December 2017

Remaining dentine thickness of root canals prepared with K-3 and ProTaper rotary systems

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ORIGINAL ARTICLE

Remaining dentine thickness of root canals prepared with K-3 and ProTaper rotary systems

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Abstract

Objective: To compare the remaining dentine thickness of root canals prepared with K-3 and ProTaper files.

Methods: This in-vitro experimental study was conducted from 1st April-30th September 2015 at the dental clinics of Aga Khan University Hospital, Karachi, and comprised human teeth. Extracted human premolars and molars were included in the study using non-probability consecutive sampling. Canals were randomly allocated into two groups i.e. K-3 and ProTaper. Changes in inner and outer walls of canals were measured using Vixwin software at 1mm, 4mm, 7mm and 10mm from the apex. SPSS 20 was used for data analysis.

Results: Of the 214 canals, 107(50%) were assigned to each group. No statistically significant difference was found in the remaining dentine thickness at 1mm, 4mm, 7mm and 10mm from the apex of the teeth prepared with in K-3 versus ProTapers system ($p>0.05$).

Conclusion: The remaining dentine thickness of the root canals prepared with K-3 files was similar to that of canals prepared with ProTaper files.

Keywords: Endodontic treatment, K-3 files, ProTaper, Remaining dentine thickness. (JPMA 67: 1814; 2017)

Introduction

The primary objective of the root canal treatment is the removal of the debris, micro-organisms as well as smoothening of the canal irregularities in order to facilitate subsequent filling of the canal space with a biocompatible material.[1-5] The ideal preparation of the root canal is a funnel shaped form with the smallest diameter at the apex and the widest diameter at the coronal orifice.[6,7] Hand preparation techniques can be time-consuming, and especially in narrow and curved canals, aberrations, such as ledging, zipping, danger zones and transportation can occur because larger instruments tend to straighten the canal.[8,9]

Nickel titanium (Ni-Ti) rotary instruments, consisting of approximately 55% nickel and 45% titanium, are developed to maintain the original canal shape and thus remain better centred. These instruments maintain the shape of curved root canals due to their high elasticity and shape memory.[10-15] Popular brands of NiTi instruments include ProTaper and K-3 systems. Presently, these two are the leading Ni-Ti rotary instruments available in Pakistan.

The K-3 (SybronEndo, California, United States [US]) rotary Ni-Ti system is a three-fluted file of constant taper with variable core diameter. Whereas the ProTaper rotary system (Tulsa Dental, US) is a variably tapered rotary instrument characterised by a convex triangular cross-sectional area, slight positive rake angle, no radial lands and a semi-active cutting tip.[16,17] Regardless of the technique, shaping the root canals with any rotary instrument results in substantial removal of dentine from the root walls. Removal of more dentin from one side compared to other side of the canal wall, which are located at similar distances from the long axis of the root, results in a procedural error known as canal transportation. Moreover, this procedural error reduces the fracture resistance of the tooth and finally results in poor prognosis of treatment.[18]

The remaining dentine thickness (RDT), the amount of thickness of dentine left after the instrumentation of the root canal system, is an important parameter that affects the success of root canal treatment and its restorative prognosis. There is an increased usage of rotary file systems observed all over the world. But there is paucity of data on RDT, especially in the curved canals that warrants attention.

The current study was planned to compare RDT of root canals prepared with ProTaper and K-3 rotary files in extracted human teeth.

Materials and Methods

The study was conducted for a duration of six months(1st April- 30th September 2015) at the dental clinics of Aga Khan University Hospital (AKUH), Karachi, and comprised human teeth. It was an in-vitro experimental study design using non-probability consecutive sampling technique.

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Extracted maxillary and mandibular premolar and molar teeth upon which no prior endodontic treatment was carried out were included in the study. Grossly carious and/or severely calcified teeth diagnosed on clinical and radiographic examination, teeth showing root resorption, root fractures/defects and teeth with open apices were excluded. The teeth were divided into two groups, i.e. ProTaper and K-3.

RDT was measured in millimetres (mm) using an angle measuring tool of radiographic computer software (Vixwin by Accusoft, USA) before and after instrumentation. Mean difference was measured at 1mm, 4mm, 7mm and 10mm from the apex pre- and post-instrumentation from both the inner and outer walls of the root canal system.

