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Original Article

Dentistry Section

Computed Tomographic Evaluation of K_3 Rotary and Stainless Steel K File Instrumentation in Primary Teeth

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ABSTRACT

Introduction: The intention of root canal preparation is to reduce infected content and create a root canal shape allowing for a well condensed root filling. Therefore, it is not necessary to remove excessive dentine for successful root canal preparation and concern must be taken not to over instrument as perforations can occur in the thin dentinal walls of primary molars.

Aim: This study was done to evaluate the time preparation, the risk of lateral perforation and dentine removal of the stainless steel K file and K_3 rotary instrumentation in primary teeth.

Materials and Methods: Seventy-five primary molars were selected and divided into three groups. Using spiral computed tomography the teeth were scanned before instrumentation. Teeth were prepared using a stainless steel K file for manual technique. All the canals were prepared up to file size 35. In K_3 rotary files (.02 taper) instrumentation was done up to 35 size file. In K_3 rotary files (.04 taper) the instrumentation was done up to 25 size file and simultaneously the instrumentation time was recorded. The instrumented teeth were once again scanned and the images were compared with the images of the uninstrumented canals.

Statistical Analysis: Data was statistically analysed using Kruskal Wallis One-way ANOVA, Mann-Whitney U-Test and Pearson's Chi-square Test.

Results: K_3 rotary files (.02 taper) removed a significantly less amount of dentine, required less instrumentation time than a stainless steel K file.

Conclusion: K_3 files (.02 taper) generated less dentine removal than the stainless steel K file and K_3 files (.04 taper). K_3 rotary files (.02 taper) were more effective for root canal instrumentation in primary teeth.

Keywords: Dentin removal, Lateral perforation, Time preparation

INTRODUCTION

Natural tooth is considered as the best space maintainer. Therefore, it is consequential to maintain the tooth in the dental arch till natural exfoliation takes place [1]. The pulpectomy procedure is the ideal treatment of infected pulpal tissue in a single rooted tooth and in molars with signs of furcal radicular involvement [2]. A realistic pulpectomy technique should include the following characteristics: (a) fast and simple procedures with shorter treatment times and a minimal number of appointments; (b) effective debridement of the root canals without weakening the tooth structure or endangering the underlying permanent teeth; (c) few procedural complications and (d) maintaining tooth function until it is naturally shed [3].

Dentistry has faced numerous improvements in earlier years. In the field of pulp therapy, there has been tremendous improvement not only in the materials used but also in the techniques and the instrumentation, thereby reaching a better quality of work [4]. Stainless steel alloys have now replaced the root canal instruments that were manufactured from carbon steel until the 1960s. In severely curved canals appropriate canal enlargement has not been achievable with the flexible stainless steel instruments with non cutting tips. In order to overcome this problem, nickel titanium (NiTi) was developed by WF Buehler in early 1960, which is nonmagnetic, salt resisting and water-proof alloy [5]. The safer and uncomplicated preparation of canals with complex anatomic characteristics can be achieved by nickel titanium (NiTi) instruments [6]. K_3 (SybronEndo) is a third generation NiTi rotary instruments, triple fluted file with constant taper, positive rake angle, wide radial land with relief land and asymmetrical cross section [7]. The non-cutting tip of the K_3 instrument helps to follow the canal path while minimizing the risk of ledging, zipping and perforation. They are 4mm shorter than their competitors, yet the working (fluted) length is the same [8].

A search of literature suggests that Computed tomography (CT) and Micro CT are at present the foremost technologies for endodontic research. In previous studies with C- shaped canals the use of high resolution computed tomography has reported excellent results [9].

The prelude of the K_3 rotary files for the instrumentation of primary root canals is recent and there are only a diminutive number of studies regarding this issue. The two different degrees of tapered K_3 rotary files (.02 and .04) have been used to analyse the utmost K_3 files for primary root canal preparation. Previous study done by Selvakumar et al., using a similar concept and methodology assessed the canal transportation and canal centring ability [10]. The purpose of the present study was to compare the amount of dentine removed, the risk of perforation and instrumentation time of rotary (K_3 file) and manual (K-file) instruments in preparing primary molars.

