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Original Research

A Comparative Evaluation Of Root Canal Transportation And Centering Ratio Associated With Hand Protaper, Rotary Protaper And Silk Rotary Files In Continuous Rotary Motion And Reciprocating Motion Using Cone Beam Computed Tomography- An In Vitro Study

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ABSTRACT

Aim: Ideally, root canal shaping should create a continuous tapered preparation from crown to apex while maintaining the original path of the canal and keeping the foramen size as small as practical. The aim of the present study was to compare the canal transportation and centering ability of Rotary ProTaper and Mani Silk files in continuous and reciprocating motion using cone beam computed tomography (CBCT) to find better instrumentation technique for maintaining root canal geometry. **Materials and methodology**: 60 freshly extracted teeth were divided into 5 group, Group A : Rotary protaper files in continous rotary motion, Group B: Rotary protaper files in reciprocating motion, Group C: Rotary Silk -Mani files in continous rotary motion, Group D: Rotary Silk -Mani files in reciprocating motion, Group E : Hand Protaper(control). Preinstrumention and postinstrumentation CBCT scans were obtained and statistically compared at 1,3,7mm with the ANOVA test and post hoc tukey test. **Results**: Data suggested that Silk-Mani files in reciprocating motion presented the better centering ability and less canal transportation than protaper files**.** **Conclusion**: Silk-Mani files in reciprocating motion have better Centering Ability and less Canal Transportation than hand and rotary protaper files.

INTRODUCTION

Cleaning and shaping are an important part of root canal therapy to remove debris and microbial flora that are responsible for endodontic infections. A number of cleaning and shaping techniques have been previously suggested that should be followed to achieve optimal results. These include developing a continuously tapering funnel from coronal access cavity to the root apex following the original canal shape and maintaining the apical foramen in its original form and function.1 Regardless of the instrumentation technique, cleaning and shaping procedure invariably leads to dentin removal from the canal wall. Excessive dentin removal from canal wall in single direction rather than all directions equidistantly from main root axis leads to what we call as “canal transportation”.2 Curved canals pose difficulties in adhering to the principles of cleaning and shaping because instrumentation technique can divert the canal away from the original axis. Also there is a greater likelihood for development of procedural errors during instrumentation which may include canal transportation, apical zipping, canal ledges, strip perforation and instrument separation.2, 3

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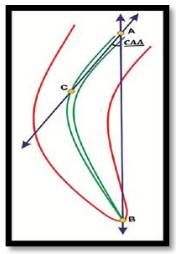


Figure 1: Canal Access Angle determination: A - Root canal orifice, B - Root apex, C - Point of deviation of straight line drawn from root apex, CAA - Canal access angle

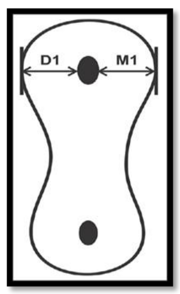


Figure 2: The preoperative remaining dentin thickness from the root canal wall to the root surface mesially and distally - M1 and D1, respectively

Development of nickel-titanium (NiTi) rotary instruments provided easier and faster root canal instrumentation.1-8 Rotary systems display different designs in their structure that help achieve a predictable canal preparation.4 Introduction of different nickel titanium rotary instruments/ files has significantly reduced procedural errors as compared to hand instrumentation technique. Therefore, it is important to evaluate the mechanical action of these files in order to improve and optimize the endodontic instrumentation. NiTi rotary files are manufactured from nitinol, an alloy which was developed by W. Buehler in 1962. In 1988, Wadia et al introduced NiTi for manufacturing endodontic instruments.4, 5

ProtaperTM has a convex triangular cross-section which reduces the contact area between file and dentine. This greater cutting efficiency has been safely incorporated through balancing the pitch and helical

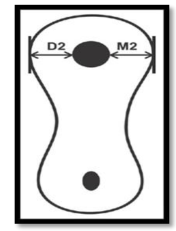


Figure 3: The postoperative remaining dentin thickness from the root canal wall to the root surface mesially and distally - M1 and D1, respectively

angles. They are available in sequence of Sx, S1, S2, F1, F2, F3.6 SILKTM by Mani possesses unique cross-sectional tear drop design which cuts exceptionally well and resists fracture, eliminating the 'screwing–in' effect common with many other rotary systems, while removing debris effectively and reducing instrument stress. The standard pack is available in size of 0.08/25, 0.06/20, 0.06/25. There is lack of literature regarding the centering ability and canal transportation created by SILKTM rotary system.