The sample size was calculated using sample size calculator (sample size determination in health studies,[19] World Health Organisation [WHO]). A study[20] reported that K3 files showed mean dentine removal of 0.26±0.07mm at 5mm from the apex after instrumentation, while K flexofiles showed mean dentine removal of 0.37±0.13 at 5mm from the apex. Keeping this difference in view, we calculated the sample size at 90% power and level of significance set at 5%. Approval was obtained from the institutional ethics review committee.

SPSS 20 was used for data analysis. Mean and standard deviation were calculated for pre- and post-instrumentation dentine thickness for ProTaper and K-3 systems. Independent sample t-test was applied to compare the difference between both the groups (ProTaper and K-3). Stratification was done on 1mm, 4mm, 7mm and 10mm from the tooth apex to see its effect on outcome using Student's paired t-test. $P<0.05$ was considered significant.

Results

Of the 214 canals, 107(50%) were assigned in each group. No significant difference was found in the pre-instrumentation dentine thickness between the two file

Table-1: Pre-operative Dentine Thickness of two files systems.

Distance from the apex	Surface assessed	File system			n=214
		K-3 Mean (SD)	ProTaper Mean (SD)	Total Mean (SD)	P value
1mm	Outer wall	1.00(0.68)	0.94(0.34)	0.97(0.54)	0.37
	Inner Wall	0.87(0.36)	0.90(0.33)	0.88(0.34)	0.44
4mm	Outer wall	1.54(0.35)	1.46(0.50)	1.50(0.43)	0.19
	Inner Wall	1.42(0.55)	1.35(0.53)	1.38(0.54)	0.36
7mm	Outer wall	1.89(0.34)	1.80(0.52)	1.84(0.44)	0.15
	Inner Wall	1.67(0.68)	1.58(0.66)	1.62(0.67)	0.37
10 mm	Outer wall	2.21(0.34)	2.03(0.50)	2.12(0.43)	0.01
	Inner Wall	1.76(0.76)	1.70(0.79)	1.73(0.77)	0.57

Two-way analysis of variance (ANOVA) test was applied. Level of significance was kept at 0.05.
SD: Standard deviation.

Table-2: Post-instrumentation RDT of two files systems.

Distance from apex	Surface Assessed	File system			n=214
		K-3 Mean (SD)	ProTaper Mean (SD)	Total Mean (SD)	P value
1mm	Outer wall	0.86(0.35)	0.86(0.32)	0.86(0.34)	0.93
	Inner Wall	0.80(0.35)	0.83(0.33)	0.81(0.34)	0.49
4mm	Outer wall	1.44(0.35)	1.36(0.44)	1.40(0.40)	0.11
	Inner Wall	1.33(0.55)	1.23(0.51)	1.28(0.53)	0.18
7mm	Outer wall	1.78(0.34)	1.67(0.52)	1.73(0.44)	0.08
	Inner Wall	1.58(0.66)	1.46(0.68)	1.52(0.67)	0.21
10mm	Outer wall	2.07(0.30)	1.88(0.53)	1.97(0.43)	0.01
	Inner Wall	1.65(0.72)	1.59(0.73)	1.62(0.73)	0.55

Two-way analysis of variance (ANOVA) was applied. Level of significance kept at < 0.05
RDT: Remaining dentine thickness
SD: Standard deviation.

