AN OBSERVATIONAL STUDY ON ROOT CANAL MORPHOLOGY OF MANDIBULAR INCISORS IN A DENTAL COLLEGE HOSPITAL

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ABSTRACT

INTRODUCTION

Additional canals are frequent findings in radicular morphology of the mandibular incisors. Finding additional canals and their obturation significantly improve the prognosis of endodontic treatment. Cone Beam Computed Tomography (CBCT) best visualize all canals and their configurations. The study assessed root canal anatomy of mandibular incisors on CBCT images of the patients.

MATERIAL AND METHODS

An observational cross-sectional study was carried during July-October 2021 on 42 CBCT images of the patients visiting Kantipur Dental College and Hospital. The samples were selected using convenience sampling presenting with bilateral mandibular central and lateral incisors. Root canals and their configurations were assessed on 168 teeth. The presence of unilateral or bilateral additional root canal was recorded and chi-square test was used to test its association with gender ($p < 0.05$).

RESULT

The prevalence of additional canal was 27.4% in mandibular incisors. Bilateral symmetrical distribution of extra canal in mandibular central and lateral incisors were 36.3% and 41.6% respectively. There was a significant association between the presence of extra canal and gender in both central incisors (p-value 0.019) and lateral incisors (p-value 0.009). Type I canal configuration was most prevalent (72.6%) followed by Type III (22.6%).

CONCLUSION

The prevalence of double canals in mandibular incisors is 35% in male and 4% in female samples confirming the male predominance. Bilaterally symmetrical occurrence of double canal is evident up to 41%. CBCT evaluation helps in the visualization of missing root canals during endodontic therapy.

KEY WORDS

Cone-beam computed tomography, Extra canal, Mandibular incisor, Root canal morphology.

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INTRODUCTION

Mandibular anterior teeth usually consist of one root and one canal.[1] Variations like, more than one canals, accessory canals and foramens are also routine findings.[2,3] Failures in endodontic treatment of mandibular incisors often are due to missed canal, particularly the lingual canal. Finding additional canals and obturating them significantly improves prognosis of the treatment.[4] Thus, thorough study of root canal morphology helps in successful endodontic treatment. The different methods of studying root canal morphology are: tooth sectioning, computed tomography (CT) scan, clearing technique and dyes. Presently, CBCT study is the most widely used as it can better visualize all canals with their configurations, and is considered as a gold standard.[4,5] This study utilizes CBCT to assess the prevalence of additional canals and their configuration in mandibular incisors, compare the symmetry of the occurrence of double canal and to find the association between the extra canals with gender.

MATERIAL AND METHODS

It was an observational cross-sectional study assessing the CBCT images of the patients referred to Kantipur Dental College and Hospital. The study was approved by Institutional Review Committee of Kantipur Dental College in June 2021 (Ref # 29/021). The study was carried out during July-October 2021.

The sampling method was convenience sampling. The sample size (N) was calculated using following formula,

$$N = (z^2 pq)/e^2 = 149.17$$

(Where, Z= 1.96 at 95 % confidence interval, p (prevalence) = 10.9% prevalence of two canals in central incisors based on the study of Zitong Lin et al.[6], q= 1-p and e = maximum tolerable error= 0.05.)

The total number of samples was 168 teeth belonging to 42 subjects including 30 males and 12 females. CBCT images of mandibular incisors with fully matured apices and good quality digital images were included in the study. Samples with internal resorption, root canal treated teeth, orthodontically treated teeth and developmental anomalies were excluded. Data information sheet was used to collect the information.

CBCT scans of mandibular incisor teeth were retrieved in a hard-drive from the Department of Oral Radiology. Scans with the lowest field of view (FOV) ranging from 5x5cm to 10x5cm at lowest possible radiation dose were used. The scans were done by CS9300 (Carestream, USA) machine. Images were evaluated by two observers independently on CS imaging suite using Digital Imaging and Communications in Medicine (DICOM) Carestream (CS) 3-D imaging software version 3.5.18. The subjects were exposed to a dose area product of 958 milligrays.cm^2. The images were assessed in axial, coronal, sagittal, and orthoradial section views. The scans were read at 90-180 micrometer cuts on the axial view for number of canals and curved coronal section for any joining of canal or canal curvature. The slices were used to visualize step by step images from pulp chamber to the apex. Then number of roots, number of root canal and canal configuration were assessed and classified as per Vertucci's canal configuration (Figure 1).[2,7]

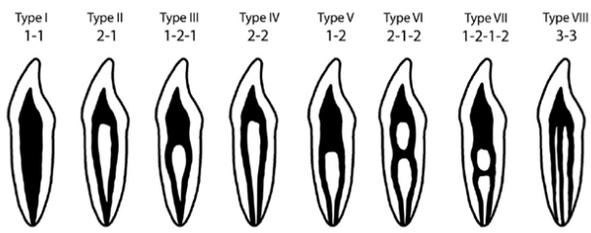

Figure 1. Systematic representation of types of root canal systems (classified by Vertucci)[7]

