International Journal of Enhanced Research in Medicines & Dental Care (IJERMDC),
ISSN: 2349-1590, Vol. 9 Issue 11, November 2022, Impact Factor: 7.125

Original article

Apical Root Canal Shape of Mandibular First Permanent Molar in Nepalese sub-population, a CBCT Study

Dr. Navin Agrawal[1], Dr. Iccha Kumar Maharjan[2], Dr. Vimmi Singh[3], Dr. Ashok Dangol[4], Dr. Neetu Jain[5]

[1]Additional Professor, Dept of Conservative Dentistry and Endodontics, CODS, BP Koirala Institute of Health Sciences (BPKIHS), Dharan, Nepal
[2]Associate Professor, Dept of Oral Medicine and Radiology, CODS, BPKIHS, Dharan, Nepal
[3]Associate Professor, Dept of Conservative Dentistry and Endodontics, CODS, BPKIHS, Dharan, Nepal
[4]Associate Professor, Dept of Oral and Maxillofacial Surgery, CODS, BPKIHS, Dharan, Nepal
[5]Senior Resident, Dept of Oral Pathology, CODS, BPKIHS, Dharan, Nepal

Correspondence Address: Dr. Navin Agrawal, Additional Professor, Department: Dept of Conservative Dentistry and Endodontics, CODS, BPKIHS, Dharan, Email: mailingnavin@gmail.com

ABSTRACT

Introduction: Knowing internal shape/anatomy of the root canal is also one of the prerequisites to ensure successful endodontic treatment. This study was designed with an objective to assess the root canal shape of apical third of permanent first mandibular molar employing Planmeca CBCT and Romexis 3.0.1.R software.

Material and Methods: Total of 90 teeth were scanned using CBCT and were categorized at based on the shape: 1. round; 2. oval; 3. long oval; 4. flat/ribbon-like. Root canal shapes were assessed within the apical third at 1 mm, 2 mm,and 3 mm. Categorical data were analyzed as frequencies using SPSS software.

Results: The most frequent shape was round at 50-53% in apical third. However, non-round canals existed with similar proportion.

Conclusions: The root canal cross-sectional shapes in human permanent first mandibular teeth are variable concurring to root apical thirds. The existence of non-round canal shape is not uncommon at apical third of the root. The reported data may help clinician understand the anatomy at apical third of the lower first molar and treat appropriately to ensure success.

Key Words: CBCT, Mandibular first molar, root canal shape

INTRODUCTION

The success of root canal treatment is straightforwardly related with knowledge of root canal anatomy, microbial control, specialized and scientific mastery of restorative protocols and a positive immune response.[1] Complex arrangements of the root canal framework may complicate the proper access of endodontic instruments to all root canal areas during instrumentation, which may influence the quality of bacterial cleaning and root canal sealing.[2, 3] Several techniques have been utilized to study the root canal framework configuration. They incorporate plastic resin infusion,[4] endodontic access and radiographs with files into root canals,[5] review assessment of radiographs,[6] clearing of samples with and without ink infusion,[7,8] sectioning and macroscopic or checking electron microscopy (SEM) assessment,[9,10] computed tomography (CT),[9] spiral computed tomography (SCT),[11] micro–computed

tomography (µCT) ,[12] and cone-beam computed tomography (CBCT).[13] The root canal comprises of tissues with different density contrasts comprising outer hard tissue shell and inner soft tissue. The drive to use non-destructive strategy to study root canal anatomy proposed utilizing tomography to study the root canal system but with limited success as a result of the poor resolution of conventional medical computed tomography scans .[14] In recent years, micro-computed tomography (MCT) that provides three-dimensional (3D) visualizations of has advanced as one of the non-destructive strategies to study root canal morphology.[12] However, at the moment, this imaging method is time-consuming and thus not reasonable for the dental office. Nowadays, cone beam computed tomography (CBCT) has become available for dental workplaces because of its diminished costs and size.[15]CBCT have a reduced acquisition time and use lower irradiation doses. Also, their field of view is limited, but the spatial resolution is very good in all planes.[15]

Considering these features of CBCT, this study was designed to study root canal shape at apical third of the root canal.

MATERIALS AND METHODS

Study Design and Participants
This study was a descriptive cross sectional study carried out from March 2016 to August 2016. It was assessed and approved by the institutional ethics committee of the B. P. Koirala Institute of Health Sciences (IRC/677/015).
The patients enrolled were from University Dental College after an informed consent was signed.

Inclusion and Exclusion Criteria
The inclusion criteria were extracted mandibular 1st molar ofNepalese patients between 16 years and above with well-defined crown and root morphology.

