Effect of early cervical preflaring and glide path utilizing rotary PathFiles or manual K-files on the amount of apically extruded debris from curved canals instrumented by rotary ProTaper system.

*Dr Abdul Rahman M. Saleh PhD, MSc, BDS **

Abstract

Introduction: The aim of this study was to comparatively evaluate the amount of apically extruded debris when rotary ProTaper system was used for instrumentation of root canals preceded by rotary PathFiles or manual K-files and the effect of early cervical preflaring on total debris extrusion.

Material and method: Forty mesiobuccal canals of lower first molar teeth, with 20 to 40 degrees of root canal curvature, were selected. A size 8 K-file was placed up to the apical foramen to determine the patency. Working length was determined with the same instrument, 1 mm short of the foramen. According to the employed technique, the groups were labeled and initial instrumentation was performed as follows: Group (1-A) initial instrumentation by hand K-files without cervical preflaring; Group (1-B) initial instrumentation by hand K-files with cervical preflaring; Group (2-A) initial instrumentation by rotary PathFiles without cervical preflaring; Group (2-B) initial instrumentation by rotary PathFiles with cervical preflaring. Further instrumentation of all canals was completed by rotary ProTaper system. During instrumentation, each root canal was irrigated with 10 mL distilled water. Debris extruded through the apical foramen was collected using the Myers and Montgomery technique.

Result: Data obtained were analyzed using Kruskal-Wallis one way analysis of variance and Mann-Whitney U test with P=0.05 as the significance level. The results show no statistically significant difference among the groups.

Conclusion: There is no statistically significant difference of early cervical preflaring on the total amount of apically extruded debris. Also there is no statistically significant difference between rotary or manual glide path on the total amount of apically extruded debris.

Introduction

The objectives of endodontic instrumentation include thorough debridement and disinfection of the root canal system, in addition to creating a suitable shape to achieve a complete 3D obturation. In an effort to obtain these objectives, debris such as dentinal shavings, necrotic pulp tissue, bacteria and their byproducts or irrigants may be extruded into the periradicular tissue [(1)].

A large number of studies have dealt with the effect of various root canal preparation techniques and instruments on the amount of the apically extruded dentinal debris and irrigants.

Apical extrusion of debris tends to be greater with hand instrumentation than with techniques that use rotary forces [(2, 3, 4, and 5)] because the files may act as pistons that push irrigating solutions and debris towards the apex [(6)]. Conversely, rotary instrumentation may move debris along the files, which may result in debris being, expelled cervically [(7)].

A study done by Luisi *et al* found that instrumentation using a continuous rotary technique, ProTaper system, produced greater apical extrusion than the hand and engine-driven crown-down techniques [(8)]. They stated that the direction of instrumentation, whether cervical-apical or apical-cervical, seems to be a more important factor influencing apical extrusion rather than mode of the instrumentation was performed by hand or engine-driven.

While Tinaz et al revealed no significant difference between instrumentation with hand K-files and rotary ProFile .04 taper files, there was a tendency with both techniques to apically extrude more material as the diameter of the apical patency increased [(9)].

Blum et al [(10)] suggested a glide path with small flexible stainless steel hand files to create or verify that within any portion of a root canal there is sufficient space for rotary instruments to follow. Berutti et al [(11)] underlined the need for preflaring apical part of the canal up to #20 K file for the ProTaper instruments so as to ensure sufficient space for the S1 file, because its tip measures 0.17 mm. They reported that the reduction in torsional stress increased the average instrument lifespan almost 6-fold, while reducing costs and the risk of instrument separation within the canal.

Previously, clinicians were limited to using small stainless steel hand K-files (size 6 up to size 15 or 20) for this purpose. This often resulted in canal blockage, deviation into the canal wall (ledging or false canal), apical zipping or tearing, or a separated instrument. This occurred because the stainless steel file tended to deviate from the canal confines based on clinician use and the impact of remaining tissue and/or calcifications in the uncharted canal space [(12)].