Vertucci's classification of root canal morphology[2]

Types	Description	Configuration
Type I	A single canal extends from the pulp chamber to the apex.	1-1
Type II	Two separate canals leave the pulp chamber and join short of the apex to form one canal.	2-1
Type III	One canal leaves the pulp chamber, divides into two within the root, and then merges to exit as one canal.	1-2-1
Type IV	Two separate and distinct canals extend from the pulp chamber to the apex.	2-2
Type V	One canal leaves the pulp chamber and divides short of the apex into two separate and distinct canals with separate apical foramina.	1-2
Type VI	Two separate canals leave the pulp chamber, merge in the body of the root, and re-divide short of the apex to exit as two distinct canals.	2-1-2
Type VII	One canal leaves the pulp chamber, divides and then rejoins within the body of the root, and finally re -divides into two distinct canals short of the apex.	1-2-1-2
Type VIII	Three separate and distinct canals extend from the pulp chamber to the apex.	3-3

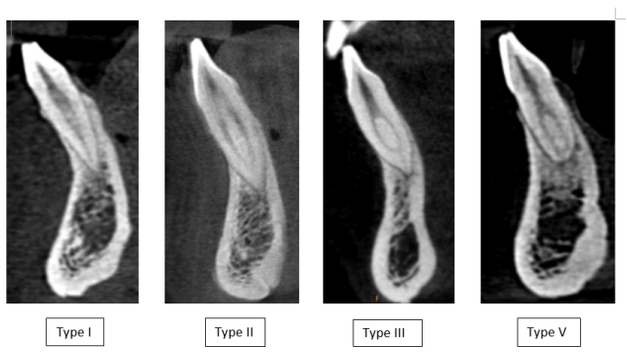

Figure 2. Vertucci's types of canal configuration observed in the study

Data were entered in Microsoft Excel and analyzed using Statistical Package for Social Sciences SPSS Version 21. Data were presented in the form of frequency, percentage, mean and standard deviation. Chi-square test was used to assess the association between extra root canal and gender. The level of significance was set at *p*-value <0.05. Randomly selected 10% of the samples were compared for the inter-observer variation using kappa test.

RESULTS

The study included 42 study participants with 30 (71.4%) male and 12 (28.6%) female. The age of the participants ranged from 11 to 55 years with the mean age 29.88 ±10.26 years. A total of 168 teeth (84 mandibular central incisors and 84 mandibular lateral incisors) were analyzed. The inter-examiner agreement was 100% for the number of roots examined. Weighted Kappa value was found to be 0.82 for the number of root canals. For all observations, the weighted Kappa (κ) values were more than 0.80, which showed almost perfect agreement (p<0.001).

All mandibular incisors had a single root and 46 (27.4%) mandibular incisors had an extra canal. The distribution of extra canal was 22 (26.2%) out of 84 central incisors and 24 (28.6%) out of 84 lateral incisors. There was no statistically significant association in number of canals between mandibular central and lateral incisors (p-value 0.729) (Table 1). More male samples had second canals in mandibular incisors; showing significant association between the presence of extra canal and gender in both central incisors (p-value 0.019) and lateral incisors (p-value 0.009) (Table 2). Among all mandibular incisors, Type I canal configuration was most prevalent i.e. 122(72.6%) followed by Type III 38 (22.6%) (Table 3). Type IV, VI, VII and Type VIII canal configurations were not present in any of the mandibular incisors. Out of the total 22 central incisors with the presence of two canals, 8 9.5%) had bilaterally symmetrical distribution of extra canals.

While only 6 teeth, 2 (2.4%) on right side and 4 (4.8%) teeth on left side had unilateral distribution of extra canals. Out of a total 24 lateral incisors with extra canals; 10 (11.9%) teeth had bilateral distribution of additional canals and 2 (2.3%) teeth on each side had unilateral distribution of extra canals (Table 4). Occurrence of bilaterally symmetrical distribution of extra canal were 36.3% for mandibular central incisors and 41.6% for lateral incisors.