The exclusion criteria were teeth with calcification that poses difficulty in canal identification and grossly carious tooth destroying root structure.

Determination of the Sample Size
The sample size was calculated based on statistical analysis. Out of 120 teeth, 90 were selected for the study.

Clinical Procedure
The acquired teeth meeting the inclusion criteria was washed under tap water and stored in distilled water with thymol iodide crystals until the collection was complete. Later, the samples was properly washed under tap water, followed by immersion in 4% sodium hypochlorite solution for 20 minutes to remove adherent soft tissue. Thereafter, if calculus and stain were present, it wasremoved with ultrasonic scaler and stored as mentioned till further use.

The teeth was scanned by a CBCT scanner (Pro Max 3D,PlanmecaOy, Asentajankatu 6,
Helsinki, Finland), in small batches of teeth at a time with identification number on each tooth mounted on a wax blockat constant thicknesses of 150 um/slice. The teeth was viewed both in cross and longitudinal section. Volume rendering and multiplanar volume reconstruction was performed by using the PlanmecaRomexis Viewer 3.0.1.R (PlanmecaOy,release date: 10/19/12)

Analysis of sample:
The following features were analyzed by 2 examiners as per the set guideline (one endodontist and one maxillofacial radiologist; Table 1). They evaluated 10% of the sample for calibration and after that inspected all CBCT scans. When results differed, an agreement was made after the scan was discussed with a third observer. The kappa coefficient was used to assess interobserver agreement in 10% of the test.

Table 1: Shape of the apical anatomy in the root canal.

Group	Description
1. Round:	if the MD and BL diameter are equal
2. Oval:	if one of the measurement is more than other
3. Long oval:	if one of the measurement is at least two times the other
4. Flat or ribbon shaped:	if one of the measurement is at least 4 times the other

Statistical analysis

Categorical variables, described as frequencies and percentages, wereanalyzed using Statistical Package forSocial Sciences 11.0 (IBM 21; IBM Co, New York, NY)

RESULTS

The distribution and frequency are shown in table 2 and 3.In apical sections at 3, 2 and 1mm, different canal morphology was equally appreciated. The agreement between endodontist was found at 86.3%. In-case of differences, third experienced radiologist was invited to sort the disagreement.

At 3mm, mesial axial section (3MAS) had two canals with 3MAS C1 and 3MAS C2 having almost equal incidences of round shaped canal at 52.2% and 53.3% respectively. In distal axial section (3DAS), round and oval shape occurred in equal proportions for canal 1, 27.8% and 33.3% respectively at 3mm. There was also a good deal of ribbon shaped morphology and long oval canal in distal canal 1, 22.2% and 15.6% respectively at 3mm. At 3 mm, almost 86.7% of the distal canal had single canal with canal 2 having predominantly round shape (12.2%). (Table 2)

Table 2 Axial Section Morphology at 3mm, 2mm and 1 mm of Mesial Canal.

Axial Section Morphology (AS)	3mm MAS C1 (Mesial Canal 1 axial section at 3mm)	3mm MAS C2 (Mesial Canal 2 axial section at 3mm)	2mm MAS C1 (Mesial Canal 1 axial section at 2mm)	2mm MAS C2 (Mesial Canal 2 axial section at 2mm)	1mm MAS C1 (Mesial Canal 1 axial section at 1mm)	1mm MAS C2 (Mesial Canal 2 axial section at 1mm)
Round:1	47/52.2%	48/53.3%	52/57.7%	51/56.6%	50/55.5%	45/50%
Oval:2	15/16.7%	14/15.5%	10/11.1%	10/11.1%	17/18.8%	12/13.3%
Long Oval: 3	8/8.9%	0	9/10%	1/1.1%	7/7.7%	1/1.1%
Flat/Ribbon: 4	19/21.1%	0	18/20%	0	15/16.7%	0
Extra Root	1/1.1%	1/1.1%	1/1.1%	0	1/1.1%	0
Single Canal	0	27/30%	0	28/31.1%	0	32/35.5%
Total	90/100%	90/100%	90/100%	90/100%	90/100%	90/100%

In 2 mm mesial axial section (2MAS), both canals showed more of round configuration, 57.7% and 56.6% (Table 2). However, distal axial section at 2mm (2DAS C1) had more of oval shaped canal, 40% of the time and round being at 26.7%. Long oval and ribbon shaped canal shape were also observed almost at equal proportion, 16.6% and 15.6% respectively Most of the second canal in distal axial section at 2mm were not present (86.7%). (Table 3).

Table 3: Axial Section Morphology at 3mm, 2mm and 1 mm of Distal Canal.

