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ORIGINAL RESEARCH

Apical Debris Extrusion during Root Canal Preparation with ProTaper Next and Mani Silk Rotary Systems: An *in vitro* Study

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ABSTRACT

Aim: To evaluate the amount of apically extruded debris after the preparation of root canals in extracted human single-rooted teeth using ProTaper Next and Mani Silk rotary systems.

Materials and methods: A total of 40 freshly extracted human single-rooted teeth with mature apices and straight root canal were selected and similar length were instrumented with ProTaper Next and Mani Silk rotary systems. Debris and irrigant extruded during instrumentation were collected into preweighed Eppendorf tubes. The Eppendorf tubes were then stored in an incubator at 68°C for 5 days. The weight of the extruded debris was determined by subtracting the initial weight from the final weight.

Statistical analysis: Data analysis was carried out using the Statistical Package for the Social Sciences (SPSS) version 20. Postweights were compared with an independent t test for 2 groups.

Results: Both instruments were associated with apical debris extrusion. There was no significant difference between the ProTaper Next and Mani Silk instruments in terms of mean weight of apically extruded debris.

Conclusion: There was no significant difference among the groups in terms of mean weight of apically extruded debris.

Keywords: Apical debris extrusion, Eppendorf tube, Manisilk, Protaper Next.

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INTRODUCTION

Root canal treatment is a procedure in which pulp tissue, bacteria are removed from the root canal system. During chemicomechanical preparation, dentin chips, irrigants, necrotic pulp tissue, and microorganisms from the root canal gain access to periapical tissues, which leads to inflammation and postoperative pain known as "flare up"[1] that disturbs healing of periradicular tissues. Several studies have shown that all instrumentation techniques and instruments cause apical extrusion of debris.[2-4]

A common finding of all the studies regarding the apical extrusion of debris and the irrigant was that the instrumentation techniques using a rotational motion tend to produce a less apical extrusion of debris than instrumentation techniques using a push–pull motion.

The amount of apically extruded debris during canal preparation using ProTaper Next and Mani Silk instruments has not been reported.

Therefore, the aim of this *in vitro* study was to assess the amount of apically extruded debris after the root canal preparation using ProTaper Next and Mani Silk instruments.

The null hypothesis was that there would be no difference among the instrumentation systems in terms of amount of apically extruded debris.

MATERIALS AND METHODS

A total of 40 extracted human single-rooted teeth were used. Inclusion criteria for tooth selection were as follows. A single root canal, no visible root caries, no fractures or cracks, no signs of internal or external resorption or calcification, a completely formed apex, and a curvature <5°, in according with protocol established by Schneider. The teeth were radiographed buccolingually and mesiodistally to rule out any atypical canal morphology and to confirm a single canal with single apical foramen. Soft tissue remnants, debris, and dental calculi that are present on the root surface are removed by ultrasonic scaler and the tooth was stored in distilled water. Endodontic access cavities were prepared using diamond burs (Diatech, coltene whaledent, Alstatten, Switzerland) with a high-speed handpiece under water cooling. After preparation of the access cavity, canal patency was established with a size 10-k file (Dentsply Maillefer). Canals with dimensions that exceeded size 15 were discarded and 40 teeth were finally selected that met the dimension criteria. To ensure standardization and to obtain a reference point,

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incisal edges of teeth were flattened using a high-speed bur and the length of all teeth were standardized to 21 mm. A size 10-k file was placed in the canal until it was just visible at the apical foramen, and the working length was established by reducing 1 mm from this point.

Instrumentation and Debris Collection

Experimental model described by Myers and Montgomery[5] was used (Fig. 1). A hole was created in the cap of an Eppendorf tube and a tooth was inserted to its cementoenamel junction. A 27-G needle was placed alongside the cap as a drainage cannula and to equalize air pressure inside and outside the Eppendorf tube. Stoppers were then attached to their Eppendorf tubes, and the tubes were fitted into the vials. Eppendorf tubes were weighed to 10^{-5} precision using an electrical balance. Three consecutive measurements were taken for each tube, and the mean values were recorded. Forty teeth were numbered and then randomly assigned into 2 groups of 20 specimens each. Each teeth was isolated with rubber dam.

