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Cbct Evaluation of Canal Centering Ability Using Rotary versus Hand Instruments- An In Vitro Study

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ABSTRACT:

AIM: To compare the centering ability of Ni-Ti rotary systems (ProTaper NEXT, hero shaper, profile) with hand instuments (stainless steel K-files, Ni-Ti Flex files and hand protaper) by cone-beam computed tomography. METHODOLOGY: 90 Mandibular teeth were taken and six groups of 15 each were made.Teeth with previous endodontic treatments, metal restorations, resorptions, incomplete apex formations and multiple visible foramina were excluded. Biomechanical Preparation was with ProTaper NEXT, hero shaper, profile, stainless steel K- files, Ni-Ti Flex files, hand protaper and Centric ability was compared. RESULT: On the basis of centric ratio, At coronal and apial third, the following order of centering ability was observed in different groups, Group VI(hand protaper) ~ Group I(ProTaper NEXT) ~ Group II (hero shaper) ~ Group III(profile) ~ Group IV(stainless steel K- files) ~ Group V(Ni-Ti Flex files). At middle third, the following order of centering ability was observed in different groups, Group VI(hand protaper) > Group I(ProTaper NEXT) ~ Group II (hero shaper) ~ Group III(profile) ~ Group IV(stainless steel K-files) ~ Group V(Ni-Ti Flex files) .CONCLUSION: Under experimental conditions, At coronal and apial third none of the between group differences were significant statistically. At middle third Protaper hand files showed more canal centering ability in comparision to other file system.

Key words :centering ability, cone beam computed tomography.

I. INTRODUCTION

Microorganisms and their products play an important role in the pathogenesis of pulpal and periradicular diseases, so their elimination from root canal system as well as prevention of reinfection are the main purpose of root canal treatment1. Mechanical preparation of the root canal system is recognized as being one of the most important stages in root canal therapy. Problems with breakage and the inflexibility of stainless steel hand instruments have led to the search for newer materials to fabricate endodontic instruments2. NiTi instruments offer new perspectives for root canal preparation that have the potential to avoid some of the major drawbacks of traditional instruments and devices . They stay more centered in the canal, produce rounder preparations, and reduce procedural accidents, such as transportation and ledging . This in turn may result in better clinical outcomes6.

II. AIM AND OBJECTIVES OF THE STUDY

The aim of the study is to evaluate, “the canal centering ability of different types of rotary and hand instruments” by using CBCT. To compare canal centering ability of six different file systems using CBCT , based on following factors:

Canal Shift in mesial and distal direction

Canal centric ratio

III. MATERIALS AND METHOD

Present study, "CBCT EVALUATION OF CANAL CENTERING ABILITY USING ROTARY VERSUS HAND INSTRUMENTS-AN IN VITRO STUDY” was conducted to compare and evaluate the canal centering ability of different types of rotary and hand instruments by using CBCT.

All teeth were embedded in wax block . All Teeth were numbered and un-instrumentation scans were performed using CBCT (i-Cat CB500 machine) equipment ((i-Cat vision Software) in the high resolution dental mode at 75 kV, 5mA with a 85cm field of view and a single scout image True and oblique axial, coronal and sagittal images with a thickness of 0.20 mm and an interval of 0.20 mm were obtained. The axial, sagittal and coronal planes of MB roots in the pre-instrumentation scans were examined for calcifications. Axial images at 3,6,9 mm above the apical foramen were acquired from the un- instrumentation scans for evaluation. The sagittal images were used for measuring the curvature of MB canal using On Demand 3D software . All the canals showed curvature ranging from 12^0 to 50^0 .The samples were then randomly divided into six experimental groups for instrumentation .. Prepared samples were scanned using CBCT with same parameters as set for unprepared samples . Axial images at 3,6,9 mm above the apical foramen were acquired from the after-instrumentation scans for evaluation.(Fig. 1,2,3).

