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Comparative Evaluation of Canal Centering Ability between Protaper Rotary and Self Adjusting File in Oval Shaped Canals – A Cone Beam Computed Tomographic Analysis

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ABSTRACT

Background: Self Adjusting Files have been introduced to overcome the disadvantage of protaper rotary files, especially for oval root canal centering. Aims and Objectives: To evaluate the canal centering ability between rotary protaper and self adjusting file in oval shaped canals using cone beam computed tomography. **Methods**: The study was carried out on 20 single rooted mandibular premolars. To compare the canal centering ability produced by different techniques, pre-instrumentation, post-instrumentation, cross section images of specimen at 3, 6 and 9 mm from the apex were obtained from the 3D CBCT images of each individual group. The images captured digitally using Image Tools Software were compared. **Results**: Inter group comparison of mean ratio of both the groups at 3, 6 and 9 mm after preparation of canal showed statistically significant difference between both the groups ($p<0.05$). Intra group comparison of mean ratio of both the groups at 3, 6 and 9 mm after preparation of canal showed that the difference between both the groups was not statistically significant ($p>0.05$). **Conclusion:** The canal centering ability of self adjusting file was efficient than protaper rotary files.

Keywords: Endodontics, Oval shaped canal, Protaper Rotary, Self-Adjusting File.

INTRODUCTION

The success of an endodontic treatment depends on three main factors, cleaning and shaping, disinfection and proper obturation. The prime goals of cleaning and shaping are meticulous debridement of the entire root canal space and precise shaping of root canal, at the same time preserving the natural canal shape and best possible canal structure. Nevertheless, this is not easy in curved canals, where there is a propensity for instrumentation procedures to alter canal curvature as a consequence resulting in procedural errors.[1,2]

A major improvement in endodontic treatment has been the introduction of nickel-titanium (Ni-Ti) rotary file systems, with which the mechanical preparation of root canals has significantly improved. Since their origin, there has been extensive studies carried out to test Ni-Ti rotary files. Now about 30 different Ni-Ti instruments systems are available in the market. Studies have shown that Ni-Ti rotary instruments, owing to their superelastic property, are capable to preserve the natural canal shape not causing considerable variation or creating irregularities like perforations, zipping or ledges in curved canals. The main disadvantage of these rotary files is that, they tend to result in circular shaped canals with unprepared buccal and lingual extensions, where there are chances of retained tissue and bacterial remnants, especially in oval-shaped canals. Hence modifications have been made in Ni-Ti rotary file systems like twisted file with R- phase technology, HyFlex with control memory, ProTaper Next with M- wire technology, self adjusting file (SAF) with flexible and compressible hollow tube.[3-5]

The ProTaper file system (Dentsply Maillefer) is a commonly used Rotary Ni- Ti system having a cross-sectional design similar to that of a reamer, with three machined cutting edges and convex core.[6]

SAF is a file designed as a hollow tube without a solid metal shaft. It is very flexible as well as highly compressible enabling it to adapt to the

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cross-sectional shape of root canals.[5,6] These files help in effective preparation of canals including oval root canals. SAF system utilizes RDT handpiece-head and an inbuilt irrigation pump VATEA (ReDent).[7]

In order to achieve proper enlargement of root canals, it is imperative that instruments should be centered. Canal centering depends on factors like nature of alloys used for preparing instruments and the design of these instruments.8 It can be assessed by various means such as radiography, serial sectioning technique, longitudinal cleavge of teeth and non-invasive Cone beam computed tomography (CBCT) scanning. CBCT provides an accurate, reproducible, 3-dimensional evaluation without compromising the teeth.[5-8]

We carried our study to evaluate the canal centering ability of rotary protaper along with endoactivator and self adjusting file in oval shaped canals using CBCT.

MATERIALS AND METHODS

20 single rooted mandibular premolars were collected, sterilized and stored in saline. A coronal access cavity was prepared on each tooth by using a # 2 round bur in a high speed hand piece. Determination of working length was carried out and the teeth were randomly divided into two groups based on the type of instruments used protaper rotary and self adjusting file, into group 1 and 2, with 10 in each group.

