ORIGINAL RESEARCH

Evaluation of Root Canal Configuration of Mandibular Premolars Using CBCT in a Defined Population of North India

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Abstract

Aim: The aim of the study was to evaluate the canal configuration in the mandibular premolars in Delhi/NCR population of North India using cone-beam computed tomography (CBCT).

Materials and methods: About 120 CBCT scans were assessed for the root canal configuration in the mandibular premolar according to Vertucci classification. The existence of bilateral symmetry of configuration in the right- and left-side premolars and any gender difference was also studied. Chi-square test was used for statistical analysis.

Results: Type I configuration was the most common in both mandibular premolars. In mandibular first premolar, there was 32.3% chance of canal variation from type I, and in the second premolar, approximately, 18.2% chances of variation exists. No gender difference was observed and bilateral symmetrical existence of canal configuration was seen.

Conclusion: The most prevalent configuration in mandibular premolars is type I. In the mandibular second premolar, chances of variant configuration are less as compared with the first premolar.

Keywords: Computed tomography, Canal configuration, Mandibular premolar, Mandibular premolars, Vertucci classification.

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Introduction

A major contributing factor for successful endodontic treatment is detailed knowledge of root canal morphology. The internal anatomy of a canal system may demonstrate additional canals, lateral and accessory canals, diverse canal shapes, fins, and isthmuses. Its understanding is necessary for complete debridement, disinfection, and obturation of canals and thereby improving the prognosis of the treatment.[1] Mandibular premolar teeth tend to vary greatly from the normal anatomy.[2–4] *Slowey* reported that the mandibular premolars were the most difficult teeth to treat endodontically.[5] These teeth predominantly encounter treatment failures and posttreatment flare-ups mainly due to the presence of too much variation in their morphology.[1] The incidence of the number of roots and canals reported in anatomic studies varies greatly in literature in both mandibular premolars.[6–10] The variation has been attributed to ethnicity, racial, and regional predispositions.[10,11] The difference has been seen in Chinese,[7] Iranian,[2,8] Turkish,[12] and Spanish populations.[13]

Identifying the configuration of canals has been done in the past using methods such as radiography and sectioning,[2] clearing, and staining,[14,15] or micro-CT scanning.[16] The cone-beam computed tomography (CBCT) scanning was introduced in the field of endodontics in 1990. This noninvasive, 3D imaging technique has many endodontic applications including intense morphological analysis which is beneficial in identifying canal configuration.[17–19] Neelakantan et al.[20] in their study reported that the accuracy of CBCT was comparable to the modified canal staining and clearing techniques in the identification of root canal anatomy The added advantage of using CBCT is that any gender difference, bilateral existence of varied configuration can also be evaluated. Previous studies have evaluated the configuration of canals in mandibular premolars in the South Indian population,[9,15] Gujarati population[21] but not many studies have been reported for the identification of canal configuration mandibular premolars with any gender difference in the North Indian population.

As ethnicity has been considered a contributing factor in the existence of variation, the study was planned with an aim to evaluate the variations in canal configuration in mandibular first and second premolar using CBCT in Delhi/NCR population of North India. Also, the occurrence of bilateral symmetry or any gender difference was evaluated.

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Materials and Methods

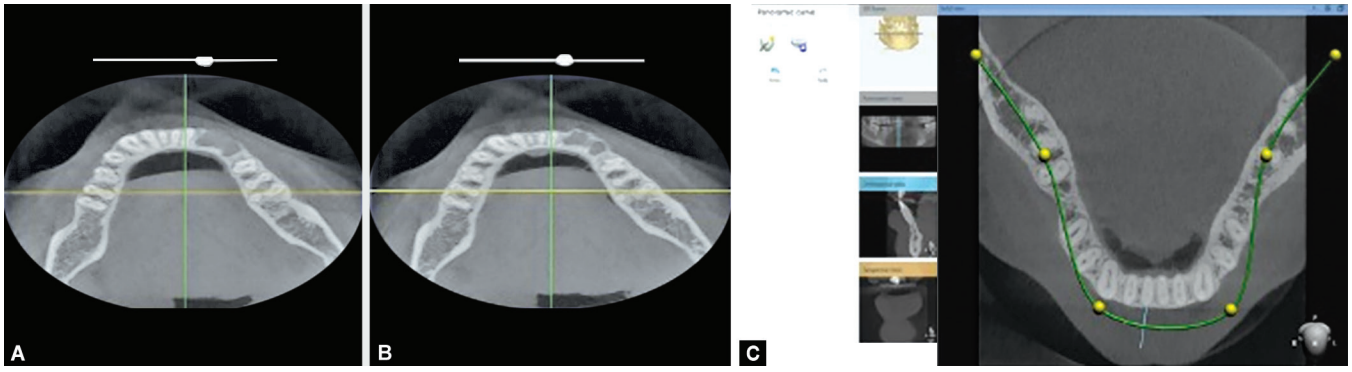
About 120 CBCT scans were collected from archives of the radiology database. Fifty-four scans were of females and sixty-six scans were

Table 1: Canal configuration in mandibular first premolar

Vertucci classification	*Type I (1–1)*	*Type II (2–1)*	*Type III (1–2–1)*	*Type IV (2–2)*	*Type V (1–2)*	*Type VI (2–1–2)*	*Type VII (1–2–1–2)*	*Type VIII (3–3)*	*Type IX (1–3) (Sert and Bayirli 2004)*
Right first premolar ($n = 113$)	73 (64.6%)	1 (0.9%)	12 (10.6%)	1 (0.9%)	25 (22.1%)	1 (0.9%)	–	–	–
Left first premolar ($n = 113$)	80 (70.8%)	3 (2.7%)	8 (7.1%)	–	21 (18.6%)	–	–	–	1 (0.4%)
Total ($n = 226$)	153 (67.7%)	4 (1.8%)	20 (8.8%)	1 (0.4%)	46 (20.4%)	1 (0.4%)	–	–	1
p-value	0.197 NS	0.311 NS	0.242 NS	0.5 NS	0.310 NS	0.5 NS			