Canal centering ability of the following file systems was compared:
ProTaper NEXT Ni-Ti files (DentsplyMaillefer, Ballaigues, Switzerland)
Hero shaper rotary (Micro-Mega, Besancon, France)
Profile (DentsplyMaillefer)
Stainless steel hand k files (DentsplyMaillefer)
K-file Ni-Ti Flex (DentsplyMaillefer)
Protaper hand files (DentsplyMaillefer, Ballaigues, Switzerland)

ProTaper NEXT file system

The ProTaper NEXT (PTN) System provides cleaning and shaping advantages through the convergence of a variable tapered design on a given file (ProTaper Universal), innovative M-Wire technology, and a unique offset mass of rotation . There are 5 PTN files available, in different lengths, for shaping canals, namely X1, X2, X3, X4, and X5. In sequence, these files have yellow, red, blue, double black, and double yellow identification rings on their handles, corresponding to sizes 17/04, 25/06, 30/07, 40/06, and 50/06, respectively.

Hero shaper rotary file system

The Hero shaper rotary system supplements the existing Hero 642. They both have the same triple helix cross-section but the helix pitch and the helix angle have been modified, while the handle has been shortened for improved access. The Hero Shaper helix angle increases from the tip to the shank that is claimed to reduce threading, while the pitch varies according to the taper and it is claimed to increase the efficiency, the flexibility and the strength of the instruments. The Hero Shaper files are supplied in the ISO sizes of 20, 25 and 30, and in 0.4 and 0.6 tapers. The Endoflare is a separate instrument that can be used in combination with other systems to aid instrumentation . It has the same blade design as the Hero 642, a 25 size, a 0.12 taper, a blade length of 10 mm and it is used only to flare the coronal third at the beginning of shaping.

ProFile rotary file system

The ProFileNiTi rotary instrument line includes orfice shapers, ProFile .02, .04 and .06 tapers, Greater Taper (GT) files, Series 29, and Pro Taper instruments. The ProFile .02, .04 and .06 tapers, GTfiles, and Series 29 files all share the same cross sectional geometries have three radial lands that each contain bi-directional cutting edges. The radial lands keep the instrument centered in the canal while their cutting edges are intended to scrape rather than actively engage and screw into dentin. The radial lands are separated by three U-shaped flutes that provide space for the accumulation of debris. The U-shaped configuration effectively augurs debris coronally and out of the canal during clinical use. These files have a parallel core that enhances flexibility; non-cutting tips are designed to follow a pilot hole and 'guide' the instrument through the canal during preparation procedures. The recommended rotational speed for these instruments, regardless of the product line, is 150-300 RPM.

Stainless steel K-files

K-files are manufactured by twisting square or triangular metal blanks along their long axis, producing partially horizontal cutting blades.noncutting tips are created by grinding and smoothing the apical end of the instrument. All stainless steel (SS) hand files have inherent stiffness leading to various aberrations during canal preparation.Use of SS files in narrow curved canals is difficult and limits apical enlargement which may hinder obturation. In a study performed by Nagaratna et al. (2006), K-files showed more deformities, while separations were seen more in Ni–Ti files, which is in agreement with this study for K-files and was due to their inherent lower modulus of elasticity .

K-file Ni-Ti Flex

Ni-Ti Flex Files are extremely flexible and are especially useful for apical enlargement in severe apical curves. They can be precurved, but only with strong overbending, this subjects the file to excess strain .Because of their flexibility, the smaller Ni-Ti Files (sizes up to # 25) are of limited use .

Hand ProTaper files (Dentsply/ Maillefer, Ballaigues, Switzerland)

The ProTaper files are used in crown-down technique to avoid stress on instruments by

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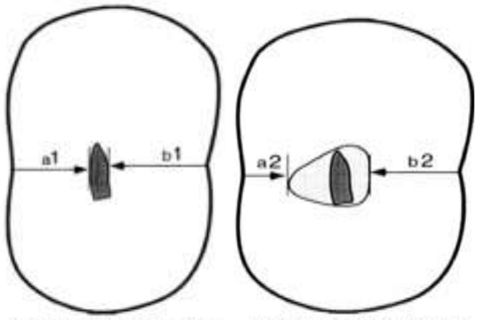
early opening of the coronal part of the root canal. crown down technique received more significantly excellent ratings than the step back method with almost similar occurrence of zipping and questionable occurrence of ledging and perforation in either technique . The apical area of all root canals were prepared to F3, as it has been shown that apical preparations to larger size instruments facilitates proper irrigation and better obturation .

