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COMPARISON OF CHANGE IN ROOT CANAL ANGLE, RADII OF CURVATURE AND VOLUME BY PROTAPER AND MTWO SYSTEMS USING SPIRAL COMPUTED TOMOGRAPHY

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Abstract:

The aim of this study was to evaluate the difference in the angle of curvature, radius of curvature and canal volume before and after root canal shaping by Protaper and Mtwo rotary systems using spiral computed tomography (spiral CT).

45 colored resin blocks with a single canal and 20° curvature were taken and divided into 3 groups of 15 samples each. Iodine based contrast was injected into the canals and preoperative scanning was done with spiral CT. The canals were prepared with Mtwo in group I, Protaper in group II and group III was kept as a negative control. All the canals were filled with contrast solution and subjected to postoperative scanning. Pre and postoperative images were recorded and compared and statistically analyzed using Digital Imaging and Communications in Medicine (DICOM) software. Group I did not show any change whereas group II showed significant change in the angle and radii of curvature in which the apical canal curvature was straightened. There was no significant difference in the volumetric change of root canal between the two systems.

Keywords: Spital CT; Protaper: Mtwo:, Root canal configuration:

Introduction:

For successful endodontic therapy a thorough knowledge of the three dimensional root canal system is necessary. The objective of making the final root canal preparation conforms to the general shape and direction of the original canal pattern. Canal shaping is a critical aspect of endodontic treatment as it influences the subsequent phases of canal irrigation and obturation.

Root canal curvature is one of the influencing factors in maintaining the root canal configuration while cleaning and shaping.(1) In general, root canal curvature is in many planes and these curvatures should be maintained as canal preparation progress. Inappropriate dentine removal, straightening of the canal and creation of a ledge in the dentinal wall, canals with hourglass appearance in cross-section are all the common consequences of deviation from the original root canal curvature leading to weakening and fracture of the root. (2)

Rotary NiTi files are efficient and faster than manual instruments in cleaning root canals.(3,4,5) The preservation of root canal anatomy with least procedural errors can be achieved by using rotary instruments.(6) Most rotary nickel-titanium (NiTi) files are used based on crown-down technique. ProTaper system (Dentsply Maillefer, Ballaigues, Switzerland) is being one of the commonly used rotary systems for crown down canal preparation.(7) It consists of one file as an orifice opener (SX), two shaping files (S1, S2) and five finishing files (F1-F5). The files have a variable tapered shaft that is designed for the crown-down technique. File tips range in size from 20 to 50, and tapers of 0.07, 0.08 and 0.09 are available .(8)

On contrary, the step-back method is made use of in the Mtwo rotary file system single-length technique. (9,10,11) It includes the basic series (standard set) of four instruments with variable tip sizes ranging from no. 10 to no. 25, tapers ranging from .04 to .06–.07 and two lengths: 21 and 25 mm and file tips range in size from 30, 35, 40 and tapers of 0.5, 0.4 and 0.7. Mtwo instruments are claimed to be effective and safe in maintaining the original root canal curvature. Its specific design and flexibility keep the root canal anatomy unchanged (9) with less file breakage and faster running speed.

Noninvasive techniques are developed nowadays to compare the canal anatomy and before and after preparation. In the endodontic research of modern era, computed tomography (CT) is the new tool for the analysis of root canal geometry. Using CT, proper cross-sections of roots can be provided and 3-dimensional CT images can be reconstructed simultaneously.(12,13) It does not require destruction of specimen. It is also highly reproducible and several images of the canals can be captured. CT has also been evaluated in endodontic imaging comparing the effects of biomechanical preparation on canal volume on reconstructed root canals in extracted teeth.(14,15,16)

Spiral Computed Tomography (CT) has introduced the concept of volumetric imaging with ionizing radiation. It has the ability to reconstruct overlapping cross-sectional images in high quality multiplanar and three dimensional reformatted image.(17,18) By giving potential to the advanced imaging techniques, we sought to use multislice spiral CT to measure the canal curvature three dimensionally. Apart from that, advantage of using a multi slice spiral CT is volumetric reconstruction of the images of the root canal in more accurate dimensions.