MATERIALS AND METHODS

The present study was conducted in the Department of Pedodontics and Preventive Dentistry, Faculty of Dental Sciences, Sri Ramachandra University, Chennai in 2009. Seventy-five extracted human mandibular primary second molars stored in 10% formalin. The inclusion criteria for the study are human mandibular primary second molars with a minimum of 2/3rd of its root length and no evident defects or anomalous morphology. The following were considered as exclusion criteria, teeth with inadequate root length, teeth showing radiographic evidence of internal resorption or root canal obliteration, grossly decayed teeth and canals showing radiographic evidence of calcification.

Coronal access was prepared using a diamond bur (BR 40, MANI, INC, Japan) and the distal root canals were controlled for apical patency with a file of size 10. Distal roots of the primary mandibular second molar were selected, since they generally have a curved, large, single root canal with a uniform canal outline and relatively less intracanal ramifications compared with the mesial roots [11]. The 15 K size file was inserted into the canal until its tip was flushed with root surface at the apical foramen. The working length was calculated as 1mm short of this length. The collected teeth were then separated into three equal groups (n=25 each) according to the instrument utilized.

Root Canal Instrumentation

The distal canals were randomly scattered and instrumented by hand and rotary files. Copious irrigation with 2mL of saline and 5.25% NaOCl solution after the use of each file using a 27-G irrigation needle (Unident) was done. The files were lubricated with EDTA gel each time they were used. All root canal instrumentation was consummated by one operator and all types of rotary files were utilized with 128:1 reduction contra-angle handpiece (NiTi contra-angle, Anthogyr). Each instrument was transmuted after five canals. Instrumentation time including time for irrigation and filing for each root canal was also recorded. The same operator did the instrumentation for the entire specimen.

Stainless Steel K File Group

Instrumentation (Step-back technique) was performed with .02 taper stainless steel K-files (Mani). A size 20 file was positioned to length, and a combination of a filing and a reciprocal reaming action was used until it fitted loosely in the canal and reached the working length. This method was repeated until the apical portion was prepared to a size of 35 file. Studies suggest that instrumentation should be halted at size 30 [12], whereas others recommend shaping up to 35 or 40 [13].

K_3 Rotary File (.02 taper) Group

Specimens in this group were instrumented with K_3 Rotary NiTi Endodontic File (.02 taper) (Sybron Dental, Westcollins, CA, USA). Canals were instrumented at a rotational speed of 250 rpm. The files were advanced while rotating slowly towards the apex and withdrawn as soon as the working length was reached, rotating until the file appeared outside the canal. Instrumentation was done up to 35 size file.

K_3 Rotary File (.04 taper) Group

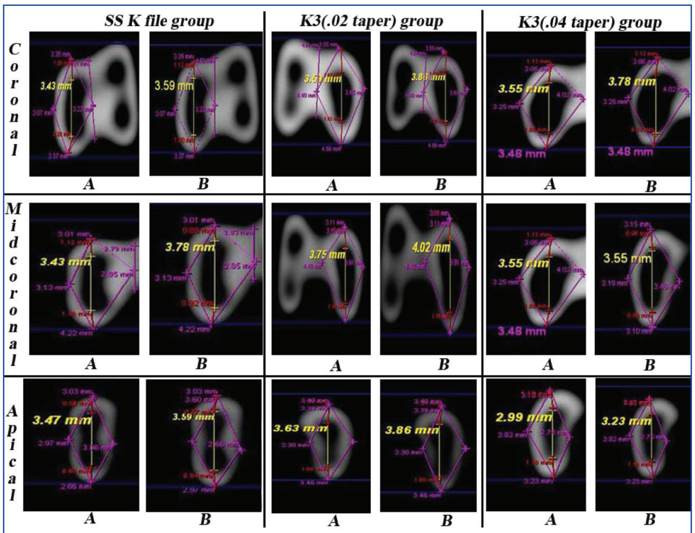
The 25 canals in this group were prepared using K_3 Rotary NiTi Endodontic File (.04 taper) (Sybron Dental, westcollins, CA, USA) at a rotational of speed 250 rpm using a similar technique as described for K_3 (.02 taper) group. Instrumentation was performed up to 25 size file.

