Original Article

Influence of Instrument Size in Debriding Apical Third of the Root Canal System

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ABSTRACT

OBJECTIVE: The purpose of this study was to compare the efficacy of root canal debridement in apical 3mm when instrumenting with traditional stainless-steel number 20 K file and traditional stainless-steel number 40 K file at working length with commonly used irrigation solutions.

MATERIALS & METHODS: This in vitro comparative study was conducted at Operative Department, Lahore Medical & Dental College, Lahore. Data was collected from 2005 to 2006. Fifty human mandibular incisor teethwere selected. Preoperative radiographs of each tooth were taken and teeth were extracted. Teeth were divided in to two groups and, decoronated at cementoenamel junction. Group A was instrumented with stainless steel # 20 K file and group B was instrumented with stainless steel # 40 K file to the working lengths. Sodium hypo-chlorite and EDTA compounds were used as chemical means to debride the canals. All these selected teeth were, decalcified and sliced at 0.5 millimeters, 1.5 millimeters, and 2.5 millimeters levels from the root apex and set for histological inspection.

RESULTS: No dissimilarities were recognized between each level within each root apex size group except at1.5 millimeters level from the apex, open dentinal tubules were seen in Group B which was instrumented with the # 40 K type file.

CONCLUSION: File size # 40 K is more effective in debris removal from the root canal system as compared to file size # 20 K while preparing the canals.

KEY WORDS: Root canal system, K type file, Irrigating solutions.

INTRODUCTION

Complete sealing of a meticulously prepared and disinfected root canal system is the basic aim of endodontic treatment. Complete debridement of the root canal space is an indispensable step to achieve this objective.[1,2] Debriding the root canal spaces achieved by both instrumentation and irrigation with suitable chemicals. This combined chemo-mechanical method reduces most of the microbial contents of the infected canals along with residual debris and contaminated dentinal shavings.[3] Mechanical debridement can be done in filing and reaming motions. The purpose of mechanical phase is to remove all residual pulp tissue, bacteria necrotic debris from the root canal and create a sufficient form for proper irrigation and satisfactory obturation. The mechanical action of endodontic files and irrigant solutions considerably decrease the number of bacterial burden in the root canal system. In the apical 3rd of the root canal system, filing with larger diameter files may lead to increased exchange irrigant solutions.[3,4] Chemical cleaning of the canal space with agents like Sodium Hypochlorite (NaOCl) and Ethylenediaminetetraaceticacid (EDTA) are able to infiltrateinaccessiblespaces. Due to their lubrication properties these irrigating compounds also increase the effectiveness of mechanical debridement of the root canal system. Sodium hypochlorite is an antibacterial chemical and contains the organic material dissolving property as well. When it is used in combination with chelating agent like EDTA, it disturbs and clears the smear layer, and produces clean canal walls.[3,5]Debris removal along with smear layer allows sealer penetration deeper into dentinal walls which ultimately entomb the remaining viable bacteria inside the tubules.[6]Apical 3rd of the root canal system is considered safe heaven for micro-organisms, as they retain their existence and its very difficult to dislodge them. This residual bacterial amount potentially causes persistent periradicular infection and inflammation. Therefore it is imperative to clean that complex area for successful root canal treatment to minimize treatment failure chances in long term.[1,3]

Over the years researchers established that bigger diameter file sizes are desirable to permit the irrigating solution to reach the apical third of the canal. The endodontic literature has shown that appropriate irrigation to the apical third of the canal can only be achieved by sufficiently large preparations to remove debris and decrease bacterial burden for ultimately proper obturation of the root canal system.[7,8]They believed that canals must be large enough so that maximum irrigation solutions should reach and interact with the apical debris in terminal areas of the root canal

system where apical ramifications make root canal difficult to be debrided efficiently with smaller instruments. Larger file sizes not only permit appropriate irrigation but also considerably reduce residual bacterial count in the root canal. These researchers validated that number 45 file size reduced 10-times more microbial growth as compared to smaller size instruments. When canals were instrumented with smaller files at apical third of the canals, remains was not flushed out completely by irrigation.[1] On the contrary some studies found that smaller number files such as file number 25 was as effective as file number 35 or 40 for decreasing remaining microorganisms from the apical third of the root canal system.[9,10]

Although rotary instruments have taken over conventional stainless steel hand files in endodontic practice but it is observed that majority of clinicians and dental schools in our part of the world are still teaching and practicing manual instrumentation techniques using stainless steel K-files for canal preparation. The purpose of this study was to compare the efficacy of root canal debridement in the apical 3mm when instrumenting with stainless steel number 20 K type file or stainless steel number 40 K type file at working length with appropriate irrigation.