To compare the canal centering ability produced by different techniques, both prior to and after instrumentation, cross section images of specimens at 3, 6 and 9 mm from the apex were obtained from the 3D CBCT images of each individual group. The images captured digitally using Image Tools Software were compared [Figure 1-3].

Bucco lingual centering ratio was calculated by the formulae D1= (X1 - X'1)/ (X2 - X'2) (Fig 4) and Mesiodistal canal centering ratio D2 = (Y1 - Y'1)/(Y2 - Y'2) [Fig 4 and 5]. Scoring system was based on the findings of Gambill et al.9 A score of 1 indicates a perfect centering ability and the closer the score to zero, the worse is the ability of the instrument to remain centered.

RESULTS

The obtained data was tabulated and analysed statistically. Independent sample t test was carried out for inter group comparison of mean ratio of both the groups at 3, 6 and 9 mm after preparation of canal [Table 1: Graphs 1 and 2]. It showed significant difference between both the groups ($p<0.05$).

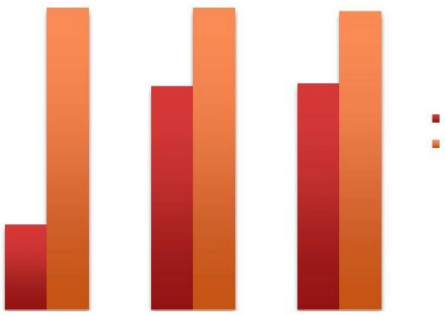
Paired t test was carried out for intra group comparison of mean ratio of both the groups at 3, 6 and 9 mm after preparation of canal [Table 2: Graphs 3 and 4]. The difference between both the groups was not significant($p>0.05$).

Table 1: Inter group Comparison of mean ratio among different groups at 3, 6 and 9mm after BMP (D1 and D2).

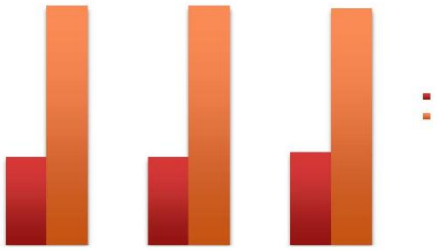
		Group 1		Group 2		P value
		Mean	SD	Mean	SD	
D1	3 mm	.27	.09	.96	.13	<0.001; Significant
	6 mm	.71	.07	.96	.13	<0.001; Significant
	9 mm	.72	.06	.95	.16	<0.001; Significant
D2	3 mm	.36	.10	.98	.08	<0.001; Significant
	6 mm	.36	.10	.98	.08	<0.001; Significant
	9 mm	.38	.10	.97	.08	<0.001; Significant

Table 2: Intra group Comparison of mean ratio among different groups at 3, 6 and 9mm after BMP (D1 and D2).

		D1		D2		P value
		Mean	SD	Mean	SD	
Group 1	3 mm	3mm	.27	.09	.36	.10 Not Significant
	6 mm	6mm	.71	.07	.36	.10 Not Significant
	9 mm	9mm	.72	.06	.38	.10 Not Significant
Group 2	3 mm	3mm	.96	.13	.98	.08 Not Significant
	6 mm	6mm	.96	.13	.98	.08 Not Significant
	9 mm	9mm	.95	.16	.97	.08 Not Significant



Graph 1: Bucco-lingual centering, Inter group Comparison of mean ratio among different groups at 3, 6 and 9mm after BMP



Graph 2: Mesio-Distal centering, Inter group Comparison of mean ratio among different groups at 3, 6 and 9mm after BMP

Graph 3 Bucco-lingual centering, Intra group Comparison of mean ratio among different groups at 3, 6 and 9mm after BMP

Graph 4 Mesio-Distal centering, Intra group Comparison of mean ratio among different groups at 3, 6 and 9mm after BMP

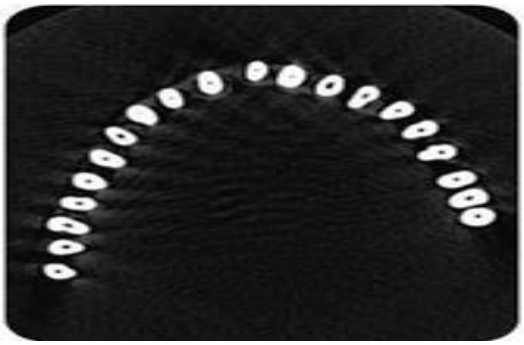


Figure 1: cross section images of specimen at 3 mm.

