Prevalence of Different Types of Apical Root Canal Morphology and their Treatment Recommendations in an Institute

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ABSTRACT

Introduction: Canals can be of different shapes in cross section including round canals, oval canals, long oval canals or ribbon shaped canals. Recesses of nonround canals may not be included in the round preparation created by rotary instruments and thus they remain unprepared. The aim of this study included determination of shape and taper of the apical root canal based on diameter at different levels. Measurement of the diameter of the root canal at one, two and three mm cross sections from the apex of the tooth were done such that apical instrumentation in root canal treatment could be modified based on the results obtained.

Methods: This was a cross sectional study which used convenient sampling technique to determine the sample size. Seventy extracted teeth were sectioned horizontally at one, two and three millimeter from the apex using the diamond disc which was observed under trinocular research microscope for the determination of diameter of root canal under 10x magnification. Digital images of the sections were taken by a camera attached to the research microscope and analysis done using DigiPro 4.0 software.

Results: The most common canal configuration was oval. The taper of the canals was 25% in mesial root and 20% in distal in bucco-lingual orientation and 14% in mesial root and 15% in distal in mesio-distal orientation.

Conclusions: The most prevalent canal configuration in this study was non round, however, most of the rotary instruments tend to prepare root canals into round shape making their use questionable. The taper of the root canals was found to be higher in our study than what most of the shaping instruments have to offer. So it would be advisable to consider this fact while selecting instruments and preparing these non-round canals as far as the Nepalese subpopulation is considered.

Keywords: *apical root canal; canal configuration; root canal taper.*

INTRODUCTION

Root canal morphology still stands as an enigma to endodontists. The knowledge of common root canal morphology and its frequent variations is a basic requirement for endodontic success.[1] Variations in canal geometry before shaping and cleaning have a greater effect on the changes that occurred during the preparation than the instrumentation techniques.[2,3] Probably because of its importance as a clinical entity, the apical third of the root canal and foramen location have been the topic of numerous researchers.[3-8] There is a great potential for failure of endodontic treatment due to lack of information/data. Keeping that in mind we have conducted this study to evaluate the apical canal diameter of mandibular molars and categorized

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into round, oval, long oval and ribbon-shaped. We also have calculated the taper of the canals in the mesial and distal roots of the mandibular molar.

METHODS

This was a cross-sectional study conducted in the Department of Conservative Dentistry and Endodontics, B.P. Koirala Institute of Health Sciences, Dharan, Nepal within a period of one and half years.[7] The study was conducted after obtaining ethical approval from Institutional Ethical Review Board of BP Koirala Institute of Health Sciences, Dharan on 3rd July 2014.

Convenient sampling technique was used to collect the samples. The sample size was calculated to be 70 and were selected from the patients visiting Department of Oral and Maxillofacial Surgery, BPKIHS undergoing extraction of their mandibular molar teeth. Every tooth extracted was included in the study until the sample size was reached. All the cases were taken in the study to remove sampling biases. The teeth were included in the study after taking informed consent from the patients and that met the inclusion and exclusion criteria. The teeth whose patency could be checked with ISO number 10k file were included in the study. Those teeth which had canals calcified, hypercementosis of root, fracture of root, external resorption of roots, distance between apical foramen and root apex more than 1mm, tooth having caries below cemento-enamel junction, root canal treated tooth or morphological anomalies of root present were excluded from the study.

The samples consisted of seventy extracted mandibular molars which were cleaned and debrided using hand scaler (API, USA). The teeth thus collected were stored and handled as per the guidelines set by occupational safety and health administration (OSHA). The patency of canals was checked using ISO number 10 k-file through the apical foramen. Markings were made at one, two and three mm from the apex with the help of digital vernier caliper. The teeth were then sectioned horizontally each of 0.3mm using the diamond disc fitted with a mandrel to an Airmotor hand-piece (NSK, Japan).

Different parameters were established to measure the diameter viz;

a. Mesio-distal (MD) diameter: two most exterior points taken as reference in mesial and distal canal walls respectively, and
b. Bucco-lingual (BL) diameter: two most exterior points taken as reference in buccal and lingual canal walls respectively.

The sections were observed under trinocular research microscope (Labomed Lx500, U.S.A) for determination of root canal diameter under 10x magnification. Digital images of the sectioned teeth were taken by the camera (iVu 1500, Labomed) attached to the research microscope and analysis was done using DigiPro 4.0 software. The taper of the root canals was analyzed from the data obtained.