MATERIALS AND METHODS

Fifty human mandibular incisors which were advised for extraction and met our criteria were selected after patient's consent. The procedure and purpose was told to the patient. Preoperative radiographs of each tooth were taken and teeth were extracted. Periapical radiographs with paralleling technique were taken using Kodak film. Selection of the teeth for current study was based on radiographic criteria of single canal with straight roots and traceable canals from coronal third to apical third. While teeth with previous endodontic treatment and with signs of root resorption were excluded for this study.

All collected teeth were stored in 10% formalin for 72 hours. The teeth were randomly distributed into two groups each with a sample size of 25 teeth, and decoronated at cementoenamel junction. The clinical measurement of all the teeth was calculated to get fixed position of sections at 0.5 millimeters of each other. For further Instrumentation the patency was established by passing a stainless steel number10 K type file (Antaeos, VDW GmbH, Munchen, Germany) pushed past the apical foramina of all root canals. Determination of working length by radiograph was established by deducting 1 millimeter from the length at which the 10 number file first visible at the apical terminus of the root.

Group A was instrumented with stainless steel # 20 K file (dentsply maillefer, USA) and group B was instrumented with stainless steel # 40 K file (dentsply maillefer, USA) to the working lengths. These teeth were instrumented utilizing a balanced force concept. These teeth were irrigated with 2.5% sodium hypochlorite solution and 15% EDTA after each file change. A 27- gauge endodontic irrigation needle was used to irrigate the canals and 10ml of irrigant solution was used for irrigation in every tooth. Recapitulation was performed and working length patency was maintained after each file change with a stainless steel 10 number K file. Group A teeth were prepared till No. 20 K file at the working length and group B teeth were prepared till the No. 40 K file at the working length in sequence from file number 15. To control file fatigue or separation of an instrument (file), one file was limited to prepare five canals only.

For histologic examination the teeth were fixed in 10% formalin for 1 week. Formalin fixed teeth were then demineralized for three days in the decalcifying solution of nitric acid (20%). After decalcification teeth were placed in distilled water to neutralize the effect of acid. A scalpel # 11 was used to section the root at 0.5 millimeters, 1.5 millimeters and 2.5 millimeters levels from the root apex. These sections were embedded in paraffin blocks. Histological sections were obtained from the microtome. Histological processing for preparation and staining of slides was performed and the prepared slides were observed under a light microscope (Humascope (GmbH) D-65205, Wiesbadan, Germany) at 100x magnification. An image of the most representative area of the slide was taken after viewing each section of the slides under microscope. Three photomicrographs of each tooth were taken at 0.5 millimeters, 1.5 millimeters and 2.5 millimeters from the root terminus. The obtained images were then inspected for the presence of smear layer over dentinal tubules with the help of experienced histologist.

