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EFFECT OF SINGLE AND MULTIPLE FILE SYSTEMS WITH DIFFERENT METALLURGICAL CONTEMPORARY ROTARY SYSTEMS ON THE APICAL EXTRUSION OF DEBRIS

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ABSTRACT

Debris extrusion, is among the difficulties experienced on instrumentation that accompanied by postoperative discomfort. This research was escorted to judge the effectiveness of XP Endo Shaper,iRace and Protaper Next rotational systems considering the extruded debris.

Materials &Methods: Forty-five single-rooted human mandibular premolars extracted teeth with closed apex. Selection of teeth with curvatures (0°–10°). Buccolingual and mesiodistal instructions were followed to substantiate just one canal as clarified by digital radiograph. Teeth had been sorted randomly into 3 groups of 15 teeth individually using NiTi rotational system for root canal preparation, ensuring glide path and equal representation of all ranges of curvature. **Group A**: XP rotating system. **Group B**: Protaper Next rotating system **Group C**: iRace rotating system. A variation of Myers and Montgomery's equipment as previously proposed in respect of the quantitative assessment of apical debris expelled. Using Eppendorf tubes at a microbalance with four decimal places in grams before and after the instrumentation. The sum of three consecutive weights was computed after five times for weighing every tube. As regard to weight estimation, subtraction had been done for tube's starting weight from its final weight.

Results: Significantly, PTN group has the greatest mean value afterwards the iRace and the tiniest value has been recorded for the XPS ($p<0.05$). While the XPS and iRace groups ($p>0.05$) reported no remarkable difference.

Conclusions: The mass of apically expelled debris was PTN > iRace > XPS with a statistical difference. XPS as single file extrude minimal mass of debris.

KEY WORDS: Debris extrusion ,iRace, XP EndoShaper.

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INTRODUCTION

Debris extrusion, which is one of the difficulties experienced through root canal treatment and linked to a higher occurrence of postoperative pain [1].

Regardless of the devices employed, the debris ejection is unavoidable side effect [2]. According to the kinematics, count of files utilized, and cutting efficacy as well as taper cross-section, the quantity of debris ejection may change [3-4].

The primary canal morphology can be preserved by glide path preparation while reducing procedural problems [5]

The traditional RaCe system (FKG Dentaire SA) was simplified with the latest introduction of the iRaCe system (FKG Dentaire SA, La Chaux-de-Fonds, Switzerland). The iRaCe instruments have active cutting zones with cutting edges that alternated and electrochemical polished [6]

Dentsply Maillefer's ProTaper Next instruments (PTN) are a system made with M-Wire NiTi to increase the malleability and resistance to instrument tiredness. PTN files have a symmetric rotating motion, a rectangular cross-section design for increased strength, unusual rotational offset mass and changeable regressive taper design are intended to minimize canal walls contact points [7].

A comprehensive review found that motion kinematics and the number of files utilized has a greater influence on the mass of extruded debris than the file design [8].

A single file XP-endo Shaper was a novel rotating system (XPS; FKG Dentaire SA, La Chaux-deFonds, Switzerland) that was unveiled more recently. The snake-shaped instrument having a triangle-shaped cross section (MaxWire [FKG Dentaire SA] [Electropolish Martensite-Austenite-flex] responds differently depending on the temperature. The file's M phase has a starting taper of 0.01 when cold; yet, by exposure to body temperature (35C), The file's martensite phase changes to austenite, and the taper rises to 0.04. The tip of the file has six blades allows the XP endo Shaper to begin shaping subsequent to customized glide path of at least 15 ISO and gently raise the dimension at the apical part to reach ISO size 30. ISO requires a manual glide path at the minimum of size 15 before. XPS is used to produce a finishing apical preparation at the minimum of 30/0.04. [9].

The presented research was conducted to judge the effectiveness of XP Endo Shaper, iRace and Protaper Next rotating systems for preparing root canals as regard to extrusion of debris for extracted teeth.

MATERIALS & METHODS

Teeth selection and preparation:

The study protocol was approved by the Research Ethics Committee (REC), Faculty of Dentistry, Cairo University, (approval no: 75 / 7/23).

Forty-five single rooted human mandibular premolars have closed apex extracted teeth due to orthodontic treatment or periodontal problems that had been selected in the present research to meet the subsequent requirements; a length of fully completed roots was 20 mm with no observations of cracks or fractures which were confirmed inside the purview of a digital operating microscope. Following Schneider's strategy, the teeth were selected related to the curvatures (0°–10°) [10]. Using a digital radiograph (RVG6100; Carestream Dental LLC, Atlanta, GA, USA), To ensure that there was just one canal, the buccolingual and mesiodistal orientations were checked. We excluded teeth having internal resorption, calcified canals, and root canals without apical patency. By using both hand and ultrasonic tools, soft tissue pieces and calculus from the exterior surfaces of the root were removed. Considering the purpose of standardizing, the

working length and creating a point of references, the occlusal surfaces of all samples were flattened to have a comparable 18 mm length, where the root length was recorded from the apical end in the average of 15mm.