Axial Section Morphology (AS)	3mm DAS C1 (Distal Canal 1 axial section at 3mm)	3mm DAS C2 (Distal Canal 2 axial section at 3mm)	2mm DAS C1 (Distal Canal 1 axial section at 2mm)	2mm DAS C2 (Distal Canal 2 axial section at 2mm)	1mm DAS C1 (Distal Canal 1 axial section at 1mm)	1mm DAS C2 (Distal Canal 2 axial section at 1mm)
Round:1	25/27.8%	11/12.2%	24/26.6%	9/10%	31/34.4%	7/7.7%
Oval:2	30/33.3%	1/1.1%	36/40%	2/2.2%	30/33.3%	2/2.2%
Long Oval: 3	14/15.6%	0	15/16.6%	0	18/20%	0
Flat/Ribbon: 4	20/22.2%	0	14/15.5%	0	10/11.1%	0
Extra Root	1/1.1%	0	1/1.1%	1/1.1%	1/1.1%	0
Single Canal	0	78/86.7%	0	78/86.7%	0	81/90%
Total	90/100%	90/100%	90/100%	90/100%	90/100%	90/100%

Shape of the canals as assessed in CBCT images, ribbon, round, and oval canal

Talking about mesial axial section at 1mm (1MAS), round configuration was common for both the canals in mesial side 1MAS C1 (55.5%) and 1MAS C2 (50%). There was considerable number of ribbon shaped configuration appreciated as well (16.7%) in canal 1 (Table 2). However, in axial sections of distal canal at 1 mm (1DAS), round and oval shape existed predominantly (34.4% and 33.3%). Considerable numbers of long oval and ribbon shape were also seen (20% and 11.1%) [Table 3]. The distal canal at 1 mm had mostly single canal 90% of the time.

DISCUSSION

The varied shapes were observed in the root canal cross-sectionsof human mandibular first molar at apical 3mm sections. It is utmost important for a clinician to have prior knowledge of the true root canalshape before preparing, which may influence on therapeutic decision-making.The shape of a root canal may be a determinant of successful access of endodontic instruments to all dentinal walls.[1, 16, 17]

Wu et al.[18] assessed human apical roots and decided the prevalence of long oval canals. In their study, roots were horizontally sectioned at 1 mm, 2 mm, 3 mm, 4 mm and 5 mm from the apex. The examination of cross-sections at 5 mm from the apex revealed that the percentage of long oval canals was 50% to 92%. As reported by Arora &Tewar[19], the incidence of oval canals was higher within the Indian populace (81%). Mauger et al .[20] assessed the existence of circular, oval, long oval and ribbon canals at 1 mm, 2 mm, and 3 mm from the root apex of mandibular incisors. In 75% of the teeth, canal shape was not continuous from one point to the next. More root canals were round or oval at points closer to the apex and tended to have a long oval or ribbon shape more coronally. In a study by Shrestha et al., they concluded preponderance of non-round canals, oval (53.5%) followed by the long oval 152 (28.6%).[21]

In this study, the frequency of non-round canals were detected in practically all apical thirds. At apical 1 mm, 55% and 50% for canal 1 and 2 in mesial root had round but considerable proportion existed for non-round canals together. Similarly, round canals only existed 34.4% in distal canal with huge portion being non-round canals. At 2mm sections, though mesial side showed 52-53% round canals, considerate numbers were non-round canals. Distal section at 2mm had more of non-round canals with round existing at 40%. At 3mm, mesial section similar proportion alike at 2mm of round canals. However, distal section at 3mm had more of non-round canals (62%) [Table 2 and 3].

The challenges postured by inner cross-sectional shapes led to studiesto characterize reference standards for the assurance of which file may fit the apical breadth of root canals.[22-25] Discrepancies between apical diameter and file size[22-25] are responsible for challenges when treating non-round canals, such as oval/long oval, flat/ribbon-like and Cshaped canals, and for poor file efficiency and lack of correlation with the anatomical apical breadth. In accordance with previous study,[25] it revealed that the preflaring of the cervical and middle thirds of the root canal improved the determination of the anatomical breadth.

This study points out the variation in anatomy that shows equal proportion of non-round canals which is important for clinician to know and choose instruments appropriately to ensure successful treatment. Further studies designed to correlate the shape of the root canal and the instruments to treat these areas should be carried out with possibility to be available in the market in near future.

CONCLUSION

The existence of non-round canal shape is not uncommon at apical third of the root. The reported data may help clinician understand the anatomy at apical third of the lower first molar and treat appropriately to ensure success.

ACKNOWLEDGEMENT

The author would like to thank all the personnel involved in the study and deny any conflict of interest.