Recently new PathFile NiTi Rotary instruments for glide path were introduced by Dentsply Maillefer (Ballaigues, Switzerland).The system consists of 3 instruments, with 21-25-31 mm length and 0.02 taper; they have square cross section. The PathFile

#1 (purple) has an ISO 13 tip size; the PathFile #2 (white) has an ISO 16 tip size; the PathFile #3 (yellow) has an ISO 19 tip size.

Berutti et al found NiTi Rotary PathFiles appear to be suitable instruments for safe and easy creation of the glide path before use of NiTi Rotary shaping of the canal. PathFiles demonstrate better maintenance of the original canal anatomy with less modification of canal curvature and fewer canal aberrations compared with manual glide path performed with stainless steel hand K-files [(13)].

Using an instrumentation technique that minimizes apical extrusion would be advantageous to both the practitioner and the patient.

The main objective of the present study was to assess the apical extrusion of dentine debris as a result of using NiTi rotary PathFile or manual K-file with or without early cervical preflaring followed by ProTaper system.

Material and method:-

1. Canals selection:
A total of forty mesial roots of extracted human mandibular first molar teeth with mature apices and with no previous root canal treatment were collected after excluding those with cracks, fractures, and resorption. Buccal and proximal radiographic examinations were performed to exclude roots with open apices, calcified or extra canals. The surfaces of the roots were cleaned using periodontal curettes , kept in sodium hypochlorite solution 2% overnight for surface disinfection followed by storage in 10% buffered formalin .
Only mesiobuccal canals of the selected root were included for this study. Canal curvatures were measured according to Schneider method [(14)]. Canals with curvature between 20 to 40 degrees were selected.
Crowns were resected to the cemento-enamel junction using a high speed carbide disk to give a standard tooth length of 12±2 mm. Canal patency was controlled with hand K-file size #8 (Dentsply Maillefer, Ballaigues, Switzerland). Working length was determined 1 mm shorter than the length at which the file was visible through the apical foramen. Only canals in which size 10 K-file or less bound at working length were selected.

2. Canals grouping and preparation:
40 canals were divided into two main groups of 20 canals, each according to the files used for glide path as follows; in (group 1) manual K files were used while in (group 2) a rotary PathFile instruments in gear reduction hand piece were used. Each group was further subdivided into two subgroups of 10 canals each as follows: (subgroup A) without cervical preflaring and (subgroup B) with cervical preflaring.

Group 1-A (manual files without cervical preflaring): hand K-files sizes 8, 10, 15 and then 20 (Dentsply Maillefer, Ballaigues, Switzerland) were used with a primary quarter clockwise rotation followed by a pull-back motion until working length was reached.

Group 1-B (manual files with cervical preflaring): Rotary S1 and Sx files were used for early cervical preflaring of the canal. S1 followed by Sx files were inserted at the fixed speed of 300 rpm. Instrument was withdrawn when resistance was felt. Hand K-file sequences were used in the same sequence as the same of group 1-A utilizing hand K files.

Group2-A (rotary files without cervical preflaring): Rotary PathFiles instruments (Dentsply Maillefer, Ballaigues, Switzerland) were used in a 16/1 gear reduction hand piece powered by an electrical motor (X-SMART, Dentsply Maillefer) at the constant speed of 300 rpm. The instruments were used, up to the working length in the following sequence PathFile 1 followed by PathFile 2 and finally PathFile 3.

Group 2-B (rotary files with cervical preflaring): Rotary S1 and Sx files were used for early cervical preflaring of the canal. S1 followed by Sx files were inserted at the fixed speed of 300 rpm. Instrument was withdrawn when resistance was felt. File sequences were used as the same of group 2-A utilizing PathFiles instruments in a gear reduction hand piece at the constant speed of 300 rpm, all to the working length.

For all groups, canals instrumentation was completed by rotary ProTaper system (Dentsply Maillefer, Ballaigues, Switzerland). ProTaper rotary instruments were used in a crown-down manner according to the manufacturer's instructions using a gentle in and out motion. Instruments were withdrawn when resistance was felt and replaced by the next instrument size. File sequences used were: Sx files were used until resistance was encountered (4–5 mm from the working length), S1 and S2 files were inserted till 2/3 of the working length and F1and F2 files were used till the full working length. Hands K-file # 10 was used at the working length between each file in order to prevent apical blockage.