Evaluation Of Canal Centering Ability
Measurements for image Cross Sections
Re-presentation drawing of tooth sections showing how transportation and centering ratio were derived unprepared image: original canal space represented by dark shaded area. Prepared image light shaded area represents canal's shape after instrumentation.



Unprepared CBCT Image Prepared CBCT Image

Centering ability was calculated using the ratio of a1-a2/b1-b2, or b1-b2/a1-a2 (the lower value is set as standard for the statistical evaluation). In this formula, the value of 1 indicates complete centering, and the results other than 1 show a change in the original canal axis .
centering ratio = a1-a2/b1-b2, or b1-b2/a1-a2
a1 = the shortest distance from the mesial aspect of un-instrumented canal to the mesial edge of the root
a2 = the shortest distance between the mesial edge of instrumented canal to the mesial edge of the root
b1 = the shortest distance from the distal aspect of un-instrumented canal to the distal edge of the root
b2 = is the shortest distance between the distal edge of instrumented canal to the distal edge of the root

Statistical analysis
Analysis of variance (ANOVA) - to measure variance within group and among the groups. Post-Hoc Tests (Tukey-HSD) test for each mean comparison .

IV. OBSERVATION

Centering Ability in Different Groups at 3 mm
Between group comparison of centering ability at 3 mm revealed minimum mean difference between Groups I and V (0.011±0.095 units) and maximum between Groups II and III (0.156±0.085 units). Statistically, none of the between group differences were significant.(Fig. 4)

Centering Ability in Different Groups at 6 mm
At 6 mm canal centering ability was found to range from 0 to 0.67 units. Mean value was minimum in Groups II and III (0) and maximum in Group VI (0.327±0.320 units) . Group VI had significantly higher mean value as compared to all the other groups(Fig. 5). On the basis of above evaluation the following order of centering ability was observed in different groups:
Group VI > Group I ~ Group II ~ Group III ~ Group IV ~ Group V

Centering Ability in Different Groups at 9 mm
At 9 mm canal centering ability was found to range from 0 to 0.75 units. Mean value was minimum in Groups II (0) and maximum in Group I (0.253±0.247 units). None of the between group differences were significant statistically(Fig. 6). On the basis of above evaluation the following order of centering ability was observed in different groups:
Group VI ~ Group I ~ Group II ~ Group III ~ Group IV ~ Group

V. DISCUSSION

The endodontic triad comprises of cleaning and shaping, disinfection and obturation of the root canal system. Cleaning and shaping was considered the most important stage of the endodontic triad (grossman 1988) as it influences the outcome of the subsequent phases of canal irrigation and obturation. Certain mechanical and biological objective of the root canal preparation had been laid down by Schilder in 1974. One of the mechanical objectives states that the maintenance of canal curvature and the creation of a funnel shaped canal form, with the smallest diameter at the apex and the widest diameter at the orifice is of paramount importance. Various parameters that affect canal-centering ability are Alloys used in manufacturing instruments, Instrument design ie Cross-section, Taper, Tip. The most commonly used materials are Stainless steel and Nickel-Titanium alloy.There have been a wide range of instruments for cleaning and shaping procedures; from the development of stainless steel K (Kerr) files to the introduction of nickel titanium alloy in 1960’s developed by W.F.Buehler, at Naval

