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RESEARCH ARTICLE

TO DETERMINE WHETHER THE FIRST BINDING FILE AT THE WORKING LENGTH IS THE APICAL DIAMETER IN CURVED ROOT CANAL BOTH BEFORE AND AFTER FLARING: AN IN VITRO STUDY

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ABSTRACT

Aim: To compare the effectiveness of different file system to determine the apical diameter of canal, before and after coronal flaring in teeth with curved apical roots. **Material and methods:** 30 extracted premolar teeth with apically curved canals were divided into 2 groups (n=15). In group 1 hand k files were used and in group 2 Ni-Ti hand files were used. After access opening and obtaining patency with no. 6 k file, progressively increasing number of file sizes were introduced in the canal upto the working length passively until binding sensation is felt in the canal with the file. The last file to passively reach the working length was fixed and was observed under stereomicroscope and the digital image was recorded. Then, cervical flaring was done in the canals and the files were reinserted in the canals and again observed under stereomicroscope. The digital images were analysed using AutoCad software. **Results:** There was no statistically significant difference between the mean diameter of files in group 1 (hand k files) and in group 2 (Ni-Ti hand files). Significant difference was found in the file diameter before flaring and after flaring in group 1 (k file) and in group 2 (Ni-Ti file). **Conclusion:** There is no difference between Ni-Ti hand files and k files in determining working width in apically curved canals.

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INTRODUCTION

Endodontic treatment aims to reduce the number of viable microorganisms present in root canal system and a perfect hermatic seal to prevent re-infection. For endodontic success three critical parameters should be followed 1) correct determination of minor apical diameter, 2) taper of the canal, and 3) horizontal dimension of the canal at its most apical extent, also known as initial apical file size (Jou, 2004) Definition of working width according to Jou *et al.* (2004)- initial and post-instrumentation horizontal dimensions of the root canal system at working length and other levels. Eg- in a round canal, the lesser and the greater horizontal dimensions are almost same, but for oval, long-oval or flat canals the greater horizontal dimension is much greater than the lesser dimension. Appropriate enlargement of canal at the apex is important as larger apical preparation will lead to zipping, extrusion of irrigants or fractures, and smaller apical preparation will lead to inadequate flushing, incomplete removal of bacteria and chances of re-infection. One method to determine apical width as described by some authors (Grossman, 1988; FS, 1996; Walton, 1996) is to enlarge the canal to three ISO file sizes larger than the first file to bind at that length. But no evidence is present to support this study. It has been demonstrated that the tactile sensation of apical file fit does not necessarily occur because of contact at the apex but might be a result of interferences in the coronal and middle thirds of the root canal (Leeb, 1983). Haga also found that mechanical preparation of root canals to two sizes larger than the original is still not adequate (Haga, 1968). Inquorate apical width preparation can be due to one of the following or a combination of reasons like, canal shape, canal length, canal taper, canal curvature, instrument used to determine working width.

Molars and premolars are often presented with curved roots and canals, which makes the proper apical width determination difficult. Using rigid instrument in a curved canal can also lead to a false tactile sense of binding. The introduction of Ni-Ti instruments in endodontics was reported by Walia *et al.* (1988). The advantage of this Ni-Ti over stainless steel files were that these files have excellent flexibility and are resistant to fracture. Various studies have also found that nickel-titanium files were more effective in maintaining the original curvature with little or no ledging of the root canal wall than stainless steel k files (Esposito, 1995). The aim of the current study was to evaluate and compare the effectiveness of stainless-steel k file and Ni-Ti hand files to determine the apical diameter of canal, both before and after coronal flaring in teeth with curved apical roots.

MATERIALS AND METHODS

Sample selection- 30 extracted human premolars with apical third curvature of 15- 20^0 (measured using Schneider's method) were selected for the study. Teeth with fully formed apices and patent foramens were selected and teeth with root resorption, any fracture line and or with history of root canal treatment were excluded from the study. Samples were stored in 0.1% thymol solution at room temperature.

Preparation of sample: Conventional access cavities were prepared, and patency was achieved using 6 No. k file, until the tip of the file was just seen at the apical foramen. The working length was kept 1 mm short of the apical foramen. The files were fixed with acrylic resin to the tooth at that working length, and the roots were grinded 1mm apically on Arkansas stone to expose the file at that length. Precaution was taken not to grind the file. The canal was then irrigated with 3% NaOCl and distilled water to wash out all the debris.