RESULTS

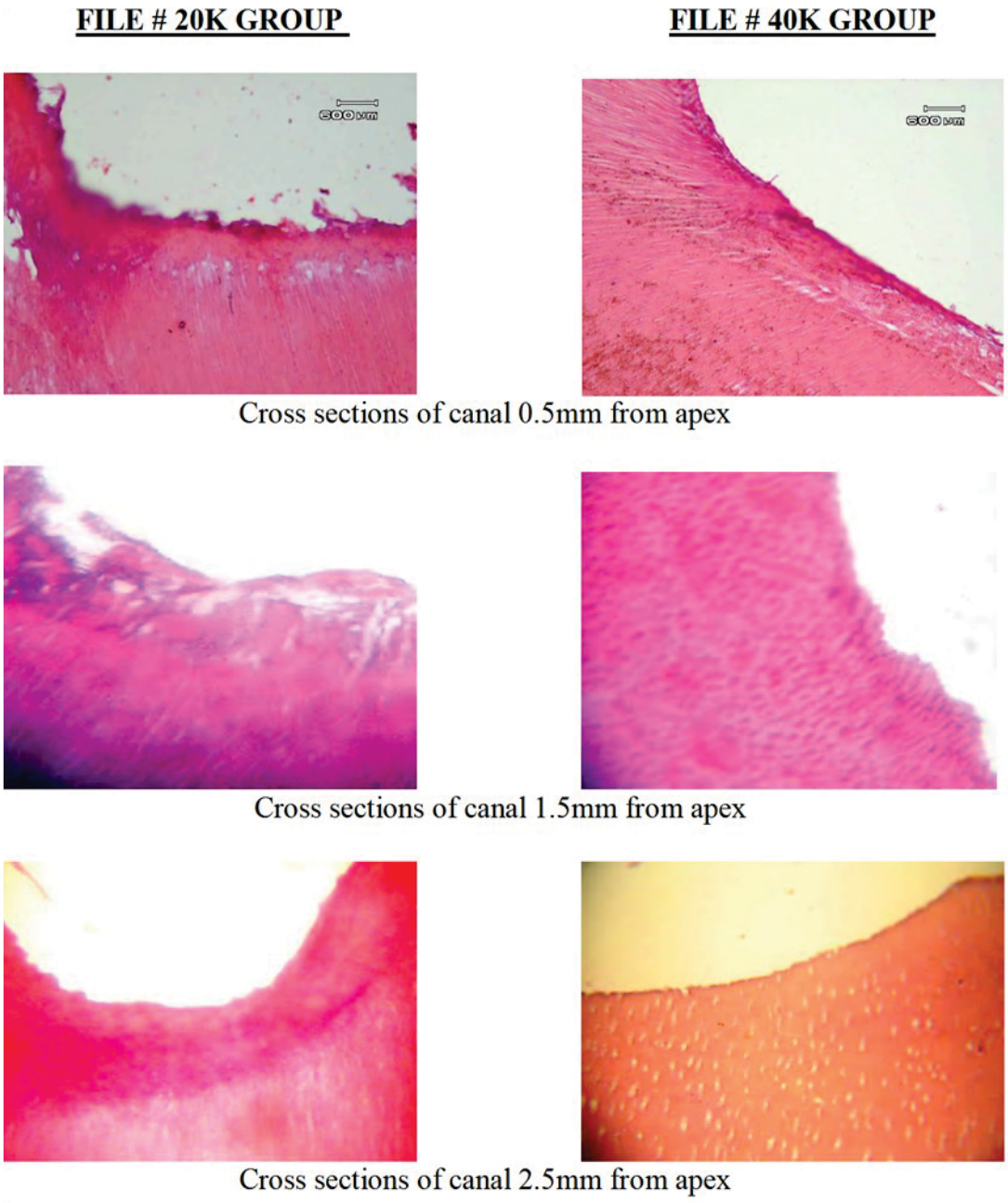
Group A was prepared till file no. 20 K and group B was prepared till file no. 40 K. There was no incidence of breakage of files in any group. Some distortion of file no.40 K was noted in group B. Twenty five canals in each group were instrumented and sliced at 0.5 millimeters, 1.5 millimeters and 2.5 millimeters from the root apex.

Due to histologic processing faults few initial samples were discarded. Finally in group A, 21 slides at 0.5 millimeters from the root apex, 22 slides at 1.5 millimeters from the root apex and 22 slides at 2.5 millimeters from the root apex were obtained and in group B,20 slides at 0.5 millimeters from the apex, 21 slides at 1.5 millimeters from the root apex and 22 slides at 2.5 from the root apex were obtained.

TABLE I:

Group	Total Teeth	Slides Included in results	0.5 mm	Slides Included in results	1.5 mm	Slides Included in results	2.5 mm
Group A 20 No. K	25	21	Debris over dentinal tubules	22	Debris over dentinal tubules	22	Debris over dentinal tubules
Group B 40 No. K	25	20	Debris over dentinal tubules	21	Open dentinal tubules	22	Open dentinal tubules

FIGURE I: CROSS SECTIONS OF CANAL FROM APEX



On qualitative analysis of canal cleanliness it was observed that canals showed a thicker layer of dentinal debris in all three sections of slides prepared with no. 20 K file (group A) none of the section in this group showed open dentinal tubules.

On the other hand group B showed significantly less debris along the canal wall in sections at 2.5 millimeters and 1.5 millimeters from the root apex, and open dentinal tubules were clearly seen. But section at 0.5 mm from the apex had debris along the wall and open dentinal tubules were not visible.