ProTaper Next Group

In this group, initially Sx were used to half of its working length, then X1 (size 17/0.04 taper), X2 (size 25/0.06 taper) were used to full working length with an endodontic motor (x-smart, Dentsply, Maillefer) at a rotational speed of 300 rpm and 2 Ncm torque, according to the manufacturer's instructions. A gentle in and out brushing motion was used. In each sample, 3 mL of NaOCl and 3 mL of saline were used as irrigation solution between the uses of files.

Mani Silk Group

In this group, root canals were prepared using Mani Silk file system-simple pack with a gentle in and out motion at 500 rpm and 3 Ncm torque with a torque controlled endodontic motor (x-smart, Dentsply, Maillefer); first, by using 0.08/25 orifice opener and preparing a glide path, and 0.06/25 and 0.06/30 files were of full working length. In each sample, 3 mL of NaOCl and 3 mL of saline were used as irrigation solution between the uses of files.

Fig. 1: Experimental model system used to evaluate debris extrusion

Evaluation of apically Extruded Debris

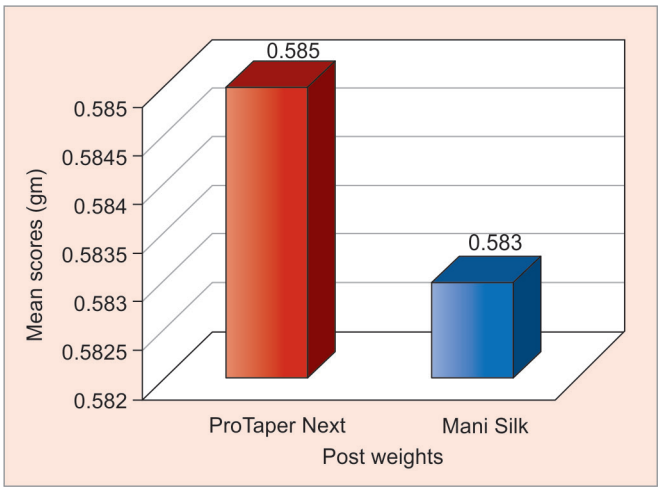
Evaluation was completed by a second examiner blinded to group assignment. On completion of the canal preparation, the Eppendorf tubes were removed from the vials. The debris adherent to the external surface of the root apex was collected by washing the root with 1 mL distilled water in the tube. The tubes were stored in an incubator at 68°C for 5 days to evaporate the irrigant solutions before weighing the debris. The net weight of the dry debris was determined by subtracting the original weight of the Eppendorf tube from the gross weight (Table 1).

Statistical Analysis

Data analysis was carried out using the Statistical Package for the Social Sciences (SPSS) version 20. Shapiro-Wilks normality test results showed that weights in both the groups follow the normal distribution. Therefore, parametric methods were applied for the analysis of the data. Basic descriptions were presented in the form of mean and standard deviation. Postweights were compared with an independent t test for two groups (Graph 1). The level of significance was set at $p < 0.05$ for all tests.

