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Comparative evaluation of efficiency of three different NiTi systems (Protaper, Neo Endo and Endo sequence) on radicular dentin - An in-vitro SEM study.

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Abstract

Aim: Cleaning and shaping is most crucial step in endodontic therapy, if improperly done, it may result in to failure. This particular step is based on the virtue of files used. Thus, present study was undertaken to compare and evaluate the cleaning efficacy among three NiTi rotary systems: Protaper, Neo Endo, Endo Sequence.

Materials and method: Sixty-six human maxillary second premolars were taken for the study; divided in to three groups: Group I: Protaper files, Group II: neo-Endo files and Group III: Endo sequence files. Each group involved 20 samples and 2 controls. 3% sodium hypochlorite solution was used for irrigation and 17% EDTA as final rinse to remove smear layer. SEM was used to compare debris and smear layer at 200X and 1000X magnification respectively. Results obtained were subjected to one way ANOVA, Kruskal Wallis and Bonferroni test.

Results: Mean debris layer was less with Endo Sequence (1.81 min) when compared to Protaper (2.23) and Neo Endo (2.61), which was statistically significant. Mean smear layer produced was found to be less with Endo Sequence (2.09) as compared to Protaper (2.59) and Neo Endo (2.34), which was not statistically significant.

Conclusion: Endo Sequence files were proved better than Protaper and Neo Endo files in term of cleaning efficacy.

Keywords: Debris Layer, Endo M Sequence, Neo Endo, Protaper, Smear Layer.

Introduction

The use of NiTi instruments dates back to 1980s; this development revolutionized Endodontics due to their offer of safety in instrumentation and super elasticity. The ability of NiTi files to negotiate curved canals, low resistance to cyclic fatigue and flexibility has been an improvement from the stainless-steel files. These resulted in fewer mishaps such as zipping, ledges and transportation of apical foramen.[1] The advantages resulted in increased use of these instruments; thus leading to development and production of various hand and rotatory NiTi files. The manufacturers are modifying the files in an attempt to increase benefits and decrease limitations. A variety of file systems are available in the market having different designs, tapers and cutting edges.

The Protaper files have increasing taper percentage over its length. The progressive taper improves flexibility, cutting efficiency and safety. The Protaper files have a triangular convex cross section which enhance cutting action and decrease friction produced by rotation.[2] The helical angle of Protaper files as well as their pitch is not fixed and it changes over their cutting blades which reduces the chances of screwing into the canal.[3] The Protaper system is comprised of three shaping and three finishing files.

Neo Endo is a third-generation rotatory files which are gold thermal treated. The files has triangular cross sectional having sharp cutting edges but a non-cutting tip. The flexibility is increased to negotiate canals. The gold thermal treatment not only increases the cutting efficiency but also increase resistance to cyclic fatigue. They are available in 4% and 6% taper. [4,5]

The Endo Sequence is made in such a manner that it creates an efficient file system with short learning curve allowing the clinicians to form a proper instrumented canal. The Endo Sequence files functions on alternating contact points, present along the instrument's cutting length, this causes the file to remain in centre of the canal and at the same time reduces the torque requirements. The file lacks radial lands resulting in thinner metal and more flexibility. [6,7]

Since availability of various files, there has been a dilemma as to which is better and which one to choose. Hence, present study was conducted to compare the cleaning efficacy of three different NiTi rotary systems: Protaper, Neo Endo and Endo Sequence on extracted teeth in the population of Chhattisgarh state.

Materials and Method

A total of sixty-six human maxillary second premolars with a slight curve to their roots were selected. The specimens were freshly extracted and stored in formalin containing 0.1% Thymol. The premolars were divided into three groups with 22 samples in each. 20 samples were instrumented and 2 were kept as controls which were not instrumented. Samples were decoronated at the level of cement-enamel junction. The samples were split vertically by preparing two longitudinal grooves on palatal and buccal surfaces throughout the length of each root using micromotor and carborundum disc. K- Flex # 15 stainless steel hand file was used to establish canal patency. Working length was determined by similar file; it was inserted till it was visible at the apical foramen using a magnifying loupe. The working length was estimated to be 1 mm less than the length obtained by this initial file. The specimens were then embedded in

silicone rubber-based impression material which was filled in plastic box so as to obtain a constant position.

Study design

The samples were prepared using files of their designated groups. The preparation was done as per manufacturers' recommendation.