Groups

Group 1: Measuring apical diameter with K file (Mani)

- Before flaring
- After flaring

Group 2: Measuring apical diameter with Ni-Ti hand files (Dentsply)

- Before flaring
- After flaring

Procedure: Groups 1 and 2 canals were instrumented with k file and Ni-Ti hand files respectively without pre-flaring. Canals were instrumented with a passive watch winding motion without forcing the file in the canal. Starting with No.8 size, the file sizes were increased until a binding sensation was felt at the working length. First file to bind in the canal at working length was recorded for each tooth. That file was fixed at the working length with acrylic resin and the apical region was viewed under stereomicroscope at 32x magnification. A metal ring of diameter 1.70 mm was placed around the apex of the samples in order to standardize the area for image analysis. Images were then recorded for each specimen (Figure 1a). Then the coronal and middle portion of the canal were enlarged with Gates-Glidden drills, size 1-4 for both group 1 and group 2. Irrigation was done with 3% NaOCl and saline between each drill and the patency was maintained with No. 8 k file.

After flaring was completed, similar procedure was done as done in pre-flaring roots. The first file to bind at working length was fixed at the length and was observed in stereomicroscope and were digitally recorded (Figure 1b).

Image analysis: Images were analysed using AutoCAD software. The largest diameter of the canal at the apex was measured with this software and was taken as the canal diameter. The difference between this largest diameter of the canal and the file diameter was put to statistical analysis.

Statistical analysis: Statistical analysis was done by using descriptive and inferential statistics using student's paired and unpaired t test and software used in the analysis was SPSS 22.0 version and $p<0.05$ is considered as level of significance.

RESULTS

Students paired t test showed significant difference in before flaring and after flaring samples in both groups, i.e significant difference was found in the file diameter before flaring and after flaring in group 1 (k file) and in group 2 (Ni-Ti file) (Tables 1 and 2 respectively). Students unpaired t test showed no statistically significant difference between the mean diameter of files in group 1 and in group 2 (Table 3). Significant difference was found between diameter of the canal and the file diameter (after flaring) in group 1 (k file) (Table 4) with a percent diversity of 30%, and also, in group 2 (Ni-Ti file) (Table 5) with a percent diversity of 23.80%.

DISCUSSION

Canal preparation aims to remove the superficial infected dentin layer, to decrease the bacterial load from the canal, to prepare space for the irrigants to flow and for the placement of medicament. Card *et al.* (2002) reported that instrumentation resulted in mechanical reduction of bacterial population from the canal. Simon reported the apical area as the critical zone for instrumentation (Baugh, 2005).

Enlarging the apical area to three file size greater than the first file to fit at the apex is still the method of choice for apical region preparation. Studies have evaluated that most of the techniques used for cleaning and shaping are inadequate and the reason being the root apical opening is larger than the instrument calibre used in the studies (Jou, 2004). Certain factors affect the proper determination of apical width of the canal such as the canal morphology, canal wall irregularities, canal curvature and instrument used for determining working width. The canal wall irregularities are removed by flaring the coronal and middle portion of the canal. Apical curvature in the canal cause deflection of the gauging instrument and increase the frictional resistance. The curvature of the root canal can be categorized into two-dimensional, three-dimensional, small radius, large radius, and double curvature. These curvatures make the determination of correct apical width very difficult as all of these curvatures have different effect on clinician's sense of tactile. Wu et al studied the efficacy of k file and lightspeed file in gauging the apical width in curved mandibular premolar canals, and found that both the instruments that bound at the working length failed to accurately determine the apical width (Wu, 2002). In this study apical curvature of 15-20^0 was selected and the efficacy of two different instruments that is k file and Ni-Ti hand files were evaluated in determine the apical width.

Table 1. Comparison of diameter of the file in Group 1before and after flaring Student's paired t test

	Mean	N	Std. Deviation	Std. Error Mean	t-value
Before Flaring	0.14	15	0.03	0.008	6.97
After Flaring	0.20	15	0.04	0.010	p=0.0001,S

Table 2. Comparison of diameter of the file in Group 2 before and after flaring Student's paired t test

	Mean	N	Std. Deviation	Std. Error Mean	t-value
Before Flaring	0.15	15	0.048	0.012	3.78
After Flaring	0.23	15	0.093	0.024	p=0.002,S

Table 3. Comparison of mean difference in diameter of the file in two groups Student's unpaired t test

