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A Comparative Analysis of Rotary NiTi, Hand NiTi and Stainless-Steel instruments for Removing gutta-percha during Retreatment using the AUTOCAD Software

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ABSTRACT

Background: A variety of different techniques has been used for removing filling materials. These include stainless hand file, heat, ultrasonics, laser and rotary instrument with or without solvent.[6] Several automated instrumentation techniques have been proposed as alternatives to manual instrumentation for removal of filling material from root canal walls. Studies have reported that NiTi instruments were safe, fast and efficient. Various assessment methods have been used in endodontic retreatment research, such as radiography and cleavage of the dental structure**.** This study will use the AUTOCAD software in assessing the surface area of residual root canal filling because it enables 2-dimensional evaluation of the root canal system**.**

Material & Methods: 80 freshly extracted human mandibular molar teeth were collected from the Out Patient Department of Oral and Maxillofacial Surgery, D.D.C.H., Udaipur. Teeth were radiographed in a buccolingual direction with RVG (Sopro). The crown of each tooth was sectioned at the cementoenamel junction, and the distal roots were removed. Each root canal was prepared using Protaper. The root canals were then obturated by the lateral condensation technique. Two-dimensional images of the roots were obtained in bucco-lingual direction. The images were evaluated with AUTOCAD software. For stratified randomization of the sample, the specimens were assigned to 4 groups of 20 teeth each (groups A, B, C and D). 1)For group A, the root fillings were removed with the Hedstrom File. 2) For group B, the root fillings were removed with the Hand ProTaper. 3) For group C, the root fillings were removed with Rotary ProTaper. 4) For group D, the root fillings were removed with K3 File System. For group A, the root fillings were removed with the Hedstrom File, for group B, the root fillings were removed with the Hand ProTaper, and for group C the root fillings were removed with Rotary ProTaper, and for group D, the root fillings were removed with the K3 File System.

Results: R-protaper showed the least amount of residual area followed by K3, H-protaper and H-file respectively.

Keywords: Rotary NITi, Hand NiTi, Oral health, Autocad.

INTRODUCTION

Endodontic treatment has provided dentistry with the ability to retain teeth that just a few decades ago would have been extracted without hesitation. A growing interest in endodontic treatment has been

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shown recently, caused by an increasing demand to preserve teeth.[1]Root canal therapy, despite having a high degree of success, may not lead to the desired response and failure may occur. When root canal therapy fails, treatment options include conventional retreatment, periradicular surgery or extraction.[2]When root filled teeth are associated with post treatment disease, and several factors may influence the decision whether to retreat or not.[3]

Nonsurgical endodontic retreatment, when indicated requires regaining of access to the entire root canal system through complete removal of the pre-existent endodontic filling material. This enables a new attempt at disinfection of the root canal system by thorough chemo mechanical reinstrumentation and disinfection of the root canals, which are prerequisite for a successful outcome.[4] A variety of different techniques has been used for removing filling materials. These include stainless hand file, heat, ultrasonics, laser and rotary instrument with or without solvent.[5]

Several automated instrumentation techniques have been proposed as alternatives to manual instrumentation for removal of filling material from root canal walls. Studies have reported that NiTi instruments were safe, fast and efficient. The maintenance of the root canal shape with the use of an automated device was more rapid and avoided apical extrusion of debris.[5]It has been reported that the retreatment time using rotary instrument was significantly shorter than that using conventional manual files. Rotary movement may produce a frictional heat to further soften the gutta-percha, making it easier to remove and thus requiring less solvent use.[6]

Various assessment methods have been used in endodontic retreatment research, such as radiography and cleavage of the dental structure.[7] This study will use the AUTOCAD software in assessing the surface area of residual root canal filling because it enables 2-dimensional evaluation of the root canal system.[8] The purpose of this invitro study is to compare the capacity of rotary NiTi, hand NiTi and stainless steel instruments for removing gutta-percha from the curved root canals of the mandibular molars.