Ordinance Laboratory, USA . The use of this alloy in endodontics was first reported by Walia et al (1988), who milled endodontic files from Nitinol orthodontic wires. Canal centering ability of Rotary files is a variable used to analyse the effects of canal instrumentation on dentin. The root canal preparation and debridement present the most significant segment of endodontic treatment. If the canal preparation in the apical-third of the root is not centered, it might lead to blockages, perforations and ledges. The ability to enlarge the canal without canal deviation is a primary objective in endodontics. So it is important to compare the efficacy of instruments during preparation of curved root canals with respect to ability of instruments to maintain original canal curvature. Protaper next (Dentsply Tulsa Dental Specialties) is designed with rectangular cross section design for greater strength. The patented design's axis of rotation differs from the center of mass. As a result, only two points of the rectangular cross section touch the canal wall at a time. It is used with unique asymmetric rotary motion that further enhances Protaper canal shaping efficiency. These files are manufactured with M-Wire NiTi alloy for increased flexibility and resistance to cyclic fatigue. Protaper Next Multiple File System had the optimal centering ability to remain in a central position within the canal for each cross section at 0,1,2,3,4,5,6 and 7 mm as compared to Reciprocatory-WaveOne and Rotary-ProtaperSystems (Anil Dhingra et al).

VI. CONCLUSION

Centering ability of the file systems are important virtues of the endodontic procedure .They greatly influence the prognosis of the treatment .Protaper NEXT Ni-Ti files(Group I), Hero shaper rotary files(Group II), Profile File system(Group III), Stainless steel hand k files(Group IV), K-file Ni-Ti Flex(Group V), Protaper hand files(Group VI) have been compared in this study. At coronal and apial third none of the between group differences were significant statistically. At middle third Protaper hand files showed more canal centering ability in comparision to other file system.

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Fig. 1 Unprepared Samples During CBCT Scaning