Specimen Scanning

Using a light speed plus CT scanner (GE Electricals, Wilwaukee, USA), the specimen were scanned before and after instrumentation. Both cross sectional and longitudinal views were taken. A constant thickness of 0.65mm per slice and a constant spiral or table speed of 0.75 and 120 KVP was used. The scanned images were measured using defined guidelines. A line was drawn connecting the cementoenamel junction mesiodistally in the centremost slices after longitudinal section, which was considered as the reference line [14]. Cross Sectional slices extend from the reference line till the apex of the apex of the tooth. The coronal section was referred as a third slice from the reference line. The centremost cross sectional slice forms the midcoronal section where it extends from the reference line to the apex of the tooth. The third slice from the apical end of the tooth was used to assess the apical section [Table/Fig-1a]. For the purpose of standardization, four reference points were taken on the outer walls of the distal root as buccal (A), lingual (B), mesial (C) and distal (D) points [10].

Amount of Dentine Removed

The amount of dentine removal was measured by subtracting the area of the uninstrumented measurement taken between the inner wall of the buccal and lingual reference point (Z_1) to the instrumented canal of the buccal and lingual reference point (Z_2) [Table/Fig-1b].



[Table/Fig-1a,b]: Pictorial representation: a) the reference lines taken for Coronal, Midcoronal and Apical region, (b) references used for calculation of amount of dentin removal

Lateral Perforation

Lateral Perforation was assessed on both pre instrumentation and post instrumentation cross sectional slices. Any discontinuity on the border of the section was considered as perforation.

STATISTICAL ANALYSIS

Mean and standard deviation of the amount of dentine removed were estimated from the sample from each study group. The mean values of different study groups were compared using Kruskal Wallis One-way ANOVA. Mann-Whitney U Test was used, followed by the Bonferroni Correction method to list out the significant groups at the 5% level. Lateral perforations were estimated for each study group by using Pearson's Chi-square Test was used to calculate the p-value. One-way ANOVA was used to compare the working time between the hand and rotary, as well as to calculate the P-value. The Tukey-HSD procedure was employed to identify the significant groups at the 5% level. In the present study, $p<0.05$ was considered as the level of significance.

RESULTS

Amount of Dentine Removed

The mean and standard deviation of the amount of dentine removed according to the type of instrumentation are summarized in [Table/Fig-2]. Stainless steel K file (.02 taper) removed a larger amount of dentine at the coronal level than K_3 (.02 taper) and K_3 (.04 taper). K_3 (.04 taper) removed a larger amount of dentine at midcoronal and apical level than other two groups [Table/Fig-3a,b].

n=25	SS K file group	K_3(.02 taper) group	K_3(.04 taper) group	Overall p-value*
Coronal Mean ± S.D	0.31 ± 0.20	0.04 ± 0.03	0.20 ± 0.17	<0.0001 (Sig.)
Midcoronal Mean ± S.D	0.21 ± 0.15	0.07 ± 0.12	0.53 ± 0.23	<0.0001 (Sig.)
Apical Mean ± S.D	0.13 ± 0.20	0.10 ± 0.12	0.31 ± 0.07	<0.0001 (Sig.)