There are no studies in literature evaluating the canal curvature relating with volumetric change in root canal using two commonly used rotary endodontic systems Mtwo and Protaper Universal. The present investigation has been designed with the objective of evaluating the difference in the change of the canal curvature and volumetric change with two different rotary NiTi systems protaper and Mtwo using multislice spiral CT.

Methodology

Forty five clear acrylic resin blocks with single colored canals were taken. All the samples were standardized with 20 degree angle of curvature with the canal length of 18mm. The samples were randomly divided into two groups (n=20). Group I – Mtwo NiTi system; Group II –. Protaper NiTi system

All the samples were mounted in an acrylic template which was made through metal die model with equal spacing of 2.5 cm between each sample. All the canal samples were injected with imaging contrast solution with the help of insulin syringe. Preoperative multi slice spiral CT imaging was done for all the samples by keeping the mounted samples in the imaging platform. Images obtained were recorded.n group I, canals were prepared with Mtwo(VDW Systems) rotary NiTi files following the sequence #10-4%, #15-5%, #20-6%, #25-6%,#25-7%. In group II, canals were prepared with Protaper Universal (Dentsply, Maillefer) rotary NiTi files following crown down technique with the sequence Sx, S1, S2, F1, F2. In control group III; canals were not prepared and as a negative control to prove null hypothesis. Instrumentation of the canal was done with X-smart torque controlled endodontic motor handpiece with preset speed, torque, gear ratio for each instrument recommended by the manufacturer. All the instruments were taken to the full working length followed the single-length technique. Between instrumentation, glyde path was maintained by recapitulating with #8 K-file. And canals were copiously irrigated with distilled water.

All the canals were dried with no.20 paper points (Dentsply,Mailefer) and were filled with (Optiray 300)Iodine based imaging contrast media using an insulin syringe. Pressure was created in the canal by closing the orifice with modeling wax so that contrast could reach till the working length. Samples were subjected to postoperative imaging by keeping the mounted samples in the imaging platform. Images were analyzed for angle of curvature, radii of curvature, volumetric reconstruction with the help of Digital Imaging and Communications in Medicine software (DICOM). The software allows the user to “sculpt out” the desired volume from the 3D structure, and, by adjusting the brightness and opacity values, to remove ‘unwanted’ voxels before calculating the final root canal volume. Slice thickness of the sample was 5mm with the system collimation (detector width) of 0.63 mm. The slice interval was 0.1mm with volumetric reconstruction at 0.1 mm level. The volume of each canal in all samples was calculated from the canal orifice till the working length. These values were recorded according to the manufacturer specifications and recommendations for imaging.

The results were tabulated and analyzed with Independent sample T-test as well as Student-t test with mean value of preoperative group as hypothetical mean using statistical package Statistica 5 software.

RESULTS

Group 1 showed no significant change in the angle and radius of curvature between preoperative and postoperative samples as shown in Table 1 & Fig 1B. There was statistically significant higher difference in the mean volumetric reconstruction between preoperative (0.099 mm^3) and postoperative (0.181 mm^3) samples.

The postoperative samples of group II showed significant decrease in angle and radius of root canal curvature with significant higher volumetric change.(Table 2 &Fig 2A). The control did not show any change in all the parameters.

On intergroup comparison, group II showed greater mean difference in the change of angle and radius of curvature than Group 1. The change in volumetric change was not significantly different between the experimental groups.

Table 1: Pre-operative Vs Post-operative (Group 1) – Mtwo

Parameters	Pre-Operative	Post-Operative
	Mean ± SD	Mean ± SD
Angle of Curvature(in degrees)	20.02[a] ± 0.00	20.14[a] ± 0.22
Radius of Curvature(in degrees)	0.067[b] ± 0.00	0.064[b] ± 0.00
Volumetric Reconstruction (mm^3)	0.099[c] ± 0.00	0.181[d] ± 0.00