Ten mL of distilled water irrigant was used for irrigation of the each root canal. Between each file, 1 ml of distilled water was delivered by disposable plastic syringe with a 28-gauge stainless steel needle (Max-p28i, Dentsply, Rinn,USA) that had been placed into the canal as far as possible without bending.

3. Debris Collection:

The method used for apical debris collection was carried out as described by Myers and Montgomery [15]. Each root was forced through a rubber plug so that it could be easily held during instrumentation. The extruded debris and irrigants were collected in a pre-weighed receptor tube, attached to the lower edge of the rubber plug. Before treatment, each tube was weighed to 10-5 gram precision by an electronic balance. Three consecutive measurements were taken for each tube and the mean value was recorded as a pre instrumentation weight. The root apex was allowed to be hung within the receptor tube. A side-mouth bottle was used to hold the device during instrumentation. The bottle was vented with a 25-gauge needle alongside the rubber plug to unify the pressure inside and outside the bottle. The bottle was obscured with a tape so that the operator was shielded from seeing the root apex during the instrumentation. Once instrumentation had been completed, each root was separated from the receptor tube and the debris adhering to the root surface was collected from root surface by washing the root with 2 mL of distilled water into the receptor tube. The receptor tubes were then stored in an incubator at 68˚C for 7 days in order for moisture to evaporate before weighing the dry debris.

4. Debris weighing:

An electronic balance was used to weigh the debris at 10-5 gram precision. This was repeated until three consecutive identical weights were obtained for each sample and the mean value was recorded as a post instrumentation weight. Mean pre-instrumentation weights were deducted from the mean post- instrumentation weights and the difference was recorded as the weight of extruded debris.

5. Statistical analysis:

The mean dry weights of extruded debris were analyzed statistically using SPSS (version 13.0). The Kruskal-Wallis non-parametric test and Mann-Whitney U test was applied to determine if significant differences existed between groups ($p<0.05$).

Result:

Data regarding the amount of debris extruded from all groups are presented in table (1)

Table (1) shows mean weight in mg of dry extruded debris apically during cleaning and shaping of each group.

Group	Mean	Std Deviation	Range
Group 1-A	.033520	.0205388	.000-
Group 1-B	. 029630	.0212485	.000-
Group 2-A	.027490	.0176193	.000-
Group 2-B	.037880	.0239471	.001-

All instrumentation techniques tested produced measureable amount of debris extruded apically. No significant difference in the quantity of debris extruded apically was noted among the different groups. The result shows no significant difference among the different groups whether using rotary or hand glide path. On the other hand, there is no effect of early cervical flaring on the amount of debris extruded apically.

Discussion:

A major objective in root canal treatment is to obtain a clean root canal system. Dentine chips, pulp tissue fragments, necrotic tissue, microorganisms, and intra-canal irrigants may be extruded from the apical foramen during canal instrumentation. This is of concern since material extruded from the apical foramen may be related to post instrumentation pain or to a ‘flare-up’.

The extrusion produced by the various techniques was expected, because it is considered a problem of all canal instrumentation methods.

The main objective of the present study was to evaluate and compare the amount of apically extruded debris with the rotary ProTaper systems preceded by manual or rotary glide path and the effect of early cervical preflaring on that. In our study, a single operator prepared all the canals to eliminate the inter-operator variable. A standardized protocol was followed to increase the probability that the amount of apically extruded debris was a result of instrumentation and to decrease the number of variables involved. The mesiobuccal canals of lower first molar used for this study were carefully selected to have a closed mature apex and tiny canal (only sizes less than size10 could pass to the working length). The teeth were decoronated at the CEJs, which helped to obtain a fixed and reliable reference point as well as an approximately similar working length of 12 ± 2 mm. A fixed amount of distilled water (10 mL) was chosen as an irrigant for this study to reduce the chances that particulate matter indwelling in other irrigants might possibly skew the final values. The size of the master apical instrument was kept constant the ProTaper rotary F2.