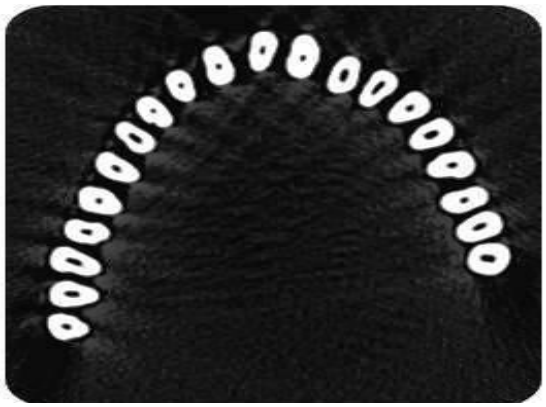


Figure 2: cross section images of specimen at 6 mm.

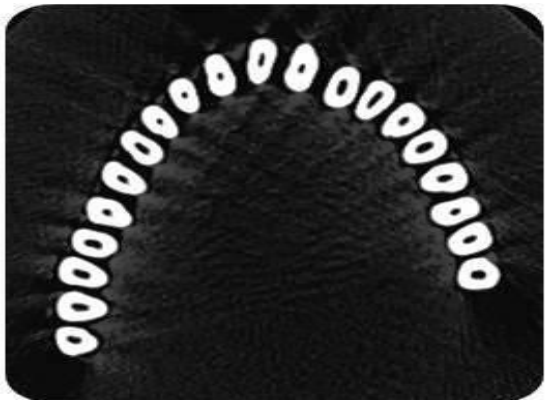


Figure 3: cross section images of specimen at 9 mm.

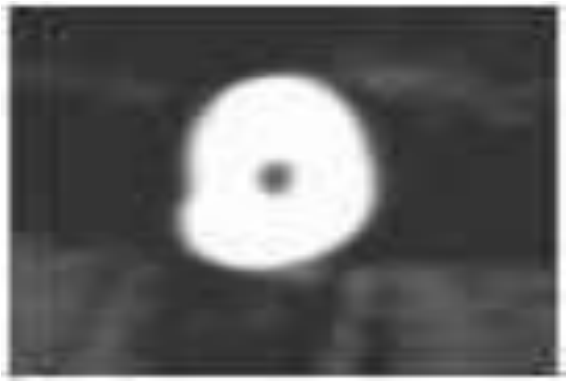


Figure 4: Bucco-lingual and Mesio-distal centering-Preinstrumentation

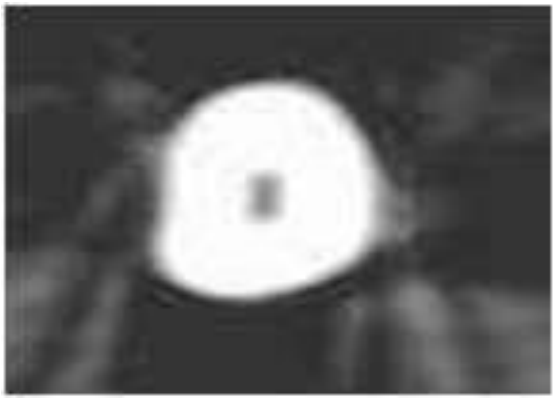


Figure 5: Bucco-lingual and Mesio-distal centering-Post instrumentation.