'Reciprocation' means repetitive back and forth movements given to file system at determined angle. Initially larger angles were used for instruments, but over time angle was reduced giving it some advantages like reduced binding of the file to the canal wall, reduction of number of cycles within root canal during preparation resulting in less flexural stress on the instrument and improved fracture resistance.8,9 A 2008 publication described a single file technique using asymmetric reciprocation. The objectives of this new technique were to reduce the working time and cost and to improve safety of the shaping procedure.9,10 Thus in the given study, two file systems were used in rotary as well as reciprocating motion to evaluate the better centering ability and less canal transportation.11

Cone-beam computed tomography (CBCT) is a modern and noninvasive diagnostic feature with compact equipment, low dose radiation and allows evaluation of detailed images using different settings. It is useful in comparing anatomical structure of the root canal before and after biomechanical preparation, allowing detection of deviations and transportation. It also allows assessment of centering ability of endodontic instruments that indicate the ability of the instrument to remain centered in the root canal.4, 11 Continuous evaluation of the mechanical behaviour of endodontic files is important to understand their effect on the chemo-mechanical preparation. Thus, the aim of this study was to evaluate canal transportation and centering ability of Protaper and SILK rotary by Mani systems in mandibular molar mesiobuccal canals by CBCT.

MATERIALS AND METHODS

For the study 60 human first mandibular molars extracted for periodontal and orthodontic purpose were collected. Teeth were stored in 10% formalin until use in the study. Teeth were selected on the basis of mature apices, similar canal curvature (15–40 degrees) by using Schneiders method [Figure 1], and separate mesial canals with no noticeable defects or abnormal root morphology. Caries and residual restoration were removed from teeth crowns, and then an access cavity was prepared using straight fissure diamond bur (SF-41 by Mani). Occlusal surfaces were reduced with diamond disk to have a comparable 18-mm length for all teeth and hence a reliable reference point for instrumentation. Size 10 K-File was inserted into the mesial canals so that their tips were just visible at the apical foramina, which were separate for both canals. Individual working lengths (WL) were calculated 0.5 mm short of these positions.

Samples were then divided into 5 groups

GROUP A: Rotary files (Protaper) in continuous rotary motion

GROUP B: Rotary files (Protaper) in reciprocating motion

GROUP C: Rotary files [Silk -Mani] in continuous rotary motion

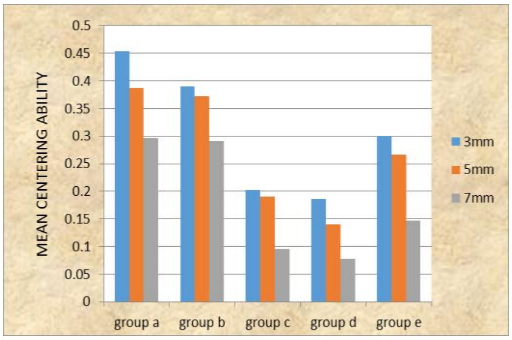
GROUP D: rotary files [Silk -Mani] in reciprocating motion

GROUP E: Control group [Hand Protaper]

All canals were prepared up to size 25 with 6% taper preparation. The canals were irrigated between each file with 2.5% sodium hypochlorite and saline. Both file systems were used in a similar manner to standardize preparations for comparison during this study. All the samples were scanned prior to instrumentation and after instrumentation with cone beam computed tomography.