Table 1. Distribution of number of canals in mandibular incisors

Sample	N	One canal	Two canals	*p*-value
Mandibular central incisor	84	62 (73.8%)	22 (26.2%)	0.729
Mandibular lateral incisor	84	60 (71.4%)	24 (28.6%)	
Total	168	122 (72.6%)	46 (27.4%)	

Table 2. Comparison between gender on the presence of extra canal in mandibular incisors

Sample	Male [30]	Female [12]	*p*-value
Central incisors with extra canal	20 (33.3%)	2 (8.3%)	0.019*
Lateral incisors with extra canal	22 (36.7%)	2 (8.3%)	0.009*
All incisors with extra canal	42 (35%)	4 (8.3%)	<0.001*
Total number of teeth	122	46	

*Significant at p<0.05

Table 3. Distribution of mandibular incisor teeth with different canal configuration types

Sample	Type of root canal				
	Type I	Type II	Type III	Type IV	Type V
Mandibular central incisor (n = 84)	62 (73.8%)	(3.6%)	(21.4%)	-	(1.2%)
Mandibular lateral incisor (n=84)	60 (71.4%)	(4.8%)	(23.8%)	-	-
Total (n=168)	122 (72.6%)	(4.2%)	(22.6%)	-	(0.6%)

Table 4. Unilateral and bilateral distribution of extra canal in mandibular incisors

Sample	Teeth	Central incisor (84)				Lateral incisor (84)			
		Unilateral		Bilateral	Total	Unilateral		Bilateral	Total
		Right	Left			Right	Left		
Male 30	60	1(1.7%)	3(5%)	16 (26.6%)	20 (33.3%)	2 (3.3%)	2 (3.3%)	18 (30%)	22 (36.7%)
Female 12	24	1(4.2%)	1(4.2%	-	2 (8.3%)	-	-	2 (8.3%)	2 (8.3%)
Total 42	84	2 (2.4%)	4 (4.8%)	16(19%)	22 (26.2%)	2 (2.3%)	2 (2.3%)	20 (23.8%)	24 (28.6%)

DISCUSSION

Morphologically, both mandibular central and lateral incisors have similar root canals with a coronally oval shaped pulp chamber (wider bucco-lingually, narrower mesio-distally) that gradually become narrower bucco-lingually at mid-root tapering towards the apex.[1,8] However, Woelfel and Scheid presented lateral incisors to be wider mesiodistally with longer length.[9] The root canal preparation is adversely affected by the variations in root canal morphology.[1,10-14]

The present study found single root in all mandibular incisors, which is also reported in other studies such as Verma et al,[15] Aminsobhani et al[16] and Martins et al.[17] Out of the total sample, 27.4% mandibular incisors had an additional canal. This finding is similar to the study by Al-Qudah et al,[18] which reported 26.2% additional canals in Jordanian population using canal staining and tooth-clearing technique. However, Miyashita et al[19] found 12.4% of the roots possessed two canals and Zhao et al[20] reported double canals in 7.6% and 4.17% in central and lateral incisors respectively; which are lower than that of the present finding. Conversely, the study by Kamtane et al[21] showed 36% mandibular incisors having two canals which is higher than that of the present study. There was

no significant difference in the prevalence of extra canals between mandibular central and lateral incisors; this finding is similar to that of Valenti-Obino et al.[22] In the present study, more lateral incisors possessed two canals than central incisors which was also reported by Lin et al.[6]

A systematic review by Hernández et al[23] reported the most frequent order of Vertucci's canal configuration types as: Type I, III, II, V, IV, VII, and VI. Similarly, the present study observed Type I, Type III, Type II and Type V most frequently. Among the central incisors with two canals; Type I canal configuration was most prevalent (73.8%) followed by Type III (21.4%) which is similar to the results of Martins et al[16] who reported Type I (72.3%), Type III (24.2%). However, this result is lower than the reports by Lin et al[6] for Type I (89.1%). Among lateral incisors with two canals; Type I canal configuration was most prevalent (71.4%) followed by Type III (23.8%) which is similar to the result of Lin et al[6] with Type I (74.5%) and Type III (19.3%).

The present study found 26.2% mandibular central incisors and 28.6% lateral incisors presented with double canals; of which the symmetrical distribution was found in 36.3% central incisors and 41.6% lateral incisors. These findings varied with the results of Kayaoglu et al[24] who reported 14.9% central incisors and 17.2% lateral incisors with double canals, of which the bilateral symmetrical distribution was reported in 45% and 29% central and lateral incisors respectively.

The present study showed more male samples having a extra canal in mandibular incisors which is similar to study done by Lin et al.[6] In contrast, a study by Sert and Bayirli showed no significant gender difference observed on Turkish population.[25] Thus, gender variation in canal configuration in mandibular incisors can be expected during endodontic therapy.

The dissimilarities in the prevalence of additional canals and their configurations could be due to the variations in examination techniques to identify the canals, study design, sampling and racial differences. This study has been done in a small sample visiting a dental college hospital; thus the results cannot be generalized to the population.

CONCLUSION

There is a prevalence of 27.4% extra canal in mandibular incisors with the chances of bilateral occurrence up to 41% with male predominance in Nepali sample. While performing endodontic treatment, single canal extending from canal orifice to apical foramen can be anticipated in more than two third of the cases, and single canal dividing into two and again merging into one canal towards the apical area can be anticipated in more than one fifth of the cases, which are best visualized in cone beam computed tomography.

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