DISCUSSION

One of the greatest challenges of root canal treatment is the complete cleaning of the root canal system in order to eliminate pulp remnants, bacteria, smear layer, and other organic material.[5,11] Most important factor for the accomplishment of proper root canal instrumentation is the chemo-mechanical preparation step.[11] The researchers are of the opinion that after chemo- mechanical procedures usually some debris, organic and inorganic residues remain inside the root canal system, due to insufficient action of the endodontic round shaped files some areas of the canal walls remain entirely unprepared[12,13]Instrumentation with traditional manual stainless steel hand files have long been remain the gold standard for canal preparation. With the introduction Nickel-Titianium (NiTi) rotary files, endodontists now a days prefer NiTi rotary files over hand stainless steel files due to obvious advantages of flexibility and speed of NiTirotaryfiles.[14,15] However in terms of efficacy of removing and extrusion of debris beyond apex hand stainless steel files has advantage over rotary files, especially at apical 3rd of the canal. Silveira et al are of the opinion that apical third preparation yields better results by using hand files.[16]Thorough instrumentation of the apical region has long been considered to be an essential component in the cleaning and shaping process. The issue of final apical preparation size remains controversial despite considerable clinical and in vitro research.[1] Removing debris from the apical most area is challenging but adequate large canal preparations may include additional anatomic irregularities and permit the elimination of a considerable quantity of bacterial cells from the root canals. Furthermore, larger file sizes instrumentation may lead to enhanced irrigation solution movement in the apical 3rd of the root canals; resultantly higher success rate of treatment may be achieved with larger preparations. The space of 2.5 mm or greater from the anatomical root apex for the irrigating solution facilitates prolonged contact with the canal walls could explain the better results in this portion prepared with larger no file size.[1,17,18]

Marending et al concluded that the smallest size file (File number 20) was unable to reach working length in 39 canals of total 80 canals, although they used rotary files of that size.[17]According to Khabiri et al. instrumentation up to number 25 file is not sufficient for irrigation penetration into the apical area. They are of opinion that in more flared canals, irrigating solution penetrates deep up to apical third of the canals.[18] Khademiand others are also of the opinion that the minimum working width needed for penetration of irrigants to the apical third of the root canal is a file #30.[18,19]The findings of all these studies support the results of this study. Our findings are also supported by Tan & Messer (2002), Usman et al.(2004); that instrumentation with larger file sizes is advantageous in decreasing the debris and amount of residual bacteria in the apical third of the root canal.[20,21]

But the results of Moghaddam et al are inconsistent with our findings, as they found no difference in cleanliness efficacy at the apical and middle thirds. Instead they observed that coronal third was more efficiently debrided with hand files. They went on to say further that anatomic complexities and minimal tissue contact, such as with in a narrow apical space could limit the debridement capability of instruments. Ideally apical foramen must not be too enlarged but it must be disinfected with preserved patency.[22]Hence; certain risks are associated in using larger number of file sizes at the patency length. Theses risks include severe injury to periradicular tissues, an apical stop loss, and extrusion of infected canal contents beyond the root apex, this may lead postoperative pain or flare -up and long term failure of root canal treatment.[23]It is almost impossible to get sterilized canals because bacteria can not be completely removed from the canals irrespective of the size of the file or preparation technique used, but significant decrease in bacterial load is achievable with proper instrumentation and irrigation to prevent thriving of residual pathogens in sufficient numbers to cause endodontic failure.[24] Therefore, it becomes obligatory to use antibacterial irrigants to maximize bacterial elimination from the root canal. EDTA in combination with sodium hypochlorite is an effective protocol in irrigating organic debris and smear layer from the root canal.[6,25] The method of irrigating with sodium hypochlorite and EDTA was employed in this study and it resulted in clean root canal walls with open tubules in many areas.

LIMITATIONS

The teeth selected were having straight canals. More studies should be done on efficacy of instruments and irrigant solutions in root canal debridement in curved canals.

CONCLUSION

Instrumentation of the apical portion of canals with 40 no K file was found to be effective in reducing the amount of debris and smear layer in apical third. The combination of sodium hypochlorite and EDTA irrigation solutions helped in providing overall good debridement of root canals. Selection of proper instrument and copious irrigation can result in improved quality of shaping and cleaning the root canal system.

RECOMMENDATIONS

K- Type file size number 40 is a large number for narrow canals; therefore more research is required on efficacy of debridement in apical 3rd with 30 or 35 number files.

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