All of the patients who provided their teeth had already given their consent indicating that they were okay with their biologic samples being used. All patients should be free of any systemic diseases, and an appropriate medical index should be utilized to assess each patient's health.

The teeth were sorted in a random way into 3 groups of 15 teeth each using the NiTi rotary system for canal instrumentation, ensuring that each group based on the glide path preparation instruments and had an equal representation of all ranges of curvature.

Grouping of teeth

Group A: XP Endo shaper rotating system.

Group B: Protaper Next rotating system

Group C: iRace rotating system

Apparatus set up and initial weighing

The current work employed a reworked version of Myers and Montgomery's [11] equipment, as suggested by Lu et al. [12], in order to do a quantitative evaluation for the debris that were extruded apically while root canals preparation. The extruded debris extruded was gathered using tubes of Eppendorf. Using a microbalance in grams with four decimal places (Citizen CX 220 Analytical Lab Balance, Internal Cal. Weighing Hook, USA), the tubes were measured their weights three times each, and the mean was computed. For the level regards to cementoenamel junction, every tooth was set inside tube of Eppendorf that had been preweighed before being secured with a silicone impression material stopper. To prevent any potential impurity accompanied with the Eppendorf tube while the instrumentation process, this unit had been placed inside a glass bottle. To even the inner and exterior air pressures, put a 27G needle that was used for irrigation into the rubber stopper before beginning root canal preparation. An electrode thermometer (MN35, Digital Mini MultiMeter, Boston, Massachusetts, USA) proved that the glass bottle had been securely fastened to the bottom of a bigger external glass container, that had been immersed in a 37°C water bath.

Irrigation and instrumentation procedures

Root canals instrumentation was used according to each system's guide lines using the irrigant solution of distilled water between files in each sample. A 1:16 reduction gear handpiece driving a torque-regulated with an electric drive in a constant rotational velocity of 300 speed and torque control of 2N/cm for all groups was used to operate all files [13]. In a crown-down order, every canal was ready to its working length, each group's apical preparation was set finally at size #30.

Endo Access bur # 2 had been attached in a high-speed handpiece to make preparation of straight-line access cavities. A size 10-K file was utilized to calculate the actual working length that was pushed into root canal till its head point was seen emerging from the apex then decreasing 1 mm than the anatomical root end. A 10 K file had been employed to standardize the foramen diameter apically and to let the canals patent, and those with appropriately suited 10 K files at the apex were exclusively used for the investigation. A glide path to the WL with a 15 K file (FKG Dentaire SA) was accomplished without coronal flaring. Then, each system underwent root canal preparations following the instructions of the manufacturers. In Group A: XPS; (21 mm) file was put into the canal, and the file's electric endo motor (FKG Dentaire SA; 800 rpm and 1.0 Ncm) was turned on to rotate the instrument. The XPS file was initially positioned passively, and once resistance was encountered, the instrument was relocated gently upward and downward for a duration of time.

Then the instrument was cleansed, 15-k-file was applied to check patency at the apex, warm distilled water was sprayed inside the canal.

Then the instrument was reinserted and advanced all way up to the working length. Once it had reached the WL, the instrument was withdrawn. The instrument was applied once more for further five upward and downward oscillations across the entire WL The revolving instrument was then taken out from the canal. These processes were repeated five counts till achieving the corrected length furthermore adding a whole of 15 mL distilled watery solution as a quantity of irrigating solution to make uniform root canal cleaning and shaping with application of 15-k-file to check patency at the apex [14].

Group B: the X1 (17/04), X2 (25/06), and X3 (30/07) rotary files were used with ProTaper NEXT, in a crown-down technique with a 1:16 reduction gear handpiece driving an electric Endo motor that was torque-regulated in 300 rpm as a speed and 2.0 Ncm as torque control. The endodontic operation is carried out by lightly applying apical pressure while brushing till working length.

In group C: Endodontic equipment by iRaCe, the iRaCe R1 (15/.06), R2 (25/.04), and R3 (30/.04) rotary files were applied in successive rotating movements in a crown-down technique using three to four strokes with gentle back and forth movements without force till the working length (A 1:16 reduction gear handpiece driving a torque-regulated with an electric endomotor,600 rpm and 1.5 Ncm).

An irrigation needle of A 30-G (NaviTip; Ultradent, South Jordan, UT) which was closed-ended boundary-perforated was used to irrigate each sample in the exact same way—passively, for the last irrigation procedure, the needle was put 2 mm below than the actual length.