Evaluation of Canal Transportation:

The canal transportation was determined by measuring the shortest distance from the root canal surface of uninstrumented canal to the outer root surface (mesial and distal), and then comparing the same measurements obtained from instrumented image. All values were measured and a mean value was taken.16 The following formula was used for the calculation of root canal transportation: (a1 – a2) - (b1 – b2), where a1 is the distance from the mesial surface of the root to the mesial surface of the uninstrumented canal, b1 is the distance from distal surface of the root to the distal surface of the uninstrumented canal, a2 is the distance from the mesial surface of the root to the mesial surface of the instrumented canal, and b2 is the distance from distal surface of the root to the distal surface of the instrumented canal (Figure 1). Results other than 0 indicated that transportation had occurred in the canal.12



Graph 1: Mean Centering Ability in all Groups

Evaluation of Centering Ability:

The mean centering ratio indicates the ability of the instrument to stay centered in the canal. The centering ability was calculated by using the following ratio: (a1 – a2)/ (b1 – b2) or (b1 – b2)/ (a1 – a2). If these numbers are not equal, the lower figure is considered as the numerator of the ratio. Ratio close or equal to 1 indicates high centering ability.12

RESULTS:

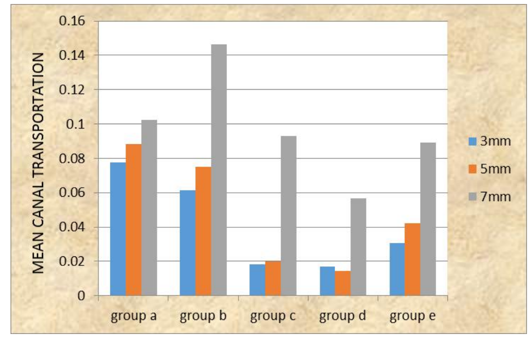
CENTERING ABILITY:

At 3 mm, centering ability of group D was highly significantly better as compared to group A and group B ($p<0.001$) and was significantly better than with group E ($p<0.01$) whereas no significant relationship was noted with group C.

At 5mm and 7mm, centering ability of group D was better than group A and B ($p<0.001$), whereas no difference was seen as compared to group C and E. Similarly, group C showed better centering ability as compared to group A and B at 3, 5, and 7mm level ($p<0.001$). Mean centering ability in all groups is shown in graph 1.

CANAL TRANSPORTATION:

At all 3, 5 and 7 mm levels group D showed significantly less chances of canal transportation ($p<0.001$) when compared to groups A and B. Group C showed less canal transportation than group A and B



Graph 2: Mean Canal transportation in all Groups

but not D and E ($p>0.05$). Mean canal transportation in all groups is shown in graph 2.

DISCUSSION:

A number of techniques are currently available to evaluate the efficacy of instruments to remain centered during root canal preparation with less chances of canal transportation. In the present study, the canal transportation and centering ability of rotary and hand Protaper and Silk rotary files used in continuous rotary and reciprocating motion was evaluated by using cone beam computed tomography technique.2-4, 13Various methods have been used to compare the canal anatomy before instrumentation and after instrumentation to investigate efficiency of instruments and technique developed for root canal therapy. Radiography is one of the methods which provide incomplete information due to its two dimensional nature. Sectioning of samples is a complicated procedure and can result in destruction of samples. In order to increase accuracy a non invasive method of analysis was selected- cone beam computed tomography. Another method, the micro-computed tomography, is emerging in several endodontic research facilities as a non-destructive and accurate method to analyze canal geometry and the relative effects of shaping instruments.13 This innovation was achieved because new hardware and software was available to evaluate the metrical data created by micro computed tomography, thus allowing geometrical changes in prepared canals to be determined in more detail.14, 15