REFERENCES

[1]. Estrela C, Holland R, Estrela CR, et al. Characterization of successful root canal treatment. Braz Dent J 2014;25:3-11.
[2]. Vertucci FJ. Root canal anatomy of the human permanent teeth. Oral Surg Oral Med Oral Pathol Oral RadiolEndod 1984;58:589-99.
[3]. Gutmann JL, Fan B. Tooth morphology, isolation, and access. In: Hargreaves KM, Berman LH, editors. Cohen's Pathways of the pulp. 11th ed. St. Louis, MO: Mosby-Elservier; 2016. p.130-208.
[4]. Skidmore AE, Bjorndal AM. Root canal morphology of the human mandibular first molar. Oral Surg Oral Med Oral Pathol 1971;32:778–84.
[5]. Pineda F, Kuttler Y. Mesiodistal and buccolingualroentgenographic investigation of 7,275 root canals. Oral Surg Oral Med Oral Pathol 1972;33:101–10.
[6]. BadanelliMarcano P, Martinez-Berna A. Surgical preparation of root canals. Rev EspEndodoncia 1983;1:61–77.
[7]. Gulabivala K, Aung TH, Alavi A, Ng YL. Root and canal morphology of Burmese mandibular molars. IntEndod J 2001;34:359–70.
[8]. Ahmed HA, Abu-bakr NH, Yahia NA, Ibrahim YE. Root and canal morphology of permanent mandibular molars in a Sudanese population. IntEndod J 2007;40:766–71.
[9]. Forner Navarro L, Luzi A, Garcia AA, Garcia AH. Third canal in the mesial root of permanent mandibular first molars: review of the literature and presentation of 3 clinical reports and 2 in vitro studies. Med Oral Patol Oral Cir Bucal 2007;12:E605–9.
[10]. Sperber GH, Moreau JL. Study of the number of roots and canals in Senegalese firstpermanent mandibular molars. IntEndod J 1998;31:117–22.
[11]. Sachdeva GS, Ballal S, Gopikrishna V, Kandaswamy D. Endodontic management of a mandibular second premolar with four roots and four root canals with the aid ofspiral computed tomography: a case report. J Endod 2008;34:104–7.
[12]. Gu L, Wei X, Ling J, Huang X. A microcomputed tomographic study of canal isthmuses in the mesial root of mandibular first molars in a Chinese population.J Endod2009;35:353–6.
[13]. Matherne RP, Angelopoulos C, Kulild JC, Tira D. Use of cone-beam computedtomography to identify root canal systems in vitro. J Endod 2008;34:87–9.
[14]. Tachibana H, Matsumoto K. Applicability of X-ray computerized tomography in endodontics. Endod Dent Traumatol. 1990;6(1):16-20.
[15]. Patel S. New dimensions in endodontic imaging: part 2—cone beam computedtomography. IntEndod J 2009;42:463–75.
[16]. Peters OA, Laib A, Gohring TN, et al. Changes in root canal geometry after preparation assessed by high-resolution computed tomography. J Endod 2001;27:1-6.
[17]. Vertucci FJ. Root canal morphology and its relationship to endodontic procedures. Endod Topics 2005;10:3-29
[18]. Wu MK, Roris A, Barkis D, et al. Prevalence and extent of long oval canals in the apical third. Oral Surg Oral Med Oral Pathol Oral RadiolEndod 2000;89:739-43.
[19]. Arora S, Tewar S. The morphology of the apical foramen in posterior teeth in a North Indian population. IntEndod J 2009;42:930–9.
[20]. Mauger MJ, Schindler WG, Walker WA. An evaluation of canalmorphology at different levels of root resection in mandibular incisors. J Endod 1998;24:607–9.
[21]. Shrestha S, Karki S, Agrawal N, Vikram M, Singh V, Shrestha A.Prevalence of Different Types of Apical Root Canal Morphology and their TreatmentRecommendations in an Institute.J Nepal Med Assoc 2018;56(210):616-20
[22]. Jou Y-T ,Karabucak B, Levin J, et al. Endodontic working width: current concepts and techniques. Dent Clin North Amer 2004;48:323-35.

[23]. Oliveira MAVC, Venâncio JF, Pereira AG, et al. Critical instrumentation area: influence of root canal anatomy on the endodontic preparation. Braz Dent J 2014:25:232-6.
[24]. Wu MK, Barkis D, Roris A, et al. Does the first file to bind correspond to the diameter of the canal in the apical region? IntEndod J 2002;35:264–7.
[25]. Pecora JD, Capelli A, Guerisoli DMZ, et al. Influence of cervical preflaring on apical file size determination. IntEndod J 2005;38: 430-5.