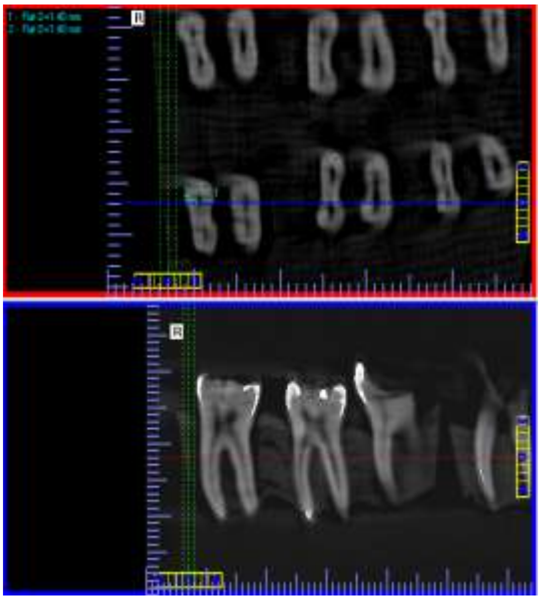

Fig. 2 CBCT Image of unprepared Sample
At the Level of 9mm

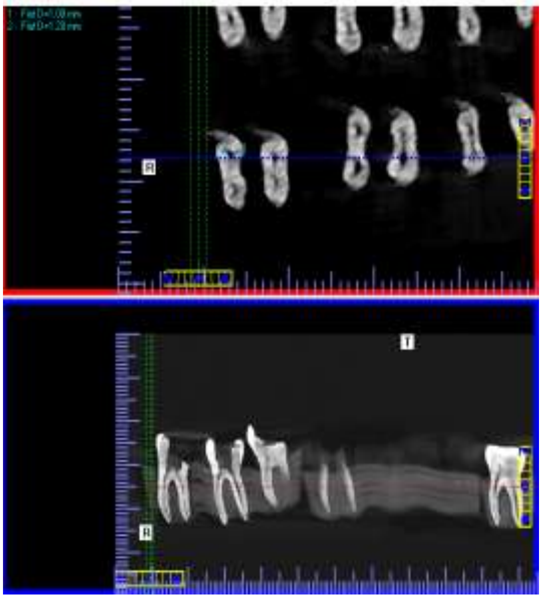

Fig. 3 CBCT Image of preparedSample
At the level of 9mm

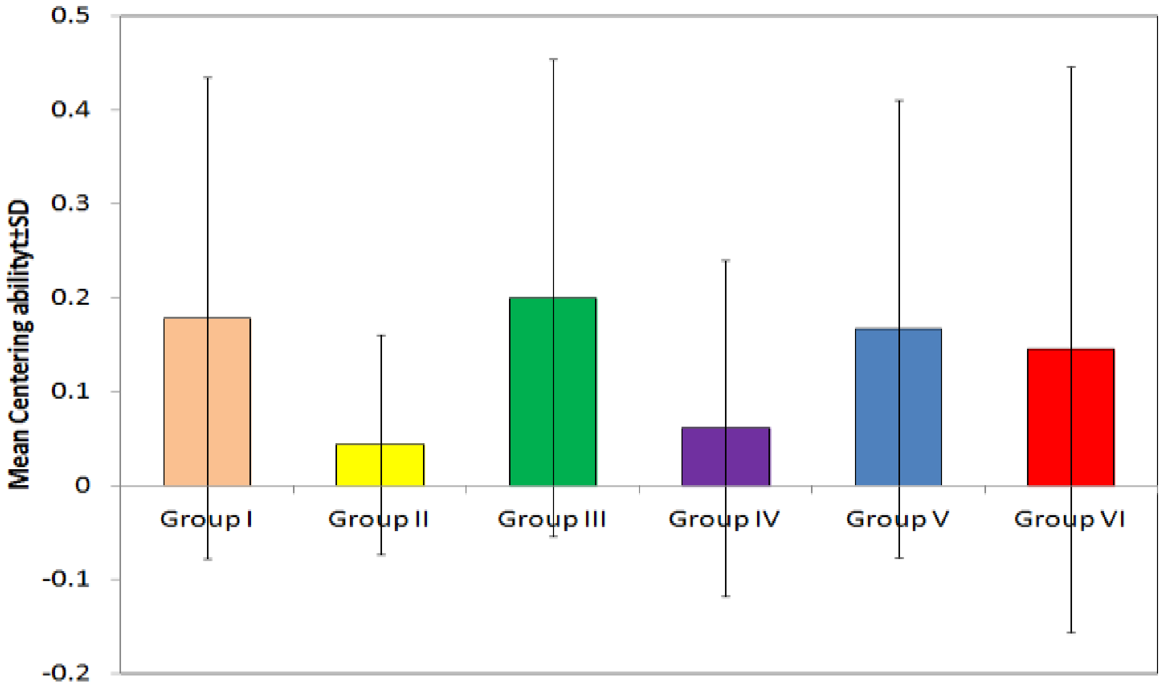