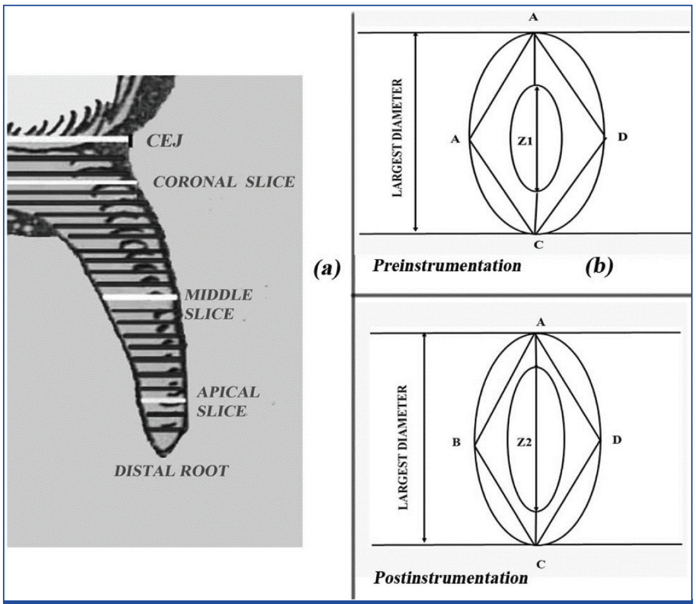
[Table/Fig-2]: Comparison of mean amount of dentin removed among different study groups.
*Kruskal Wallis One-way ANOVA was used to calculate the p-value
$ Mann-Whitney U-Test followed by Bonferroni Correction method was employed to identify the significant groups at 5% level.
Overall P-value is significant (p<0.0001)

Instrumentation Time

The mean time with the K_3 rotary files (.04 taper) instrument was 3.51 minutes, whereas with the K_3 rotary files (.02 taper) instrument was 3.59 minutes. No significant differences were found among the two systems. The mean time with stainless steel K file (.02 taper) was 4.45 minutes that were statistically significant [Table/Fig-4].

Lateral Perforation

Results regarding root perforation are summarized in [Table/Fig-5]. The perforation rate was higher in the K_3 (.04 taper) group than other two groups at apical level [Table/Fig-6].



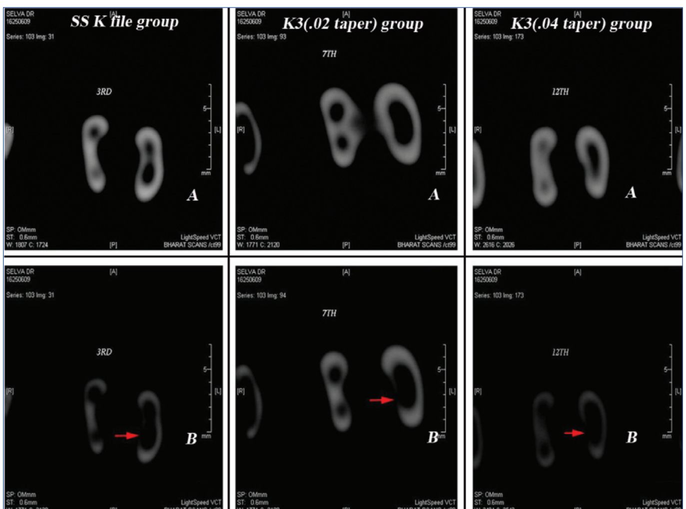
[Table/Fig-3]: Cross-sectional spiral computed tomography view of dentin removal: a) before instrumentation; b) after instrumentation

Group	Mean ± S.D.	Overall p-value*
SS K file group	4.45 ± 0.56	<0.0001 (Sig.)
K_3(.02 taper) group	3.59 ± 0.65	
K_3(.04 taper) group	3.51 ± 0.64	

[Table/Fig-4]: Canal preparation time in seconds
*One-way ANOVA was used to calculate the P-value
$ Tukey – HSD procedure was employed to identify the significant groups at 5% level
Overall P-value is significant (p<0.0001)

	SS K file group n=25		K_3(.02 taper) group n=25		K_3(.04 taper) group n=25		
Perforation	No. of tooth	%	No. of tooth	%	No. of tooth	%	p – value@
Apical	4	16	2	8	8	32	0.09(NS)

[Table/Fig-5]: Lateral Perforation
@ Pearson's Chi-square Test was used to calculate the p-value



[Table/Fig-6]: Cross-sectional spiral computed tomography view of lateral perforation: a) before instrumentation; b) after instrumentation

Instrument Failure

There were no hand files or rotary instrument breakage during preparation.

DISCUSSION

While performing endodontic therapy in primary teeth, due to the factors like ovular-shaped canals with discontinuous and unpredictable constrictions, curvature of the primary tooth root canal system, endo-perio communications and possible damage to the permanent tooth bud, it is not always possible to effects an adequately, done shape and fill of the root canal system, like in permanent teeth [15].