MATERIAL AND METHOD

This in vitro study "A comparative analysis of Rotary NiTi, Hand NiTi and Stainless steel instruments for removing gutta-percha during retreatment" using the AUTOCAD software was done in the Department of Conservative Dentistry and Endodontics, Darshan Dental College & Hospital, Udaipur. 80 freshly extracted human mandibular molar teeth were collected from the Out Patient Department of Oral and Maxillofacial Surgery, D.D.C.H., Udaipur. Teeth were radiographed in a buccolingual direction with RVG (Sopro) and care was taken to exclude teeth: open apices, dilacerated roots, presence of root fillings, internal resorption, and calcified canal.

The crown of each tooth was sectioned at the cementoenamel junction, and the distal roots were removed with a water-cooled double-faced diamond disk operated at low speed. The real length of the canal was recorded by measuring the length with #08/#10 K-file, and the working length was calculated by subtracting 1 mm from this measurement. The canals were enlarged till #15 K file. After each instrument, the root canal was flushed with 2ml of 3% NaOCl and EDTA (Glyde). Each root canal was prepared using Protaper. After chemo-mechanical preparation, the canals were dried with absorbent paper points. The root canals were then obturated by the lateral condensation technique, with a F1 protaper gutta-percha cone and Zinc Oxide Eugenol sealer. The root canal entrances were sealed with temporary filling material, and specimens were stored at 37°C in 100% humidity. After 1 month, the roots were numbered randomly from 1 to 80 and placed in individual flasks, where they were kept hydrated.

Method of Evaluation: The temporary filling material was removed from each canal entrance. On a sheet of A4 paper, a space for each root was demarcated and numbered (from 1 to 80). Exposure time was 0.2seconds and voltage was kept constant at 234v. The distance between the X-ray source and object was set at a constant distance of 5cms and between object and the film was 2cms.Two-dimensional images of the roots were obtained in bucco-lingual direction. The images were evaluated with AUTOCAD software. The area corresponding to the root-filling mass was outlined and measured in square millimeters.

Method of Group Division:

- For stratified randomization of the sample, the specimens were assigned to 4 groups of 20 teeth each (groups A, B, C and D).
- For group A, the root fillings were removed with the Hedstrom File.
- For group B, the root fillings were removed with the Hand ProTaper.
- For group C, the root fillings were removed with Rotary ProTaper.
- For group D, the root fillings were removed with K3 File System.

Method of removal of Gutta-percha:

In the preparation for removal of the root-filling material, one drop of Orange Oil (RC Solve) was applied at the canal entrance and left for 3 minutes. A path was then created within the softened gutta-percha using #20 and #15 K-type files, applied sequentially, until the working length was reached. After that root canal was negotiated and the working length was reached, removal of gutta-percha was continued with one of the mechanical systems under study.

For group A, the root fillings were removed with the Hedstrom File, for group B, the root fillings were removed with the Hand ProTaper, and for group C the root fillings were removed with Rotary ProTaper, and for group D, the root fillings were removed with the K3 File System.

Method of Evaluation after removal of GP:

Once removal of the root-filling material was completed, the specimens was repositioned on the demarcated sheet of A4 paper, in the same places and in the same positions as were in initial imaging. Images of the roots were repeated, and the area of filling material remaining in mesiobuccal and mesiolingual canals were outlined and calculated using the 'AUTOCAD software'.

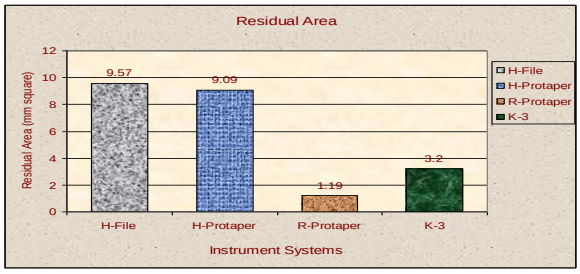
Results- To study the residual gutta-percha into the root canal with AUTOCAD software a total number of 80 samples were used. The samples were sectioned, instrumented, obturated and radiographed. The gutta-percha was removed with different manual and rotary systems and again they were radiographed. These radiographic images were assessed with AUTOCAD software. Data obtained were subjected to statistical analysis.

Table 1: Mean values for different groups (Instrument Systems) in both canals and mesial root.