Fig. 4 Centering Ability in Different Groups at 3 mm

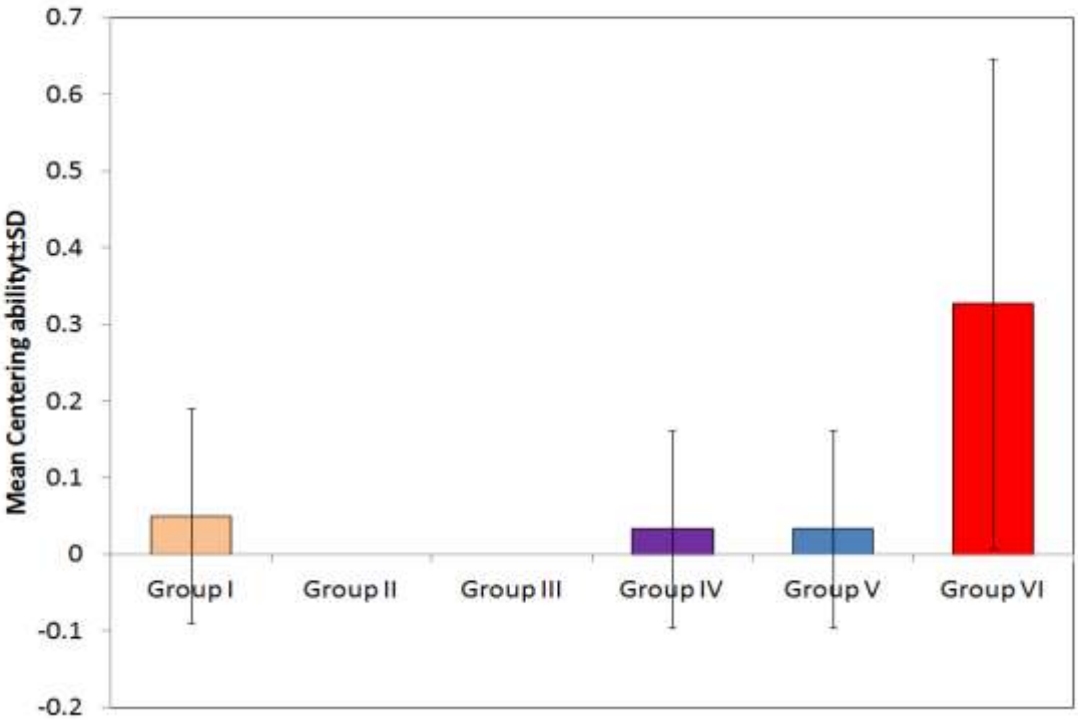

Fig .5 Centering Ability in Different Groups at 6 mm

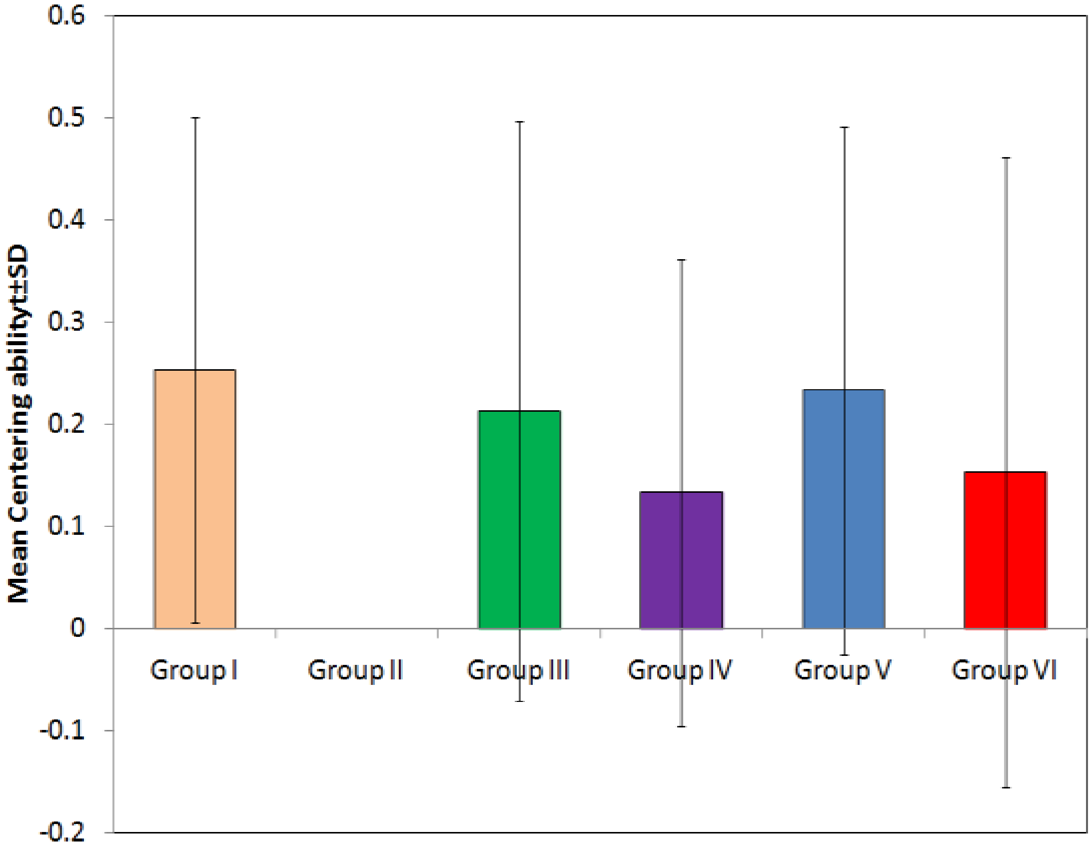

Fig. 6 Centering Ability in Different Groups at 9 mm