According to the manufacturer, PathFiles are a 3-file system of .02 constant taper, with a square cross section and an improved tip design reducing the risk of ledges and canal transportation [13].

The results of this study demonstrate that all instruments tested caused a measurable apical extrusion of debris. This is in agreement with a previous in vitro study which compared the quantity of debris and irrigant extruded apically using the ProTaper system to other systems [7, 8, 16].

Rotary NiTi PathFiles and small sizes of manual K-files have virtually eliminated the problems encountered when trying to create an acceptable and predictable pathway prior to the use of larger or variably tapered NiTi instruments. Their smaller taper gives increased flexibility and more resistance to cyclic fatigue. This means less canal transportation, more flexibility, faster instrumentation time, preservation of the original canal anatomy, no transportation of the apical foramen, and no ledges if they are used short of the desired working length [12].

In our study no instrument fracture occurred. One possible reason for no breakage could be the elimination of interference carried out by the glide path files whether rotary or manual which help to eliminate potential anatomical problems before rotary instrumentation and reduce the taper lock of the tip of ProTaper files.

In our study, we used rotary ProTaper systems which has characteristic features such as a progressive taper and a modified guiding tip. These files demonstrate a convex and triangular cross-section design, which results in a reduced contact area between the dentin and the cutting blade of the instrument, allowing it to achieve a greater cutting efficiency. They also have active cutting blades with a positive rake angle. Their design features include a variable helical angle and balanced pitches, which allow for debris removal and prevent the instrument from screwing into the dentinal walls of the canal. A significant advantage of the ProTaper system is a reduction in the number of instruments used which saves time and operator fatigue.

The general view in endodontic literature is that linear filing motion extrudes more debris apically than rotational motion. In our study we did not find a significant difference between the manual or rotary glide path .The reason for the non-significant results may be because both those instruments have similar and smaller taper which is 2% which is not enough to make aggressive cutting effect and they could provide advantages in the form of a less invasive and safer approach to the subsequent canal instrumentation with any NiTi Rotary system.

Comparing the mean weights of apically extruded debris (table no 1), although there is a difference in the movement between the rotary PathFiles (continuous rotation) and manual K-files (combination of watch-winding and push-pull) which results in an increase of amount of extruded debris with manual K-file group as compared with the rotary groups, but it was not statistically significant. The reason for that is probably related to the fact that both rotary and manual glide path file are used for scouting and initial enlargement to prepare space for the large taper and aggressive files to shape and clean the canals.

Tanalp et al. compared ProTaper systems (without using glide path) with other continuous rotary techniques and found significantly greater amounts of extruded debris when using the ProTaper technique. In their study, this technique had significantly more apical extrusion results than those found for a hand technique and a reciprocating rotary technique. Although the ProTaper System uses fewer instruments, it promotes greater dentin wear in a shorter time because of its greater cutting capacity and taper. The other techniques in their study (hand and alternating rotary technique) required the use of more files with only one, lower taper (0.2 mm). Their cutting capacity was, therefore, lower, and the root canal was prepared slowly and gradually until the working length was reached. The tapering of the ProTaper files favors the preparation of the apical third as soon as instrumentation begins. Thus, wear occurs early throughout the whole canal because the instruments reach the working length in the beginning of the preparation, which causes greater apical extrusion [7].

There are many advantages of early cervical preflaring on the initial file working length and accuracy size determination [17], but there is no study of its effect on the amount of extrusion of debris apically.

Although there is a better tactile sensation and easy insertion of all the successively used files during the process of cleaning and shaping, our study did not find any significant difference as a result of using or not using the early cervical flaring .The reason why it does not decrease the extruded debris can be that it will allow more irrigation to push debris apically especially those which are suspended after file planed the canal wall.

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. * Dr Abdul rahman M Saleh is Assistant Professor, Department of Restorative Dentistry ,Ajman University of Science and Technology ,UAE. For further details contact at
E-mail :drabdulrm@yahoo.com
00971502283188