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Quantitative Analysis of Apical Extrusion of Debris by Different Retreatment File Systems

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Abstract:
Aim: To assess the effect of various retreatment file systems on apical debris extrusion.
Material & method: Extracted human maxillary premolars were biomechanically prepared and obturated with gutta percha. They were divided into four groups according to the retreatment file used: Group 1 –M two, Group 2 - Hyflex, Group 3 – Neoniti & Group 4 - Protaper retreatment. The gutta percha was removed and extruded debris were collected. The amount of apically extruded debris by different retreatment rotary file systems obtained from the experimental groups was calculated. The arithmetic mean & standard deviations were calculated for intra & inter group comparisons. The One way Anova analysis of variance test was applied to find the significant difference among the four groups. The One way Anova analysis of variance revealed significant differences among the four groups.
Conclusion: Retreatment rotary file Hyflex EDM showed maximum amount of apically extruded debris, and the lowest values were displayed by M two and Neolix file.

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I. Introduction

The retreatment of an endodontically treated tooth requires the removal of root canal filling material to achieve endodontic disinfection. In the retreatment procedure, as much as possible the bulk of Guttapercha and the canal sealer should be removed. However, current available instruments and techniques are incapable of preparing root canals or removing root fillings without debris and irrigant extrusion. The host immune response against irrigating solutions, debris, or foreign body reactions to obturation materials such as GP may provoke postoperative pain and swelling during the retreatment.

In an effort to obtain complete debridement of the root canal system, debris such as dentinal filings, necrotic pulp, bacteria or irrigants may be extruded into the periradicular tissue, this debris may lead to postoperative pain and discomfort. Studies have shown that almost all instrumentation techniques produce apical debris of some degree. Therefore using an instrumentation technique that minimizes apical extrusion would be advantageous to both the practitioner and the patient.[1]

Various instrumentation methods have been introduced to remove the canal filling material such as; hand files, NiTi files in reciprocal motion, NiTi files in rotational motion and retreatment files.[2] The retreatment files were suggested to remove the root canal filling materials. These instruments remove the GP more rapidly than hand files. The success of endodontics is based on thorough debridement, disinfection and a three dimensionalobturation. A complete debridement of the root canal by instrumentation and irrigation solutions is the critical step in endodontic treatment.[3] All instrumentation techniques cause some amount of extrusion of debris, even when the root canal preparation is maintained short of the apical terminus.Extruded debris consists of irrigation solutions, necrotic tissue, microorganisms, pulpal fragments and dentinpowder. This is responsible for postoperative inflammation and failure.In spite of adequate chemomechanical preparation and obturation, endodontic flare up may be caused by extruded material referred as the "worm" of necrotic debris.

For more than a decade, various rotary systems are in use which differs in material property, cross section, taper, symmetry, etc. Although modifications in instrument design are done to improve cutting efficiency, flexibility, fatigue resistance etc., it does not improve all the properties.[4] Instruments with asymmetrical cross-section are considered to decrease the axial stress. Single file systems based on M-wire technology namely the Reciproc (VDW, Munich, Germany) and WaveOne (Dentsply, Maillefer, Ballaigues,

Switzerland) systems, shape the root canal in reciprocating motion and are found to have greater fatigue resistance and better centering ability.

Other studies also found less dentinal debris extrusion when using engine driven rotary systems despite hand instrumentation. File systems can differ in their design, such as in radial lands, flute depth, different tapers,cross sections, kinematics and this situation may influence the amount of apically extruded debris through the apical foramen.

The ProTaper Universal retreatment system (PTUR) (Dentsply Maillefer, Ballaigues, Switzerland) consists of D1 (30/0.09), D2 (25/0.08), and D3 (20/0.07) files, which are designed with various tapers and the tip diameters. While the Mtwo retreatment system (Mtwo R) (VDW, Munich, Germany) has two files: R1 (25/0.05) and R2 (15/0.05).There are few studies evaluating the amount ofapically extruded debris during the removal ofroot canal filling material using the Reciproc andRaCe instruments.

To the best of our knowledge, there is no reported study assessing the apical debris extrusion during retreatment by recent file system. So the aim of this in vitro study is to assess the effect of retreatment file systems on apical debris extrusion.