The canals were categorized and interpreted depending on the data obtained as follows: (Figure 1)

a. Round: MD and BL diameter are equal.
b. Oval: one of the measurements (MD or BL) is more than other.
c. Long oval: one of the measurements (MD or BL) is at least two times the other.
d. Flat or ribbon-shaped: one of the measurements (MD or BL) is at least four times the other.

The data were tabulated in Microsoft Excel 2007 and statistical analyses were done utilizing Statistical Package for Social Science (SPSS) version 11.5. For descriptive statistics mean, median, standard deviation, proportion, and percentage were calculated. For Inferential statistics, chi-square test and median test were applied to find out differences between the groups keeping the confidence interval at 95% where P=0.05.

RESULTS

A total of 420 sections with 531 root canals were obtained among which the most prevalent type of canal configuration was oval 284 (53.5%) followed by the long oval 152 (28.6%), round 65 (12.2%) and ribbon-shaped 30 (5.6%) canal. No significant association in the percentage difference of mesio-distal and bucco-lingual measurements in one versus two mm and two versus three mm between mesial and distal root was obtained (Table 1). The data derived from the study has signified that the mean percentage of difference that is the taper of the canal in bucco-lingual diameter from one to two mm is more in distal root compared to mesial root whereas it is more in mesial root compared to distal root from two to three mm. Similarly, the mean percentage of difference that is the taper of the canal in mesio-distal diameter from one mm to two mm is more in distal root compared to mesial root and slightly more in distal root compared to the mesial from two to three mm.

Table 1. Percentage difference of buccolingual and mesiodistal diameter of canals in mesial and distal root.

Variables (in % difference between) Mean ± SD		Mesial Root			Distal Root			P value
		Median	Mean Rank	Mean ± SD	Median	Mean Rank		
Bucco- lingual diameter	From 1mm to 2mm	25.25 ± 28.59	17.80	87	28.12 ± 39.97	20.34	91.66	0.54
	From 2mm to 3mm	25.11 ± 26.20	19.03	91.34	20.79 ± 19.53	18.16	85.89	0.48
Mesio-distal diameter	From 1mm to 2mm	16.42 ± 22.69	11.58	88.35	20.29 ± 29.77	12.38	89.87	0.84
	From 2mm to 3mm	14.32 ± 14.50	10.25	88.12	15.56 ± 16.74	12.02	90.17	0.79

DISCUSSION

The study of the internal anatomy of teeth has been a challenge since long back due to lack of techniques and methods which can exactly depict it. Conventional radiographs used for the diagnostic purpose can give information about the periapical status but are bidimensional images and are not able to provide enough details of internal anatomy.[7] Adding to the difficulty, it has been well established that variations are a rule rather than exceptions in case of root canal anatomy.[2,9-18] The apex is the root terminus and the apical anatomy tends to be non-uniform and unpredictable.[2] The only consistent aspect of the apex is its inconsistency.[19] A common concept is that canals round out in the apical region but this is not always true. Canals can be of different shapes in cross-section including round, oval, long oval or even ribbon-shaped. These non round canals cannot be enlarged to a round shape without perforating or weakening the roots.[20] Different morphologies of canal require different techniques of canal preparation and obturation. Recesses of non round canals may not be included in the round preparation created by rotary instruments and thus they remain unprepared, potentially leading to failure of the root canal treatment. Only a sound knowledge of the subject can prepare clinician for the unseen challenges that may be encountered during treatment. Anatomical studies are one such tool that can prepare and guide clinicians whenever required.

In this study, 420 cross sections at one, two and three mm from the apical canal opening in mandibular molar roots were examined. An overall discrepancy between the bucco-lingual and mesio-distal dimension of the canals in both the roots show that majority of these canals are not round. The overall distribution of canal types as shown by this study is oval canal 284 (53.5%), long oval 152 (28.6%), ribbon-shaped 65 (16.9%), and round canal 30 (12.2%). Wu et al. in their study found out that long oval canal was present in 25% of cross sections which is more or less similar to the result extrapolated from this study and the remaining 75% were round or slightly oval.[4] Martos et al. in their study found out a statistically significant difference among the three levels of assessment for mandibular and maxillary roots with a lower value at one mm and higher at three mm, which is entirely in agreement with the results depicted by our study.[11]