Group I: Root canal preparation by Protaper rotary files

Group II: Root canal preparation by Neo Endo rotary files

Group III: Root canal preparation by Endo sequence rotary files

All three systems were used in traditional Crown-Down pressure-less technique. X-Smart torque control endo-motor with 16:1 reduction gear contra-angle hand-piece was used to fit the files. Glyde gel was used as lubricating agent. 3 ml of 3% Sodium Hypochlorite was used as an intra-canal irrigant after instrumentation with each file. Each set of files was used to prepare five root canals and then disposed of to avoid breakage.

Root canal preparation

Group I: Once the patency was established, Protaper Shaping files were used; S1 was first used in the canal, moving apically and kept little short of working length at 300 rpm. The canal was irrigated thoroughly and a hand file was used to breakup debris accumulation. After irrigation, SX file was used in a brushstroke action to selectively remove dentin. It was used in a passive fit and was taken deeper in the canal until a light resistance was encountered. The resistance was bounced off and brushed out in an apico-coronal direction. Then a hand file was used to negotiate rest of canal; working length and patency was confirmed. After that S1 was used to verify smooth glide path and S2 was used till working length. F1 was then used till working length to finish apical one-third of the canal. F2 and F3 followed the suit. Canal was irrigated at the end.[8]

Group II: The canal was explored using #10 file and patency was established. Neo Endo files were used in gentle brushing motion. The file was taken to the point of passive resistance and brushed out of canal. Neo Endo files with tip size #20, #25, #30 and taper 0.04 were used. The files were used in full clockwise rotation with speed of 350 rpm and 1.5 N/cm torque. The procedure is repeated until working length was established. Copious irrigation was maintained throughout the preparation.[9]

Group III: The patency was established and then an expeditor size 27, 0.04 taper file was used in the canal to determine the file set to be used. Expeditor file was inserted in canal to a length where significant resistance was encountered. Since expeditor file reached more than half of the canal length and hence a medium sized pack was selected. The initial file of size #40, 0.04 taper was used in a crown-down manner at 600 rpm speed. This was followed by #35, 0.04 taper and #30, 0.04 taper being used in the canal. The files were used in a single "1-2-3" motion. The file was taken to engagement (1) and back, to second engagement (2) and back and finally to third engagement (3) and out of canal. Two series of three engagements were performed before moving to the next file. Copious irrigation was used during entire procedure.[10]

After completion of cleaning and shaping, the specimens were irrigated by 17% EDTA for one minute. The final irrigation was done with 3% sodium hypochlorite. The canals were dried with paper points. A paper point was left in to canal so as to avoid contamination during sectioning. An orthodontic cutter was used to slice the roots longitudinally in Bucco-lingual direction. Out of the two halves of the samples obtained, any one was randomly selected for examination.

SEM examination

Specimens were examined under Scanning Electron Microscope at junction of middle and apical third of the canal for presence of debris layer at 10 kV and 200X magnification and smear layer at 10kV and 1000X magnification. The amount of debris and smear layer on the canal walls were rated using five scale methods (Hulsmann et al) [11] by three independent observers.

Statistical Analysis

The average of the readings done by three observers was calculated and analysed statistically using non parametric Kruskal-Wallis Test ($p<0.05$) and one-way Anova. Bonferroni multiple comparison tests were also done to see the difference between three groups. The results of analysis of SEM photographs were taken at 200X and 1000X magnification for debris layer and smear layer respectively.

Results

The mean and standard deviation obtained are summarised in table 1 and 2. On comparison of three groups in case of debris layer a statistically significant difference was found, where debris layer was formed minimum in group III followed by group I and was maximum in group II. While comparing smear layer, similar results were found where group III least amount of smear layer followed by group II and then group I.

Discussion

The instrumentation of root canals results in dentinal debris as well as smear layer formation. Debris is accumulated in the form of dentinal chips and residues of vital or necrotic pulp. This debris layer, if left in the canal will result in bacterial contamination leading to endodontic failure; hence complete debris removal is the aim, endodontists thrive to achieve.[12] Smear layer is a thick surface layer measuring approximately 1-2µm comprising of dentin debris, bacteria and fragmented pulp tissue present on the dentinal walls during root canal instrumentation.[12] Complete removal of smear layer and debris not only allows the diffusion of the irrigants/medications to the root canal system; but also improves the adaptation of filling materials to root canal dentin which in turn reduces the apical and coronal microleakage.[13]In the present study, the apical preparation of all the canals was done using #30 file, this was followed for all three systems.[14] 3% sodium hypochlorite solution was used for irrigation after each file and 17% EDTA as final rinse to remove smear layer[15] and longitudinal sections of tooth were evaluated.