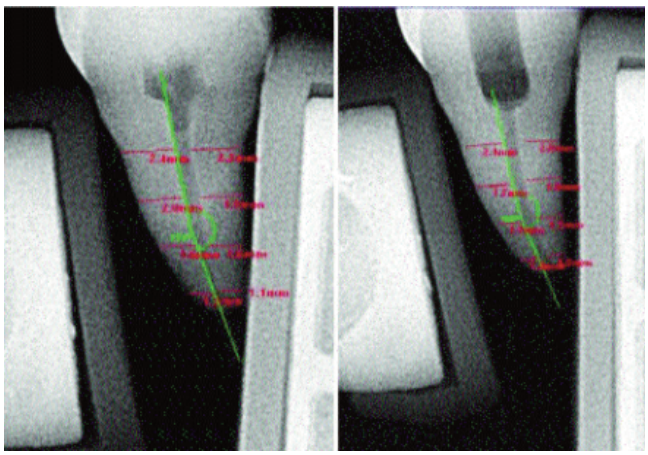
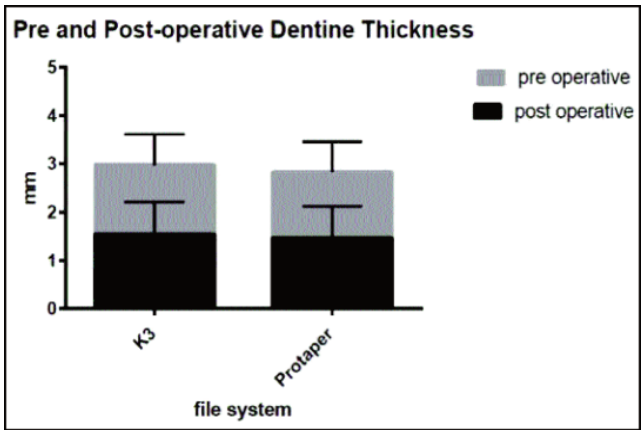


Figure-1: Pre and post instrumentation digital radiograph of premolar.



One way ANOVA was applied. Level of significance: <0.05.
ANOVA: Analysis of variance.

Figure-2: Pre and post instrumentation difference between two comparison groups in the removal of dentine.

systems at 1mm, 4mm and 7mm (p>0.05). However, significant difference was seen at the outer wall at 10mm from the apex (p=0.01) (Table-1).

When post-instrumentation dentine thicknesses of the two file systems were compared, no statistically significant difference was observed at any level except 10mm from the apex (p=0.01) (Table-2).

A statistically significant difference was found between the two groups when pre-instrumentation and post-instrumentation dentine thickness was compared (Figure-1-2).

Discussion

NiTi rotary files are now essential materials in endodontic therapy. They have many advantages over stainless steel files such as excellent flexibility and improved cutting efficiency.[21,22] Researchers traditionally use resin blocks to study rotary files efficiency but in the present study we have used extracted human teeth. RDT becomes an important parameter that describes longevity of root canal treated teeth as it had been suggested that root canals with a wall thickness less than 0.3mm might not be strong enough to withstand the compaction force during obturation and hence pose a risk of perforation or crack and subsequent failure.[4]

The RDT obtained with K-3 system and ProTaper system exhibits that the outer wall possessed the maximum thickness at 10mm in both the file groups and least being on the inner wall at 1mm from the apex for both the file systems. Schafer[20] reported dentine removal using K-3 and flexofiles, with the highest thickness at 3mm on the outer wall and lowest at 1mm on inner wall.

Our results are in accordance with the study conducted by Iqbal et al.[23] on extracted mandibular molars, in which ProTaper and ProFile instruments are comparable to each other in their ability to optimally enlarge root canal with minimal transportation and loss of working length. However, our results contradict the findings of Yoshimine[24] who reported that ProTaper instruments caused significantly greater widening of canals (2.64±0.12mm) compared to K-3 files (2.36±0.08mm). Similarly, Yun & Kim[25] compared the root canal shaping abilities of four nickel-titanium rotary instruments also reported that ProTaper files removed more dentine from canal wall on the inner side.

Strengths of the present study are that extracted teeth were employed instead of using resin blocks in the study to obtain readings that will be closely applicable to clinical situation; extracted teeth mimic the actual environment of canal far better than the artificial canals of acrylic blocks which differ in the hardness and surface texture. Therefore, the resultant data on extracted teeth may be truly applicable to the clinical situation.[26] We employed randomised assignment of the tooth specimen to the two treatment groups and the commonly used rotary systems (K-3 and ProTaper) were compared. There was a paucity of locally published data on this topic; therefore, it was relevant to conduct a study on this research question.

The study had its limitations as well. For instance, advanced techniques such as cone beam computed tomography (CBCT) were not employed for the assessment of remaining dentine thickness. To maintain the proper RDT, we recommend that a careful assessment

of root canal anatomy, employing a careful technique and strict adherence to manufacturer's recommendations should be ensured in order to avoid iatrogenic errors.

Conclusion

No significant difference was found in the amount of dentine removed by the two rotary file systems at various distances, i.e. at 1mm, 4mm, 7mm and 10mm, from the apex.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

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