A 5 mL distilled water was applied in between each filing for irrigation of root canals. A 1 mL of distilled water was added to flush every sample on the conclusion regards to the instrumentation for any debris stuck to the root canal walls.

Debris collection and weighing

When endodontic instrumentation process has been finished, the tubes of Eppendorf were separated from the glass flasks then, the teeth and the needle were detached from the tube consecutive for the instrumentation. Before measuring the weight of the dried debris, the tubes had been kept in an incubator at 70 °C five days to let the distilled water to dry up. To determine the ultimate weight of the tubes of Eppendorf accommodating the ejected debris, Using the same analytical balance, the tubes were weighed. The mean of three successive weights had been worked out. By deducting the original mass of the tubes from its end mass, the apically extruded debris's net weight was calculated.

STATISTICAL ANALYSIS

The data was presented using the median and range values. The data was examined for normalcy utilizing the Kolmogorov-Smirnov test. The data recorded values were regularly distributed as clarified by the Kolmogorov-Smirnov test results. To compare groups, one way analysis of variance (ANOVA) was employed, and then Tukey's post hoc test for pairwise comparison. The threshold of relevance had been fixed at $p \leq 0.05$. SPSS 18.0 for Windows was utilized for statistic reliable investigation. (Statistical Package for Scientific Studies, SPSS, Inc., Chicago, IL, USA)

RESULTS

The error of standardization, mean results of ANOVA and post hoc try out for comparing apical debris extrusion between evaluated rotary methods for root canals are shown in Table 1. An experimental set up for debris collection are shown

TABLE (1) Showing The standard deviation, mean results of ANOVA and post hoc tests for comparing apical debris extrusion between evaluated rotary methods for root canals

Groups	N	Mean	±SD	±SE	95% C.I. for Mean		Min.	Max.	F-test	p-value
					Lower	Upper				
XPS group	15	0.022[B]	0.015	0.004	0.013	0.030	0.0001	0.050		
PTN group	15	0.051[A]	0.015	0.004	0.043	0.059	0.030	0.090	16.892	0.00*
I iRace group	15	0.024[B]	0.017	0.004	0.014	0.033	0.0002	0.060		

: Significant at P ≤ 0.05

in Figures 1. The PTN group has the highest mean value (0.051±0.015), followed by the iRace Group (0.024±017), and the XPS Group has the lowest mean value (0.022±0.015). The ANOVA test found a dependably meaningful difference (P=0.00) between groups. Tukey's post hoc test did not find a notable dissimilarity related to the XPS and iRace categories (p>0.05).

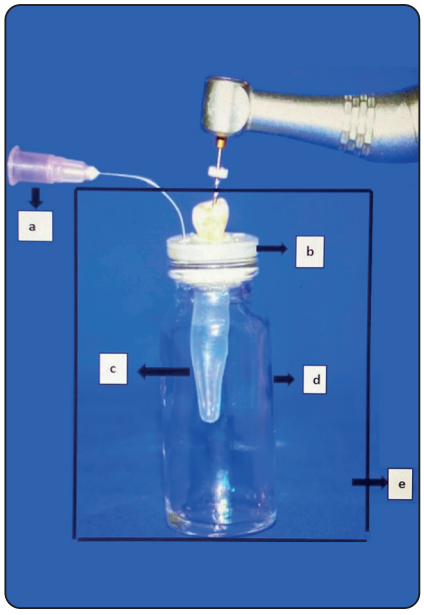

Fig. (1) An experimental set up for debris collection a: Irrigating needle b: the component incorporating tooth and needle had been secured to the cover with cyanoacrylate c: Ependorff tube d: glass bottle e: outer glass container contained hot water bath 37C.

DISCUSSION

It is well recognized that during the cleaning and shaping process, unintentional ejection of dirt and irritants inside the peri radicular tissues is a common problem. Cautious endodontic instrumentation is the major element in minimizing the risk of flare ups [15]. The development of postoperative pain may be significantly impacted by these variations in the sum of expelled debris [13].

The apical mass of ejected debris could be reduced through expanding the coronal space for debris [16]. Debris extrusion might also result from preparing the glide path. Despite the fact that they only extrude a small number of debris, the toxicity of the early debris is higher than that of the debris produced later by shaping files [17]. Therefore, in the present study there was glide path with no coronal flaring instrument during canal preparation

In order to create categories that were as close as feasible which respecting the anatomical traits in earlier investigations, mandibular premolar teeth with a single root had been employed. We only chose teeth that have foramens compatible with size 15 K-files to prevent variances that regards to the bacterial volume extruded as a result of increasing apical size, the master apical radius of apical instruments was standardized for all the groups as ISO size 30 [18].

Teeth samples with 10 K files were included at the apex for a fair system comparison. Working length was meticulously fixed to 18 mm while remaining 1 mm shy of the physical end for reducing the total amount of debris that is and managing amount of irrigant penetration [19].