Table 2: Pre-operative Vs Post-operative (Group 2) – Protaper Universal

Parameters	Pre-Operative	Post-Operative
	Mean ± SD	Mean ± SD
Angle of Curvature(in degrees)	20.02[a] ± 0.00	17.97[b] ± 0.18
Radius of Curvature(in degrees)	0.067[c] ± 0.00	0.037[d] ± 0.00
Volumetric Reconstruction (mm^3)	0.099[e] ± 0.00	0.171[f] ± 0.00

Table 3: Post-Operative - Mtwo Vs Post-operative - Protaper Universal

Parameters	Post-Operative (Group 1)	Post-Operative (Group 2)
	Mean difference in change	
Angle of Curvature (in degrees)	0.120[a]	2.050[b]
Radius of Curvature (in degrees)	0.003[c]	0.030[d]
Volumetric Reconstruction (mm^3)	0.082[e]	0.072[e]

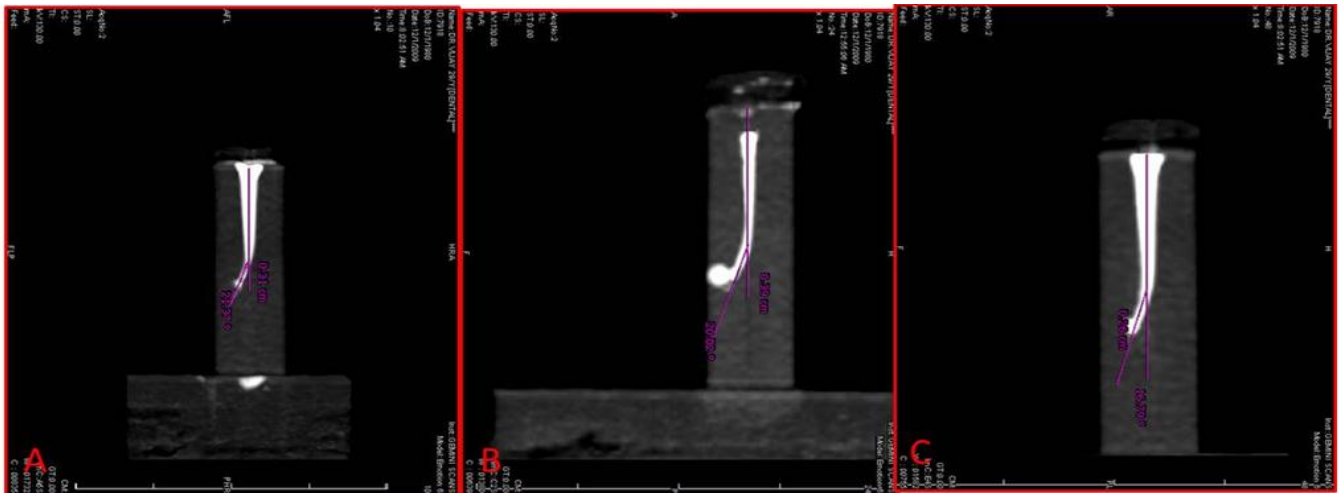

Figure 1: Preoperative spiral Ct images of group 1(A), 2(B), 3(C)