The present study evaluated the cleaning and shaping efficacy of three rotatory NiTi files in terms debris layer and smear layer removal. The files systems were: Protaper, Neo Endo and Endo Sequence. The estimation of debris and smear layer was done using Scanning Electron Microscope at 200X and 1000X magnification respectively. This was due to the fact that, at low magnification, large amount of debris can be easily seen but details of smear layer or identification of dentinal tubules has to be observed at a higher magnification.[11] The results obtained were in favour of Endo Sequence. In the present study, only 35% of specimen study showed a complete clean canal wall without any remaining debris (score 1), while remaining specimen were placed under scores 2 and 3, this was consistent with the result obtained by Paque et al. [16]

Vaudt et al have suggested that endodontic instruments vary in their debris removal efficacy and smear layer production due to variations in the flute and blade design. Endo Sequence file has a reamer like design with alternate contact point geometry.[17] According to Koch and Brave helical angles determine the debris removal as the file moves apically.[10] Endo Sequence files have

variable helical angles which result in moving debris coronally, out of canal thereby reducing the amount of extrusion of debris in periapical tissue. Moreover, these instruments are electro-polished which removes the greater majority of micro-imperfections presents on surface of file and thus produces a sharper instrument with an increased cutting efficiency. In case of Protaper files, since they have a progressive taper, they allow better irrigation and effectively remove dentinal debris particularly from coronal and middle part of the canal. [14,18] In the present study, there was no statistically significant difference found with regard to debris layer between Protaper and Neo Endo group and Protaper and Endo Sequence group. But statistically significant difference was found with regard to debris layer between Neo Endo and Endo Sequence group. (Figure A-D) On comparing smear layer, no statistically significant differences were seen between all three groups. However, Endo Sequence group produced minimum smear layer. (Figure E-H) This was in accordance to the study done by Yang et al. [19] Hulzman and Bluhm have also shown similar results in their study of three different NiTi rotary instruments, where all sections showed a comparable level of smear layer removal.[19]

The SEM evaluation was done at one section of root canal in the present study (at the junction of middle and apical third), which can be a shortcoming of this study, since all sections may have variations in smear layer removal and debris formation.

Conclusion

The authors conclude that all three NiTi files are effective in debris and smear layer removal as compared to control teeth. The results were skewed in favour of Endo Sequence which showed maximum efficacy in removal of both smear layer as well as debris, followed by Protaper. Neo Endo files, though showed effectiveness but were inferior as compared to other two file systems.

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Legend Tables and Figures

Table 1: Table showing descriptive statistics

	N	Mean	Std. Deviation	Median	ϰ2-value
Debris Layer					
Group 1	20	2.23	1.06	2.16	9.18
Group 2	20	2.61	1.00	2.33	P=0.01
Group 3	20	1.81	0.64	2.00	S, p<0.05
Smear Layer					
Group 1	20	2.59	1.16	2.49	2.06
Group 2	20	2.34	0.84	2.00	P=0.35
Group 3	20	2.09	0.40	2.00	NS, p>0.05

* p<0.05-significant, p>0.05-non significant

Table 2: Table showing Multiple Comparisons: Bonferroni Test

Group		Mean Difference (I-J)	Std. Error	p-value	95% Confidence Interval	
					Lower Bound	Upper Bound
Debris Layer						
Group 1	Group 2	-0.38	0.29	0.584 NS, p>0.05	-1.10	0.33

	Group 3	0.41	0.29	0.474 NS, p>0.05	-0.30	1.13
Group 2	Group 3	0.79	0.29	0.024 S, p<0.05	0.08	1.51
Smear Layer						
Group 1	Group 2	0.25	0.27	1.000 NS, p>0.05	-0.42	0.92
	Group 3	0.50	0.27	0.216 NS, p>0.05	-0.17	1.17
Group 2	Group 3	0.25	0.27	1.000 NS, p>0.05	-0.42	0.92

* p<0.05-significant, p>0.05-non significant

Figures

Fig 1: Debris Layer - SEM comparison (Figure A-D)