A comprehensive understanding of root canal morphology is important for successful endodontic treatment. Unfortunately, canal preparation is adversely influenced by the unpredictable root canal anatomy and the relative incapability of the operator to visualise this anatomy from radiographs [16]. Procedural faults such as ledge development or transportation of the apical foramen from zipping to apical perforation, or stripping can occur [17].

Various methods have been utilized to assess endodontic instrumentation including plastic models, histologic sections, serial sectioning, scanning electron microscopic studies, radiographic comparison and silicone impression of uninstrumented canals [16]. CT has been put to good use in endodontics in recent times as it allows for measuring the amount of dentin removed in a non destructive manner [18].

Based on the results of this study, suggest that dentine removal was significantly less in K_3 (.02 taper) group in all the three slices. In the coronal slice stainless steel K file (.02 taper) showed the highest amount of dentine removal whereas in the midcoronal and apical slice, dentine removal was highest in K_3 (.04 taper). The findings of the present study are consistent with Schafer and Schlingemann which compared the cleaning efficacy of the K_3 system versus K-flexofile and observed K- flexofile was more effective in cleaning the coronal and middle thirds of canals [19]. Kummer et al., proved the manual instrumentation removed more dentine when compared with rotary instruments in primary teeth [20]. Azar et al., reported no significant differences in cleaning efficiency between Manual K-files and the Mtwo and ProTaper rotary systems in primary teeth [21]. Other deciduous molars studies comparing manual files and rotary instrumentation found no significant difference in the amount of dentine removal [11,22].

In this study, K_3 with .04 tapers were found to remove more amount of dentine in the midcoronal and apical sections compared to the other two instruments. This might be due to increasing the taper of the instrument compared to the other two groups. Rosa et al., reported two perforations using rotary systems in primary teeth [23]. Versumer et al., reported that with the greater instrument size the amount of instrumented canal walls will increase [24].

The present study shows a higher lateral perforation rate in K_3 rotary files (.04 taper) (32%) followed by a stainless steel K file (.02 taper) (16%). K_3 rotary files (.02 taper) showed the least perforation (8%) among all three groups. K_3 rotary files.04 tapers produced more perforation compared to the other two groups, because of the increase in the taper of the instruments and the lesser thickness of the dentinal wall of primary teeth that resulted in lateral perforation of the canal. Michael Hulsmann stated that the incidence of perforations in clinical treatment as well as in experimental studies has been reported as ranging from 2.5 to 10% [25].

The mean time for canal preparation was significantly reduced with a rotary system when compared to stainless steel K files. Rosa et al., reported that mean time for root canal preparation was significantly shorter using the rotary system than using the manual system [23]. Bahrololoomi et al., stated that Working time was significantly shorter when using the rotary system [26]. The findings of the present study are consistent with Sergio Luiz Pinheiro et al., which compared the instrumentation time and cleaning between manual and rotary techniques in deciduous molars reported the Protaper system presented shorter instrumentation time compared to manual instrumentation [27].

Clinical Relevance

The present study emphasizes the usage of rotary K_3 (.02 taper) over manual instrumentation in primary teeth as it requires a lesser instrumentation time and provides considerable dentin removal thereby reducing the risk of lateral perforation however ensuring adequate canal cleaning. The K_3 rotary files are shorter than the competitors, so utilization of K_3 rotary files is well indicated in paediatric dentistry, especially treating uncooperative children.

LIMITATION

The limitation of the present study is that the distal canals have only been used to assess all the parameters. Though In-vitro studies have shown the K_3 NiTi rotary files are better than stainless-steel hand instruments, randomized clinical trials are required to assess clinical outcomes.

CONCLUSION

According to the results obtained from the present study, the K_3 rotary files (.02 taper) were more effective for root canal instrumentation in primary teeth, presenting shorter working time than a stainless steel K file. Further investigation should be conducted to determine the effectiveness of K_3 rotary files in primary teeth.

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