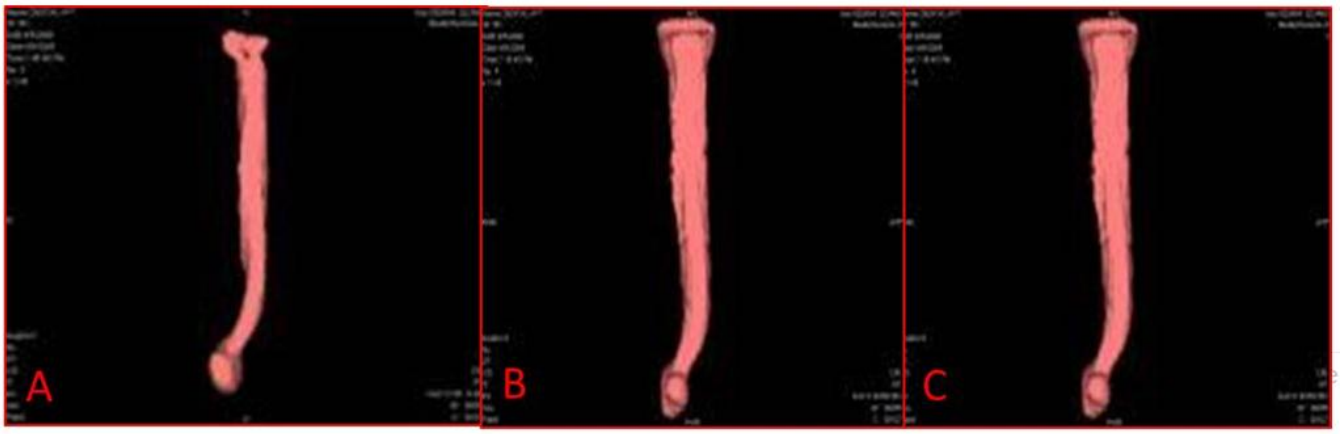

Figure 2 - Preoperative spiral Ct images of group 1(A), 2(B), 3(C)

Discussion:

Several studies based on histological sections and dye penetration demonstrated rarely demonstrate straight canals and root canals never follow simple direction as seen in two dimensional X-ray images. Other studies like high-resolution morphological studies, micro computed tomography (μCT), cone beam computed tomography(CBCT) and spiral CT have been used to evaluate root canal anatomy.(14,15,16,17,18) In this study, multislice spiral CT has been used as it is reproducible and three dimensional anysis can be evakuted.

Simulated root canals were used in this study to standardize the research method and to exclude parameters that could influence the preparation outcome. On contrast to most of the studies using simulated root canals, in the present study the canal walls were pre-colored to highly differentiate the unprepared canal walls after preparation. In general, a root canal curvature is in many planes and these curvatures should be maintained as canal preparation progresses. The greatest problem encountered by the endodontists is apical canal preparation and care must be taken to maintain the direction of curve in this region to avoid transportation.(1) Thus, in this study, the change in angle of curvature and radii of curvature pre and postoperatively by two different commonly used rotary NiTi systems Protaper and Mtwo were compared. Both the systems are active cutting instruments with positive rake angle with different cross-sections and configurations.

When comparing the changes in the angle of curvature, group II (Protaper universal) shows greater change in angle of curvature, indicating a tendency to straighten the curved canals. In the same way, when comparing the mean radii of the curvature, group II shows significant change in radii of curvature compared to group I. These results were in accordance with the previous study reports of Yun and Maitin et al.(19,20) This could be attributed to the geometry of the instrument with positive rake angle, progressive taper, with more flutes, rounded triangular cross-section with three cutting edges which removes and shapes more of root canal dentin.

Mtwo rotary NiTi instrument respects the original canal curvature due to the geometry of the instrument with greater flexibility in the apical third. Geometry of Mtwo system incorporates a variable pitch and steep helical angle with various fixed tapers and S-shaped cross section with no radial lands and minimal core width which renders optimal cutting and shaping efficiency.(21) Moreover, Mtwo prepares the canals using step back technique using fewer instruments with negligible change from the original curvature. (9,22) Yang et al proved that both the instrumentation systems produced canal preparations with adequate geometry but with larger values of transportation with Protaper Universal system compared to Mtwo group at the apical third.(23) This shows that Group I maintains the canal curvature compared to group II in which canal was straightened significantly.

This study also demonstrated significant increase in the volume of root canal postoperatively. However, there was no statistically significant volumetric change was seen between the systems. Based on this, it can be inferred both the systems are capable of performing a more anatomical preparation with less dentin removal. Our results were consistent with the previous studies (24,25, 26, 27) which conclude that cutting efficiency of rotary systems is better and could preserve the curvature of root canals with no much loss remaining dentin thickness on both the systems.

Conclusion

Within the limitations of this study, using multislice Spiral CT analysis, Mtwo rotary NiTi system maintains the angle of curvature, radii of curvature better than Protaper Universal Rotary Systems. It is recommended that Mtwo system can be used in shaping canals with a complex curvature, especially during apical preparation and ProTaper universal file system be can be used in combination with other less tapered more flexible systems to avoid straightening of curvature in curved canals.

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