S. No	Machine	Mesiobuccal		Mesiolingual		Mesial root	
		Mean	SD	Mean	SD	Mean	SD
1.	H – File	7.59	13.16	11.47	16.19	9.57	10.61
2.	H – Protaper	12.63	14.65	4.96	11.02	9.09	10.30
3.	R – Protaper	2.09	4.74	0.76	3.40	1.19	2.38
4.	K 3	3.28	5.62	3.07	5.04	3.20	4.70

Table 1 depicted the mean value of residual area in the both canals and mesial root of 4 groups.

1. In mesiobuccal canal R-protaper was most effective as it had least amount of residual filling material i.e. 2.09 followed by K3 i.e. 3.28 followed by H-file i.e. 7.59 followed by H-protaper i.e. 12.63.
2. In mesiolingual canal R-protaper was most effective as it had least amount of residual filling material i.e. 0.76 followed by K3 i.e. 3.07 followed by H-protaper i.e. 4.96 followed by H-file 11.47.
3. In mesial root R-protaper was most effective as it had least amount of residual filling material i.e. 1.19 followed by K3 i.e. 3.20 followed by H-protaper i.e. 9.09 followed by H-file i.e. 9.57.
4. Mesiobuccal canal- One way ANOVA, F value is 32.65; best machine is R-protaper.
5. Mesiolingual canal- One way ANOVA, F value is 92.66; best machine is R-protaper.
6. Mesial root - One way ANOVA, F value is 108.64, best machine is R-protaper.



Graph 1: Column chart showing the mean values of the residual area of different groups (Instrument Systems)

R-protaper showed the least amount of residual area followed by K3, H-protaper and H-file respectively.

- Post hoc analysis revealed significant difference between the groups.
- However there was no significant mean difference between groups in both the canals and the mesial root.
- In mesiobuccal canal the highest mean difference was found between group B and C i.e. H-protaper and R-protaper, followed by group B and D, followed by group B and A.
- In mesiolingual canal the highest mean difference was found between group A and C i.e. H-file and R-protaper, followed by group A and D, followed by group A and B.
- In whole mesial root the highest mean difference was found between group A and C i.e. H-file and R-protaper, followed by group A and D, followed by group A and B.

Table 2: Post Hoc Scheffe Test

S. No	Machine	Treat (J)	Mesio buccal			Mesiolingual			Mesial root		
			Mean difference (I-J)	SE	P value	Mean difference (I-J)	SE	P value	Mean difference (I-J)	SE	P value
1.	H - File	B	-5.04	2.39	0.000(S)	6.51	1.50	0.000(S)	0.48	2.11	0.000(S)
		C	5.50			10.71			8.38		
		D	4.31			8.40			6.37		
2.	H – Protaper	A	5.04	1.59		-6.51	1.99		-0.48	1.31	
		C	10.54			4.20			7.90		
		D	9.35			1.89			5.89		
3.	R – Protaper	A	-5.50	2.33		-10.71	0.98		-8.38	3.81	
		B	-10.54			-4.20			-7.91		
		D	-1.19			-2.31			-2.01		
4.	K 3	A	-4.31	2.81		-8.40	2.28		-6.37	2.57	
		B	-9.35			-1.89			-5.89		
		C	1.19			2.31			2.01		

DISCUSSIONS

Nonsurgical endodontic retreatment of previously filled root canals is the initial treatment of choice for the management of endodontic failure. Removing as much sealer and filling material as possible from inadequately prepared and filled root canal is critical to uncover remnants of necrotic tissue or bacteria that may be responsible for periapical inflammation and failure.[4] The present study was intended to assess the efficiency of 2 mechanical and 2 rotary systems for removing filling materials from the curved root canals of mandibular molars.[8]

According to Gambarini (2000)[9], mechanical instrumentation with low torque enhances tactile sensitivity and as a result, increases the control of rotary files during root canal preparation. This approach, used in the present study, minimizes the risk of zips, ledges and perforations during root-filling removal and also avoids breakdown of engine-driven instrument[8].