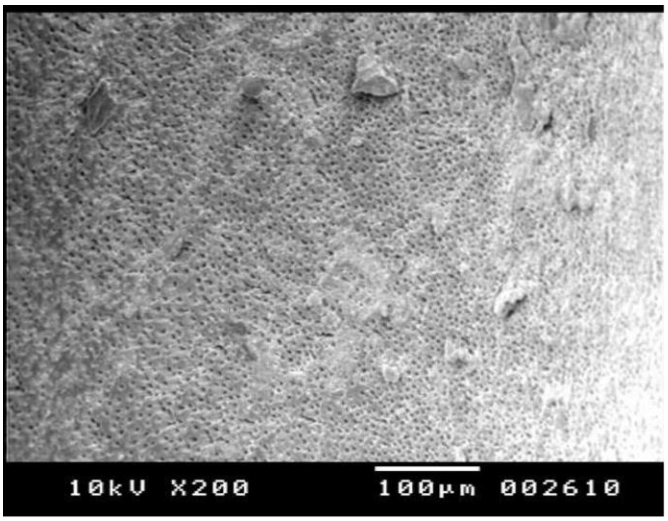

Figure A: Debris Layer in ProTaper specimen

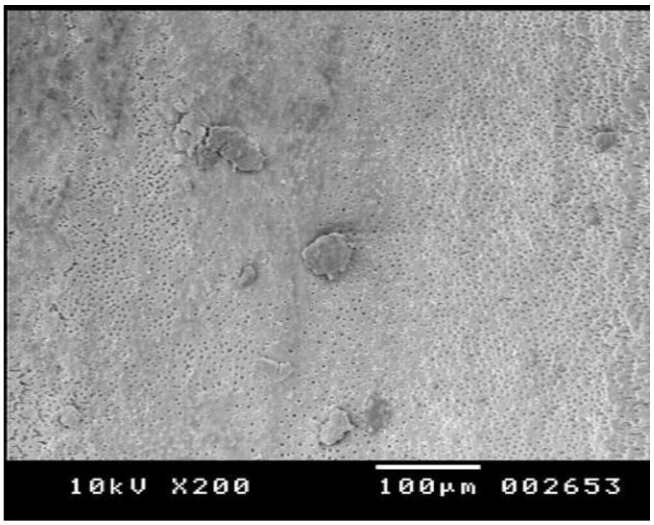

Figure B: Debris Layer in NeoEndo specimen

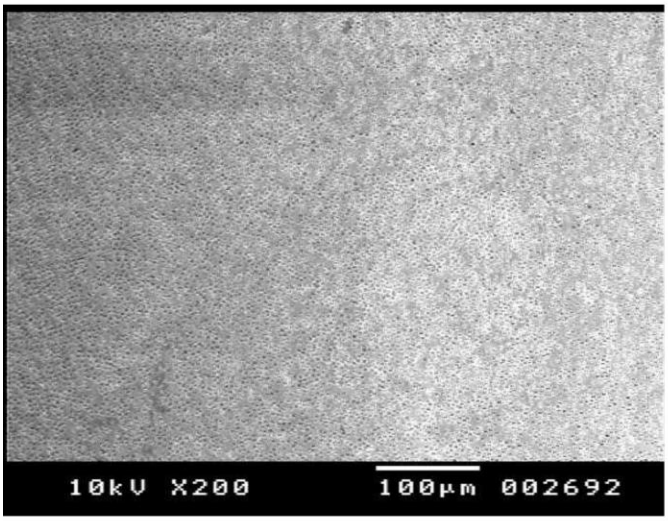

Figure C: Debris Layer in EndoSequence specimen

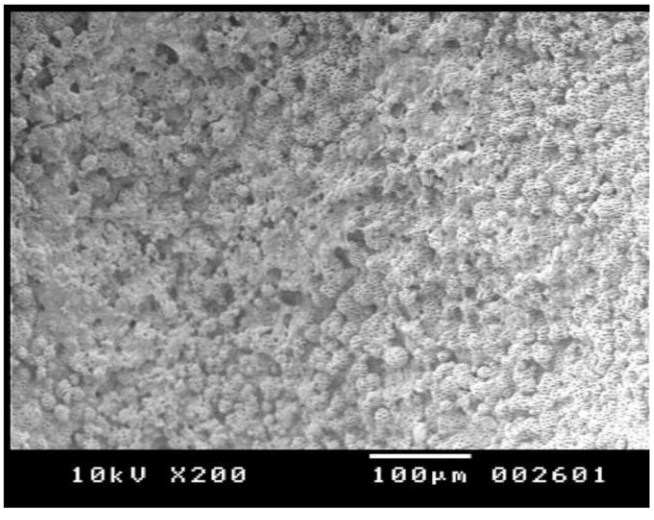

Figure D: Debris Layer in Control Group specimen

Fig 2: Smear Layer - SEM comparison (Figure E-H)