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
Group 1	15	0.063	0.035	0.009	0.72
Group 2	15	0.080	0.081	0.021	p=0.47,NS

Table 4. Comparison of canal diameter and file diameter after flaring in group 1Student's unpaired t test

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
After Flaring	15	0.20	0.041	0.010	3.02
Canal Diameter	15	0.26	0.054	0.013	p=0.005,S

Table 5. Comparison of canal diameter and file diameter after flaring in group 2 Student's unpaired t test

Group	N	Mean	Std. Deviation	Std. Error Mean	t-value
After Flaring	15	0.21	0.058	0.015	2.27
Canal Diameter	15	0.26	0.058	0.015	p=0.031,S

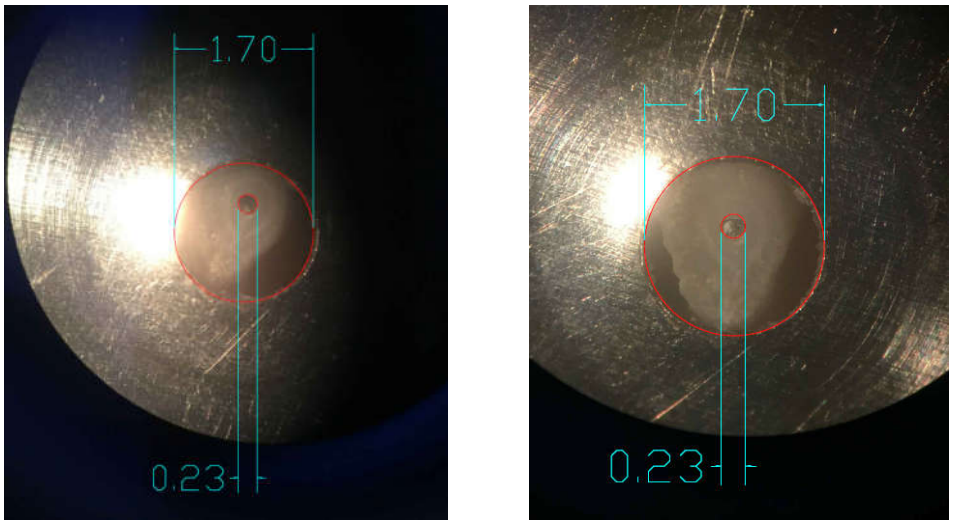

Figure 1. Apical foramen is seen with tip of the file in its centre as seen under stereomicroscope Outer ring is placed as a reference to measure the canal diameter. a-before flaring. b-after flaring

Weine et al in 1975 reported that instrumentation with stainless steel in curved canals mostly resulted in apical transportation, thereby making apical seal difficult (Weine, 1975). Nickel titanium alloys exhibit superelastic behaviour and a shape memory effect. Hence, it potentially allows shaping of narrow, curved root canals, without causing aberrations (Bramante, 2000). Hence, in this study Ni-Ti hand files were used for apical gauging in canals with apical curvatures. The result of this study showed that pre-flaring the canal upto middle third determined the apical width significantly better with both stainless steel k file and Ni-Ti hand files.

This result is in accordance with results obtained in studies of Wu et al, Pecora et al and Tan BT et al, which showed that early preflaring of the canals removes coronal interferences and thus provide better apical size information (Wu, 2002; Pecora, 2005; Tan, 2002). Stainless steel k file and Ni-Ti hand files, both gave similar instrument calibration at the apex even after flaring. Tan *et al.* (2002) and Marending *et al.* 2012) in their study compared stainless steel k file with light speed file and concluded that instruments with a flat widened tip were found to determine apical cross section diameter better than round tapered instruments.

Ni-Ti hand files have taper of the file similar to stainless steel k files, hence, no significant results were found in our study. Also, the commonly used method to determine the working width even after flaring used in this study had significant difference with the canal diameter. Hence, this method does not determine the apical width accurately.

Conclusion

In teeth with apical curvatures using the first file to bind at apex, even after flaring, for gauging the diameter of the apical canal and as guide for apical enlargement is not a reliable method. There is no difference between Ni-Ti hand files and k files in determining working width in apically curved canals. Better results are obtained in pre-flared canals using any file system. Clinician should consider introducing a non-tapered instrument to working length after coronal flaring because determination of the initial narrow apical canal diameter plays a major factor in identifying the extent of final apical shaping. Efficacy of the newer systems like the SAF to accurately detect the canal diameter should be checked.

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