Table 1: Weight of Eppendorf tubes – preweight and postweight in (gm-grams)

Sl. no.	*ProTaper next preweight of eppendorf tubes (gm)*	*ProTaper next postweight of eppendorf tubes (gm)*	*Mani Silk preweight of eppendorf tubes (gm)*	*Mani Silk postweight of eppendorf tubes (gm)*
1	0.48	0.51	0.56	0.61
2	0.58	0.59	0.55	0.56
3	0.59	0.60	0.56	0.61
4	0.54	0.57	0.55	0.61
5	0.56	0.57	0.56	0.58
6	0.57	0.59	0.55	0.56
7	0.56	0.58	0.55	0.58
8	0.56	0.61	0.58	0.59
9	0.56	0.58	0.58	0.60
10	0.55	0.60	0.55	0.56
11	0.54	0.59	0.57	0.63
12	0.57	0.62	0.54	0.55
13	0.58	0.62	0.57	0.59
14	0.57	0.58	0.58	0.62
15	0.57	0.62	0.56	0.57
16	0.56	0.57	0.56	0.57
17	0.55	0.57	0.55	0.57
18	0.55	0.62	0.54	0.55
19	0.54	0.56	0.58	0.59
20	0.55	0.56	0.55	0.56



Graph 1: Independent t test was performed between two groups

RESULTS

The mean values and standard deviations for both groups are listed in Table 2. The apical debris extrusion was seen in all specimens. There was no significant difference among the groups in terms of mean weight of apically extruded debris ($p > 0.05$). Thus, the null hypothesis of the present study was accepted.

DISCUSSION

Most influential factor for neuropeptide expression (Substance-P and CGRP) after root canal preparation is the design of the instrument, regardless of the number of files or the type of movement.[6] Postoperative pain following root canal treatment is related with extrusion of debris during root canal preparation.[7] Therefore, a reduction in debris extrusion during canal preparation will reduce postoperative pain during or after root canal treatment.[8]

In this study, two different NiTi rotary systems were evaluated in terms of apical debris extrusion using a commonly accepted methodology.[9] This methodology could be disadvantageous, since there is no apical barrier to mimic the periodontal ligament against the apical extrusion.

The main parameter of the file that causes apical extrusion of debris is cross-section of file and design of file. ProTaper Next[10] (Dentsply Maillefer, Ballaigues, Switzerland) is a fifth-generation NiTi system. These files incorporate a new M-Wire alloy. The design features include off set-rectangular cross-section[11] design for greater strength and less debris extrusion, unique asymmetric rotary motion that further enhances shaping efficiency, and variable tapers. ProTaper Next files are manufactured using M-Wire NiTi to enhance both flexibility and cyclic fatigue resistance. Various studies reported that M-Wire provides superior flexibility and resistance to cyclic fatigue than conventional NiTi alloy, and retains its cutting efficiency.[12,13]

Mani Silk file[14] has unique cross-sectional tear drop design that cuts exceptionally well and resists fractures, which eliminates the "screwing-in" effect common with many other systems, while removing debris effectively and reducing instrument stress. Ground-breaking proprietary heat treatment provides excellent flexibility without scarifying efficiency and safety. Mani Silk files are available in simple pack – for straight canals, standard pack – for mildly curved canals, complex pack – for moderately and severely curved canals. In this study, Mani Silk-simple pack files were used for straight canals.

The results of the present study revealed that both instrument systems cause apical extrusion of debris during canal preparation. This is consistent with other apical extrusion studies,[15-17] and reinforced the fact that it is impossible to prepare a root canal system chemico-mechanically without apical extrusion of debris. But mechanized instrumentation minimizes the extrusion of debris when compared to manual instrumentation.[18] Both ProTaper Next and Mani Silk rotary systems cause extrusion of debris. Therefore, the null hypothesis of the present study was accepted.

Table 2: Mean values and standard deviations for both groups

Groups	*Frequency*	*Mean ± SD*	*Mean difference*	*t-value*	*p-value*
Post weights			0.0025	0.309	0.759
ProTaper Next	20	0.585 ± 0.027			
Mani Silk	20	0.583 ± 0.024			

Independent t test was performed between the groups; *$p < 0.05$ (significant), $p > 0.05$ (not significant)

CONCLUSION

The apical debris extrusion was seen in all specimens. There was no significant difference between ProTaper Next and Mani Silk rotary systems in terms of mean weight of apically extruded debris.

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