II. Method

A total of 80 freshly extracted human maxillary premolars were selected, cleaned and stored in physiologic normal saline.The degree of curvature was calculated using methodology described by Schneider.The apical region of the roots were inspected using a stereomicroscope under 20 X magnification. Only those teeth with single canal were selected. Endodontic access cavity was prepared with the help of diamond bur in a high speed airotor hand piece and the pulp tissue was removed. A size 15 K file was introduced in the canal and intraoral periapical X-ray will be carried out to determine the working length. The biomechanical preparation of the root canals was done with silk rotary endodontic file. After irrigation with sodium hypochloride, canals were dried with absorbent points and obturated with gutta percha. All the samples were divided into four groups.

Group 1 –M two (VDW)
Group 2 - Hyflex (EDM)
Group 3 - Neoniti (Neolix, France)
Group 4 - Protaper retreatment (Dentsply)

The gutta percha was removed from all the samples. Extruded debris and irrigant will be collected in a pre-weighted receptor tube. A second bottle will be used to hold device during instrumentation So that no contact with the collecting vial was possible.The collector bottle will be vented by a 25 gauge needle.

The receptor tubes will then be stored in an incubator at 70°C for 5days to evaporate moisture before weighting dry debris.An electronic balance with accuracy of 0.00001 g will be used to weigh the tubes containing debris.

III. Result

The amount of apically extruded debris by different retreatment rotary file systems obtained from the experimental groups were presented in Table 1. The arithmetic mean & standard deviations were calculated for intra & inter group comparisons. One way Anova analysis of variance revealed significant differences among the four groups ($P > 0.05$).Retreatment rotary fileHyflex EDM showed maximum amount of apically extruded debris, and the lowest values were displayed by M two and Neolix file.

IV. Discussion

One of the most significant complications that occurs as a consequence of apical extrusion during root canal procedures is interappointment flare ups, as well as postoperative pain, which is an undesirable occurrence both for the patient and the practitioner.

In this study, to eliminate possible complications, such as WL loss or nonstandard preparation and irrigation incurved root canals, straight and single rooted teeth were used. The generally accepted method of Myers and Montgomery was used to collect the apically extruded debris. Although the vital periapical tissues, such as the periodontal ligament, cannot be mimicked, the technique allows for the comparison of file systems.[5]

Proper cleansing of the root canal space is considered essential for success in endodontics. An acute inflammatory response may develop in the periradicular tissues as a result of insults from the root canal system,which can be mechanical, chemical, or microbial in origin. Mechanical and chemical injuries are usually associated with iatrogenic factors, such as over-instrumentation,apical extrusion of debris or irrigant, perforations,etc.Apical extrusion of contaminated debris into the periradicular tissues is one of the principal cause of midtreatment flare-up and postoperative pain.

Apical extrusion of debris, which is one crucial reason of postoperative pain and discomfort, is still unavoidable.[6] On the other hand, there are various studies that reported favorable effectsof Ni–Ti rotary

instruments (either introduced for retreatment or for preparation procedures) compared to conventional techniques on amount of apicallyextruded debris. Furthermore there are few studies which evaluatedthese systems effect on the amount of apically extrudeddebris during endodontic retreatment. Hence,the aim of this study was to evaluate the effect ofretreatment systems onthe amount of apically extruded debris. Retreatment rotary file Hyflex EDM showed maximum amount of apically extruded debris, and the lowest values were displayed by M two and Neolix file. There are controversial results regarding apical debris extrusion potential during primary rootcanal treatments.[7] Reciproc system resulted inmore apical debris extrusion than the Mtwo systemaccording to Lu et al.However, Dincer et al. andSilva et al. reported that Reciproc was associatedwith less debris extrusion when compared witha conventional rotary retreatment system such asProTaper Universal retreatment system and Mtworetreatment system. The result of present study wasconsistent with these two studies.[8] Reciproc produced significantly less amount of apical extruded debris than the other groups. Koçak et al and De Deus et al reported that there was less apically extruded debris with Reciproc, however Bürklein et al and Bürklein and Schäfer reported that there was more amount of debris extruded apically with Reciproc. One possible reason of this result might be the number of files that were used for retreatment; the other one might be the motion kinetics of files.

M two rotary single file system showed less amount of apical debris and irrigant extrusion when compared to wave one and protaper hand file. The reciprocation movement in WaveOne system is formed by a wider cutting angle and smaller release angle. While rotating in the release angle the flutes will not remove debris but push them apically.[9] Moreover, WaveOne file is quite big, rigid with an increased taper which is directed to reach the apex.