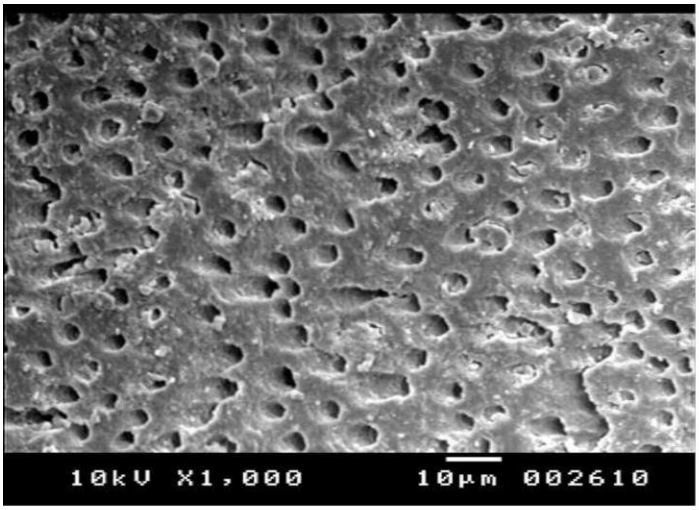

Figure E: Smear Layer in ProTaper specimen

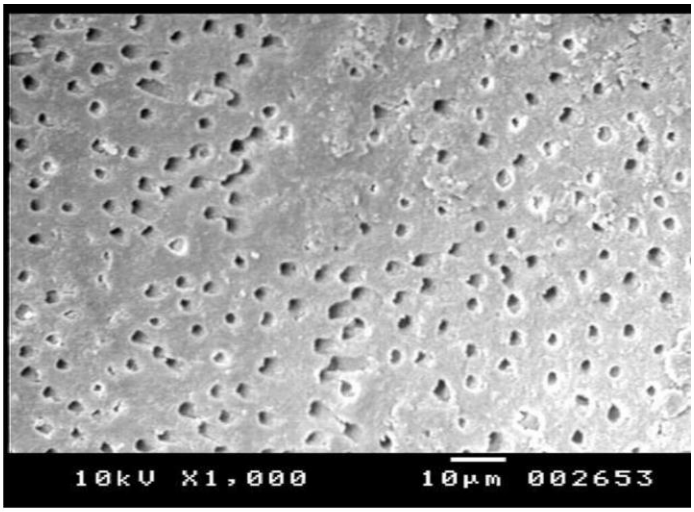

Figure F: Smear Layer in NeoEndo specimen

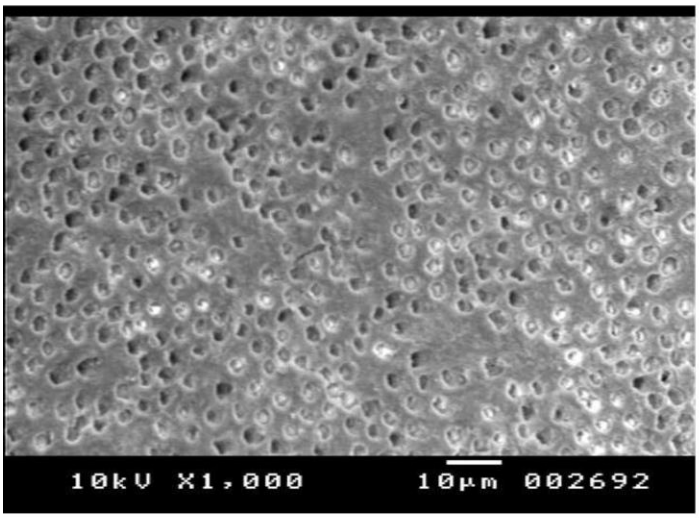

Figure G: Smear Layer in EndoSequence specimen

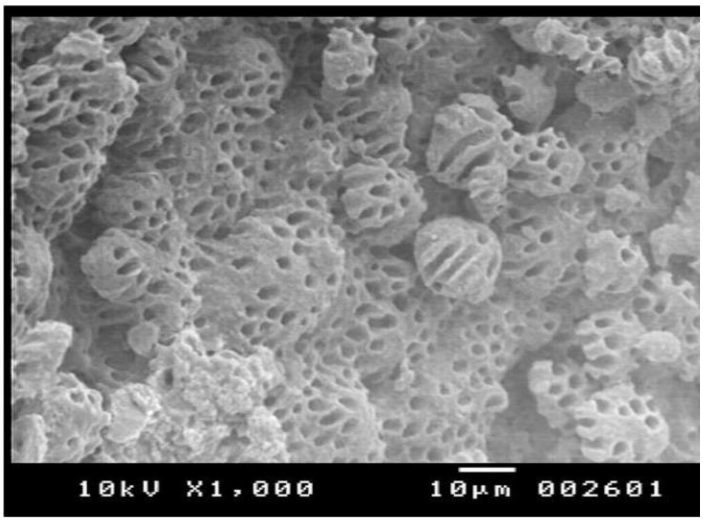

Figure H: Smear Layer in Control Group specimen