GROUPS	3mm from apex	5mm from apex	7mm from apex
	Mean ± SD	Mean ± SD	Mean ± SD
Group A-rotary Protaper	0.0778± 0.01355	0.0882± 0.01757	0.1024± 0.02554
Group B-rotary Protaper reciprocating	0.0613±0.02 191	0.0749±0.020 23	0.1464±0.1834
Group C-Silk by Mani (rotary)	0.0182±0.00 5266	0.0201± 0.006471	0.0931± 0.01699
Group D-Silk by Mani (reciprocating)	0.0171±0.00 5782	0.01436±0.00 4137	0.0568±0.0068 93
Group E-Hand Protaper	0.0306±0.00 5275	0.0423±0.005 078	0.089±0.00930 9

Table 1: Distribution of mean and SD values of apical transportation at 3 mm from apex, 5 mm from apex and 7 mm from apex in groups A,S,C,D and E

Recently a new NiTi rotary file system was introduced by Mani with trade name "SILK". The unique tear drop cross section helps to eliminate screwing effect common with many other system and also removes debris effectively reducing instrument stress and also the number of instruments required.16 A unique feature of Protaper system is its progressively tapered design, which clinically serves to significantly improve flexibility and cutting efficiency; it typically reduces the number of recapitulations needed to achieve length, especially in tight or more curved canals.17 Protaper has a convex triangular cross-sectional design that reduces the contact area between the blade of the file and dentin, and serves to enhance the cutting action and improve safety by decreasing the torsional load.18 The cutting efficiency increases due to the triangular cross-section of the instrument. Each instrument creates its own crown-down effect and the larger conicity creates space for the smaller ones thus maintaining the canal curvature with a small risk of apical transportation.18,19,20 Both the files systems

GROUPS	3mm from apex	5mm from apex	7mm from apex
	Mean ± SD	Mean ± SD	Mean ± SD
Group A-rotary Protaper	0.454 ±0.09980	0.387±0.1090	0.296±0.0957 1
Group B-rotary Protaper reciprocating	0.39±0.04899	0.372±0.1488	0.291±0.1014
Group C-Silk by Mani (rotary)	0.202±0.07465	0.191±0.07218	0.0961±0.024 21
Group D-Silk by Mani (reciprocating)	0.186±0.06552	0.1408±0.0440 1	0.0773±0.013 64
Group E-Hand Protaper	0.3±0.05812	0.267±0.1228	0.1474±0.059 40

Table 2: Distribution of mean and SD values of centering ability at 3 mm from apex, 5 mm from apex and 7 mm from apex in groups A,B,C,D and E

were used with Marathon reciprocating endomotor according to manufacturing instructions.

Overall in all three sections, Group D (rotary Silk reciprocating) showed less canal transportation and more centering ability as compared to other groups and Group A (rotary Protaper) showed more canal transportation and less centering ability as compared to other groups.

LIMITATIONS:

The canals were instrumented to size 25/0.6 because previous researches have demonstrated that to get irrigant to the apical third of the canal, it must be instrumented to at least a size #25 file. Although in most cases this would probably be fine, in some cases the apex might need to be opened to a larger size, or retreatment cases might require opening the canal to a larger size/taper to fully clean and shape the canal properly; the effects of a larger taper need to be investigated. Our results demonstrated a statistically significant effect of length for the 25/.06 files, with the 1mm and 7mm level being significantly different. Thus, further studies need to be conducted on larger tapers and/or apical sizes because these parameters might affect transportation and centering ability. Differences in the metal of the 2 files might play a more significant role in larger file sizes. Further investigations on larger sample size need to be performed as sample size play important role in the results.

CONCLUSION

Within the limits of this study, all the five groups showed significant difference and it was found that "Silk" by Mani used in reciprocation has better centering ability and less canal transportation than Hand and Rotary Protaper used in continuous rotary and reciprocating motion.

RECOMMENDATIONS:

Silk Mani files with or without reciprocation can be recommended as an alternative to other systems having advantages in terms of less canal transportation and better centering ability.

CONFLICT OF INTEREST: NONE

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