Crystals of sodium hypochlorite have the potential to alter the ejected debris's weight. As a result, the study's alternative irrigation solution was bi-distilled water. Side vented needles decrease the possibility of irrigants extrusion. The Meyers and Montgomery method [11] was used to determine how much apically extruded material. The periapical tissues represent a physical blockade and back force that are supposed to tolerate irritants and dirt ejection are absent from this experimental setup. Foam of flowers can be applied in a simulation of back pressure from the periradicular tissues [20]. However, this arrangement may absorb irrigants and debris that impair the study's results. Consequently, Debris collection evaluations have also made by the usage of bare tube of Eppendorf [16]. Despite its limitations, the Myers and Montgomery model [11] was chosen to work out the expelled debris because it is feasible. It is impossible to obtain comparable clinical conditions, despite greatest attempts. Furthermore, in the matter of apical ejection level that related to the extruded dirt is not as significant as bacterial pathogenicity and host immune defenses [21].

Regarding apical ejection of dirt, endodontic procedures are frequently performed at regular temperature. In an attempt about 35 C as considered an intraradicular temperature. The apical diameter of XPS is equivalent to size 30 mm, with a constant taper of 1%. The transformation phase of martensite phase that belongs to a MaxWire alloy of the instrument's martensite phase at normal temperature to the phase of austenite at body temperature, added to the taper of 1% increases to 4% due to a twisted form of a snake [22].

Modern improvements in the manufacturing of NiTi files gave rise to single NiTi systems, in which a solitary file is used to finalize the mechanical preparation, instrumentation has been made simpler by working up the whole canal with only one file rather than using consecutive multiple-file systems [23].

When compared to other examined rotary systems, the rotary XP Endo Shaper produced the tiniest count of debris that had been expelled apically as revealed in the present research. This could be attributable to the characteristics of the file, its geometry, and its mode of operation. At intracanal temperature, the XPS file's slim shape and narrow 1% taper will resemble a snake. With S-modeled style of XP which had spooned shaped when moving to enable unsurpassed disposal of debris. This feature enables stress-free three-dimensional structuring of the canal. With a 0.04 taper, its adjustable core design allows for beginning to sculpt the canal pathways with size 15 and increase till size 30 [24]. XP Endo Shaper MaxWire technology, which offers superelasticity and shape memory capabilities with less cutting efficiency, may be relevant to these discoveries which fit to other reported studies [29] and confirmed by the results of previous study [25]

As one instrument employed for preparation opposed to the number of instruments used in other groups so longer interaction that accompanied the walls of canals lead to the production of more dirt in the apical area. Increasing the number of instruments was attaining the accurate length may result in increased extrusion, while, the greater rotational speed and smaller taper generated more turbulence inside the canal which contribute to a decrease in debris extrusion [26-27].

These findings were inconsistent with another reported study [28] which may be related to the large file taper that was used could be the cause of the disparate outcomes. In the even now investigation, XPS had been in a comparison to PTN and IRace rotating approaches, whereas in the previous study Reciproc blue was used for comparison.

Previous research found that the most popular causes of postoperative pain is the ejection of

debris during canal instrumentation [29]. The current findings were consistent with other studies [22, 30], which found respectively that XPS created minimal expelled debris at the apical part among tested rotary systems and less postoperative discomfort than iRace, and this conclusion was reinforced by the results that XPS has less apical extrusion than iRace.

The mass of apical dirt ejection possibly will differ relying on the finished instrument's size [13]. In this investigation, every rotary system possessed a perimeter end that was comparable as size 30. In order to achieve a standardization in approach, the size of the apical expansion was equal in our study.

Although PTN (M wire metallurgy) indicates greater flexibility than traditional NiTI, I Race rotary system (Traditional Ni Ti) reported minimal extrusion of debris in contrast to the ProTaper Next rotating system in a current investigation. These results could be attributed to their small triangular cross-sectional design, the working part with alternating cutting edges might have a beneficial impact on increasing their flexibility, preventing the screwing in effect, and providing more space for debris removal. It might be also explained by the difference in the taper of the instrument (4% for irace vs. PTN7%), since the lower taper could result in more upward disposal of debris [31]

The revealed results of the current investigation coincided with those of other investigations, that came to the conclusion that cross-sectional design elements and core size may be deleterious to the expelled debris at terminal end. [32]

Within limitations of this work, periapical resistance was not artificially recreated as previously revealed that the utilized foam may be sucked up inside the canal and it had been no specific information to establish apical resistance [20]. Additionally, more research is required to replicate the periapical resistance.

CONCLUSIONS

The mass of apically ejected debris recorded for dissimilar rotary systems was PTN > iRace > XPS with a statistical contrast While, a remarkable contrast as regard to the XPS and iRace groups ($p>0.05$) has not been discovered.

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