file with lower apical extrusion, when compared to cases where the apical constriction remained intact. This is in agreement with what was observed in the continuous rotation groups, but not for reciprocation groups. Possibly the effect of the patency file in the prevention of debris accumulation on the apical third in combination with the screw conveyor effect of continuous rotation, may justify the results found in Group D. To the knowledge of the authors, there are no studies that compare both variables, so the combination of kinematics and patency that produced the less extrusion of debris is difficult to compare with previous investigations.

The benefits of patency also include favoring the preservation of the original anatomical shape of the apical

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third without causing transportations or perforations, helping to maintain a stable WL during endodontic therapy, and allowing irrigation material to reach the apical third.[30] Since there were no statistically significant differences found in debris extrusion when using a patency file for reciprocation, and an apparently positive effect for continuous rotation, its use is still recommended.

The results obtained reinforce the concept that all instrumentation techniques will produce a certain degree of debris extrusion to the periapical tissues.[1,22] Although this extrusion was found to be greater in reciprocating instrumentation, the difference is still minimal in relation to continuous rotary instrumentation, which is also consistent with previous studies in the literature.[7,8,15,22,23]

CONCLUSION.

Within the limitations of our study, we can conclude that Reciprocating Rotary System Reciproc with or without the use of a patency file, and the Continuous Rotary System Mtwo without the use of a patency file, extruded significantly more debris than the Continuous Rotary System Mtwo with the use of a patency file.

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