The taper of the canal is another important aspect to consider; if the taper of the instrument being used to clean and shape canal does not correspond to the taper of the canal the objective of biomechanical preparation will not be obtained. If the instrument has excessive taper it will lead to an undue removal of radicular dentin whereas if there is under taper then the instrument would not be able to clean the canals effectively. High variation in the taper of mandibular molar canals was observed in our study which is in accordance to the study conducted by Wu et al, where the taper was found to be as high as 42% in the mesial canal and 15% in distal canal.[4] Our study has shown that the taper of mesial canals in bucco-lingual direction is 0.25 mm/mm and 0.14 mm/mm in mesio-distal direction and in the distal canal it is 0.2 mm/mm in bucco-lingual direction and 0.15 mm/mm in mesio-distal direction. This taper is significantly higher than standard ISO files (0.02 mm/mm) and most of the rotary systems thus confirming significant discrepancy in the conventional instrument design with actual presentation. Instrumenting canals to this taper would leave uninstrumented recesses in the bucco-

lingual direction and to some extent in mesio-distal direction. Increasing the taper of instruments will be beneficial in such cases but it also has a disadvantage of removal of excessive dentin thereby reducing the wall thickness. The extent to which this weakens the root is unknown, however. Circumferential filing or Self Adjusting File System may be the choice in such cases.

Biomechanical preparation of root canals may be done by either hand or engine driven instruments where canals are cut and shaped by rotation or by circumferential push-pull movement. Whether entire wall of the main canal is adequately instrumented and shaped depends on the number of factors like morphology of canal, the thickness of canal wall, the taper of the canal, type of instrument used, size of the instrument, etc.[21] Among these, the morphology of root canal could be considered as the most crucial one as all the other factors depend on it. It is very difficult to adequately debride canals only by instrumentation which increases the importance of proper irrigating solution with adequate volume and method. The fact was further highlighted by Wu and Wasselink where they reported uninstrumented extensions in 65% of oval canals prepared with files using balanced force technique.[22] Rodig et al. also supported this fact by pointing that nickel-titanium rotary instruments did not allow controlled preparations of buccal and lingual extensions of the oval canal.[23] The instruments instead created a round bulge in the canal leaving the extensions unprepared and filled with smear layer and debris. Acoustic microstreaming by ultrasonic irrigation may clean the oval canals better along with other nonround canal configurations.[24] With the advent of newer irrigation systems like Endovac, Endoactivator and Self Adjusting File system the effective cleaning of root canals are becoming achievable. Just like cleaning and shaping, obturation also possesses difficulty to fill non round apical canals and uninstrumented recesses with cold lateral condensation technique. The use of heat and chemically activated gutta percha techniques may give a predictable outcome in such cases.[25]

Many reasons such as those mentioned above which governs the outcome of RCT, have made it clear that canals should be enlarged to a suitable size depending on the apical canal diameter. Appropriate canal enlargement not only provides adequate debridement and irrigation but also permits manipulation and control of obturating materials and instruments without needlessly weakening the roots.[26-32] Here we do not have to overemphasize the importance of apical canal diameter as we now are clear that it is one such factor that affects not only one but all the stages of root canal treatment. This study highlights the importance of using circumferential filing method to shape and clean root canal and also recommends increasing the taper of various hand and rotary files for adequate debridement of canals. The importance of various irrigating devices along with thermoplasticized gutta percha technique for obturation is recommended by this study.

As this study was conducted using a diamond disk to section the tooth the room for procedural error has increased due to lack of precision of placing the disk at the designated reference points. Had a hard tissue microtome been used this inevitable risk for procedural error would have been minimized to almost negligible. The study would have been more informative if the samples were differentiated as mandibular first or second molars. Also, there is an inherent risk of procedural error related to the use of digital vernier caliper as there may be errors while placing the calipers on the markings.

CONCLUSIONS

Apical canal diameter was variable in this study with most being non round canals. The taper of the root canal of the study population exceeded the taper of most currently available instruments which tend to make round preparations, making their use to shape these non-round canals questionable. Thus it is advisable to consider this fact while selecting instruments and preparing these non-round canals. This study has provided baseline information regarding root canal morphology of the Nepalese population however it should be remembered that a lot of research has yet to be performed to extract more information regarding root canal morphology.

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