Apical debris extrusion occurred independent of the type of instrument or the motion.[10] It has been reported that waveone produced the highest amount of extrusion followedby ProTaper and the least extrusion with Revo S. Thoughthere was a statistically significant difference amonggroups, the difference between Revo S and WaveOnewas extremely significant. The triangularor modified triangular crosssection of ProTaper andWaveOne produces a lower cutting efficiency and smallerchip space. The smaller chip space limits their ability to allow coronal removal of debris resulting in a piston like action.[11] Moreover, instrumentation in reciprocal motion may enhance debris transportation toward the apex. This is because a continuous rotary motion acts like a screw conveyor and improves the coronal transportation of dentin debris. But because of limited flute space, ProTaper was probably unable to effectively transport thedebris as much coronally as Revo S. The smaller taper withthe asymmetrical cross sectional design of Revo S alsoallows oscillation of the file, providing adequate space forupward debris elimination, facilitating coronal movement of debris.and acts like a screw conveyor producing transportation of debris, dentin chips and its evacuation out of the rootcanal in a coronal direction.

WaveOne and Reciproc file has been found to extrude more debris compared to single use rotational sequence One Shape system. WaveOne file works in 170° counter clockwise (large rotation angle in the cuttingdirection) and 50° clockwise reciprocating motion (smallerrotating angle in the disengaging direction). This unequal reciprocal motion, in and out filing motion acts like a piston causes more debris extrusion apically.[12] The file with aggressive cutting ability removes a substantial amount of radicular dentin in a relatively shorter period, but unable to displace debris coronally that enhances the apical extrusionin combination with reciprocating motion. Ozsu *et al* found that ProTaper Universal produced maximum debris extrusion whereas WaveOne, ProTaperNext, self adjusting file produced less debris extrusion. The variation may be due to the difference in the experimentalsetup; moreover, vital pulp tissue cannot be simulated inthe vitro model, decreased width of apical constriction,etc., significantly reduce the amount of debris extrusion.Üstün *et al*. also reported that waveOne produced the least debris extrusioncompared to twisted files and ProTaper next. This can beexplained by the reciprocating action, which is a type ofmechanized balanced force pressure less technique.Xavier *et al* reported that Wave One extrudedless debris compared to Reciproc. The reason was that WaveOne (largefile) size 40 (0.08 taper) had 20% smaller diameter at the tip Moreover, system extruded less debristhan Reciproc due to the following reasons WaveOnesingle file is used at rotational angles of 130° counterclockwise and 50° clockwise, this system has a differentcross sectional design along its entire active part.[13] The tip has a triangular cross section modified with radial lands,and there is a change to a neutral rake angle with a convextriangular transverse cross section in the middle and neckportions of the working part of the instrument, it has a decreasing taper along its entire length, this may have lesscutting power and would produce less debris. Hyflex CM has been shown less debris extrusion as compared to protaper and wave one. The difference may be due to variable cross sectional design or the preparation technique.[14] Marques da Silva et al. reported that supplementary instrumentation performed afterthe use of ProTaper and D RaCe retreatment files provided more effective cleaning than the use of only retreatment instruments in the apical third.[15]

There are a few limitations of this study. The results obtainedcannot be generalized to teeth with multiple roots, severelycurved canals, incomplete root development, open apicesas teeth only with single root canals with <20° curvature was selected. In the present study, no attempt was made to determine the association of debris

extrusion with various irrigation systems, reassessment of apical dentinal plug,simulation of vital/necrotic pulpal tissue and periapicaltissue by floral foam that serves as natural barrier limiting apical debris extrusion, histopathological correlation ofperiapical inflammation with apical debris extrusion.

Retreatment rotary file Hyflex EDM showed maximum amount of apically extruded debris, and the lowest values were displayed by M two and Neolix file. The arithmetic mean & standard deviations were calculated for intra & inter group comparisons. The One way Anova analysis of variance test was applied to find the significant difference among the four groups. The One way Anova analysis of variance revealed significant differences among the four groups ($P > 0.05$).

It is important to emphasize that file systems werecompared in an experimental model using thatcollected apically extruded debris from extractedteeth. This technique allows a comparison of the filesystems under identical conditions and has beenused in many studies previously,but itdoes have limitations. The main disadvantage ofthe method is that vital periapical tissues cannot bemimicked. Apical extrusion was not limited, becauseof the absence of a physical backpressure providedby periapical tissues in vivo. This is an imminentshortcoming of in vitro designs with no periapicalresistance; as a result certain degree of caution shouldbe taken when transferring the present results tothe clinical situation. Furthermore, this study waslimited to teeth with mature root morphology. Theobserved results should not be generalized to teethwith immature root development and open apices.

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