Yared et al (2001)[10] pointed out that systems powered by air could not control torque, and air pressure variation might affect the rotational speed and torque. Such findings justified the use of reciprocating systems powered by an electric motor.[8]The low-torque motor increased tactile sensitivity, gave better control of rotary instrumentation and reduced the risk of instrument separation (Gambarini 2000, Yared et al 2001).[9,10] This might be the reason for the lack of instrument

fracture in the present study (Hulsmann & Bluhm 2004).[11]

The present analysis was carried out by methods reported by Barletta & Lagranha (2002)[7] without longitudinal cleavage and with radiographs being analyzed by means of a software package developed for civil engineering and architecture, the AUTOCAD 2004. The images obtained were magnified several times, and the canal areas with filling debris were outlined and measured using specific tools available in AUTOCAD software.[7]This method is more reliable as remaining gutta-percha or sealer might get lost by splitting the roots while using conventional methods (Ferreira et al 2001, Masiero & Barletta 2005, Shirrmeister et al 2006b).[13,14,15]However, this method has limitations as radiographic images provides only two-dimensional information on a three-dimensional structure and may be subject to magnification and distortion in addition, small volumes of debris may not be visualized.[8]Another limitation is that the software cannot calc ulate areas of objects with irregular outlines and therefore analyzes only the largest areas.[7]

In the present study it was only possible to make a semi-quantitative evaluation of the amount of debris remaining. Complete removal of root canal filling material was difficult to achieve. Less than 50% of the teeth (6/20 for H-file, 8/20 for H-protaper, 15/20 for R –protaper and 10/20 for K3) had clean root canals. When evaluated radiographically, none of the techniques evaluated remove all filling material from root canals, a finding that is consistent with previous reports (Wilcox et al 1987, Barletta & Lagranha 2002).[16,12] The evaluation of total percentage of remaining filling material did not reveal any statistically significant differences in effectiveness for removal techniques studied.

The mean of the remaining material measured for each instrument used was recorded in present study. The mean describes a statistical distribution of data. In mesiobuccal canal Group A showed 7.59± 13.16, Group B 12.63±14.65, Group C 2.09±4.74 and Group D 3.28±5.62. In mesiolingual canal Group A showed 11.47±16.19, Group B 4.96±11.02, Group C 0.76±3.40 and Group D 3.07±5.04. In mesial root Group A showed 9.57±10.61, Group B 9.09±10.30, Group C 1.19±2.38 and Group D 3.20±4.70. Based on the above readings the Group C (R-Protaper) efficiently removed the gutta-percha fillings from both the canals and the mesial root.

The reason is that, as Rotary Protaper instruments present a negative cutting angle, they might yield better results in terms of root canal cleanliness than manual instruments (Hulsmann & Bluhm 2004).[11] Also the design of protaper instruments is helpful in drawing out debris coronally (Koch & Brave 2002).[17] Neither of the systems used in this study afforded complete removal of the filling material. Furthermore, the findings of the present investigation showed the two rotary NiTi instruments, the Rotary ProTaper and K3, to be significantly more effective in removing gutta-percha from root canals compared to Hedstroem file and Hand Protaper.

The mean of the remaining material measured for each canal used was recorded in present study. The mean describes a statistical distribution of data. In mesiobuccal canal showed 7.59± 13.16 and mesiolingual canal showed 5.07±10.83.After application of the removal techniques, a higher percentage of filling material remained in the mesiobuccal canals than in the mesiolingual canals. This finding can be explained by the anatomic complexity of the mesiobuccal canals, which makes retreatment procedures more difficult (Barletta et al).[7]

Although this study suggested efficiency of R protaper in gutta-percha removal, this study employed fewer rotary systems and the method used provided 2 dimensional information and none of the systems completely removed gutta-percha. Further factors like, operators variables, number of usage of instruments, solvents, anatomical variations of each tooth must be taken to consideration. The results of present study indicate the need for more studies with rotary systems with more canal variables and three dimensional evaluations before drawing a final conclusion. Further laboratory and clinical evaluations are recommended for better retreatment results.

CONCLUSION

Under the experimental conditions, the following conclusions are made-

- All instruments used in retreatment, rotary or hand, left some filling material inside the root canal.
- Both rotary NiTi systems proved to be helpful and safe devices for gutta-percha removal in root canal retreatment.
- The two types of rotary NiTi instruments were significantly more effective and faster than Hedstroem files in removing gutta-percha during retreatment.
- Rotary protaper significantly showed the best results with regard to the area of filling material left inside the canals after mechanical and rotary instrumentation.
- There was a significantly lower amount of filling material remained in mesiolingual canals than in mesiobuccal canals.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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