DISCUSSION

Root canal preparation is an important part of endodontic treatment. With expanding mechanization in the field of endodontics, the usage of Ni-Ti rotary instrument systems is extensive. The chief goal in endodontic preparation is to create a shape that tapers, preserving the original canal shape.10 Instruments should remain centered in the root canal throughout the preparation.[11]

When different morphologies are present in root canal, there is a tendency for preparation techniques to divert the canal away from the original axis. Its also essential that the instrument should remain centered and maintain original canal anatomy.[12]

The foremost purpose of mechanical preparation of root canal is to shape a continuously tapered configuration with the slightest and largest diameter at the apical foramen region and at the orifice respectively, so as to allow effective irrigation and filling. This is especially important in thin and curved root canals using various instruments and different techniques with maximum precision and shortest working time. To achieve this many instruments have been recommended, while only a small number of them emerge to be capable to attain these most important objectives of root canal preparation consistently.[8-10]

Recently introduced protaper rotary systems have been shown to be very successful in endodontic treatment. The advantages of these systems are having variable taper and rigidity due to the significant amount of metal in their structure. But these instruments have been shown to get locked in the cervical third of curved root canals.[11,12]

Cone-beam computed tomography (CBCT) is a recent and non-invasive investigative procedure. It has many advantages like low dose radiation and permits assessment of detailed images using different settings. In the field of endodontics, It is helpful in comparing anatomical structure of the root canal prior to and after biomechanical preparation. It may also permit evaluation of centering ability of endodontic instruments that show the capability of the instrument to remain centered in the root canal.[3-5]

Ni-Ti instrument systems are chiefly used as they have superior flexibility and ability to maintain the original shape without causing any iatrogenic affects like perforations etc. Several Ni-Ti rotary systems have been introduced into the market and their canal centering capability is being studied by many researchers with varying results. Dissimilar results might be because of disparity in file design, taper of various files, design of the instrument tip, method employed to study centering ability, method of root canal preparation.[8-10]

A study by Kandaswamy et al showed the better canal centering ability of Ni-Ti instrument system when compared to that of stainless steel instrument system.8 Hence, most of the findings of studies on maintaining original canal curvature have concentrated on Ni-Ti instrument systems composition and design. Some of the recently introduced Ni-Ti syatems are RS, GTX, TF and Mtwo. These latest systems differ in their geometric design and method of manufacture.[8, 9]

Therefore, the study was carried out to evaluate the canal centering ability of rotary protaper system along with endoactivator and self adjusting file in oval shaped canals using CBCT. Non-invasive CBCT technique was used in our study as it provides a precise, reproducible, three-dimensional assessment not causing any damage to the teeth.[8-10]

Various methods are used generally to evaluate root canal shaping capability. They are radiographs, tooth sections and plastic blocks. To gauge the action of root canal instruments on the canal walls, pre and post operative periapical radiographs are usually taken. Studies have been carried out to evaluate endodontic instrument effectiveness by CT radiographs, as this method is a non invasive method and permits measuring the quantity of root dentin removed by root canal instruments. Recently Cone beam computed tomography (CBCT), a three-dimensional high-resolution imaging technique is also in use. The advantage of CBCT is that it a non-invasive technique and it analyses variables like surface area, volume, cross-sectional shape, and taper precisely. CBCT can even measure a fraction of prepared surface with its software, not interfering with the original format of the images.[10-12]

We evaluated the canal centering ability of protaper rotary and self adjusting file using CBCT at three levels (i.e., at 3 mm, 6 mm, 9 mm from the root apex) as they represent the apical, middle and coronal thirds of root canal.

We found that SAF had better centering ability in coronal, middle and apical areas. The possible reason might be as SAF has flexible and compressible hollow tube which adapts to canal anatomy and due to its scrapping action it removed minimal circumferential dentin than protaper rotary.[12,13]

In the present study, SAF was centered in both bucco lingually and mesio distally. The possible reason might be due to its file and scrapping action.[14]

In the present study, Protaper rotary was not centered mesiodistally and bucco lingually at 3 mm. The possible reason might be due to its cross sectional design. Whereas protaper rotary was centered buccolingually at 6 mm and 9 mm. The

possible reason might be that the file may be untouched in buccal and lingual surfaces as the root canals are oval in shape.[15]

CONCLUSION

Ours is the first study comparing canal centering ability of SAF and rotary files Within limitations of this study, it can be concluded that the canal centering ability of self adjusting file was efficient than protaper rotary files. There was statistically significant difference in the degree of canal deviation after cleaning and shaping.

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