Table 2: Canal configuration in mandibular second premolar

Vertucci classification	*Type I (1–1)*	*Type II (2–1)*	*Type III (1–2–1)*	*Type IV (2–2)*	*Type V (1–2)*	*Type VI (2–1–2)*	*Type VII (1–2–1–2)*	*Type VIII (3–3)*	*Type IX (1–3) (Sert and Bayirli 2004)*
Right second premolar ($n = 108$)	91 (84.2%)	8 (7.4%)	3 (2.8%)	–	5 (4.6%)	–	–	–	1 (0.9%)
Left second premolar ($n = 112$)	89 (79.5%)	9 (8%)	4 (3.6%)	–	9 (8%)	–	–	–	1 (0.9%)
Total ($n = 220$)	180 (81.8%)	17 (7.7%)	7 (3.2%)	–	14 (6.4%)	–	–	–	2 (0.9%)
p-value	0.175 NS	0.531 NS	0.520 NS	–	0.225 NS	–	–	–	0.742 NS



Figs 1A to C: (A and B) Showing type IX configuration in mandibular second premolar; (C) Showing bilateral type III configuration in mandibular first premolar

of males. Scans with fully erupted premolars present bilaterally were included in the study. Teeth with any periapical lesion, any previously filled or endodontically treated teeth, or teeth with any open apices, or missing premolar on one side were excluded from the study. Out of 120 scans, in 7 scans, the first premolar teeth were not taken into consideration, and in 10 scans, the second premolars were not evaluated as per exclusion criteria. So, a total of 226 first premolars and 220 second premolars were evaluated. The CBCT used had specifications with an exposure time of 8–9 seconds at 120 kVp, 18.5 MPa, and voxel size ranging from 4 to 15 mm.

The scans were studied in all three spatial directions – axial, sagittal, and coronal. Serial CBCT images were assessed by repeatedly moving the toolbar from the floor of the pulp chamber to the apex to precisely ascertain the canal configuration according *to* Vertucci classification.[22] As this classification has only eight configurations, if any other configuration was detected, those canals were classified according to the classification given by Sert and Bayirli.[14] The number and percentage of each configuration were calculated bilaterally for both the mandibular premolars. Data analysis was done using SPSS software. For statistical analysis, the Chi-square test was used to see the significance level between right- and left-side premolars and between males and females. The level of significance was set at 0.05

Results

The results showed that in mandibular first premolar, the most common configuration was type I for both right-side (64.6%) and left-side (70.8%), followed by type V and then type III. The percentage of type II was 1.8% only. Type IV, type VI, and type IX configurations were rarely seen (0.4%) (Table 1). So there was 32.3% chance of canal variation from type I.

In the mandibular second premolar, type I was the most common configuration on both right-side (84.2%) and left-side (79.5%), followed by type II (7.7%) and then by type V (Table 2). Type IX configuration was seen only in one scan which was present bilaterally (0.9%) (Fig. 1). In none of the premolars, type VII and type VIII were present. Variation from type I configuration was found in 18.2% of second premolars. The statistical analysis showed no significant difference on right- and left-side of the premolar for all the types of configurations. When canal configuration was compared between males and females, statistically, a nonsignificant

Table 3: Percentage of canal configuration in males and females

	Mandibular first premolar				*Mandibular second premolar*			
	Type I	*II*	*III*	*V*	*Type I*	*II*	*III*	*V*
Males	64.4%	4.1%	9%	21.4%	82%	7.9%	4.4%	5.3%
Females	72.7%	1%	9%	15%	82%	10%	3%	4%
p-value	0.122 NS	0.160 NS	0.595 NS	0.152 NS	0.105 NS	0.322 NS	0.476 NS	0.504 NS

Table 4: Existence of type I configuration in mandibular premolars in different populations

Study	*Method*	*Mandibular first premolar*	*Mandibular second premolar*	*Population*
Present study	CBCT	Type I – 67.7%	Type I – 81.8%	North Indian
Llena et al.[13]	CBCT	Type I – 78.1%	Type I – 90.6%	Spanish
Yu et al.[7]	CBCT	Type I – 86.8%	Type I – 97.2%	Chinese
Sobhani et al.[23]	CBCT	Type I – 90.8%	Type I – 90.7%	Turkish
Shetty et al.[9]	CBCT	Type I – 83.81%	Type I – 93.48%	South Indian
Singh and Pawar[15]	Indian ink	Type I – 80%	Type I – 66%	South Asian Indian
Jain and Bahuguna[21]	Clearing technique	Type I – 67.4%		Gujarati
Khedmat et al.[2]	Radiograph, staining	Type I – 88.47%		Iranian
Liu N et al.[16]	Micro-CT	Type I – 65.2%		Chinese
Evren OK et al.[12]	CBCT	Type I – 93.5%	Type I – 98.5%	Turkish

difference was present (Table 3). Though in females, predominantly, type I configuration was present in the first premolar, the difference was statistically not significant. In the second premolar, again there was no gender difference.

Discussion

Cone-beam computed tomography imaging can be an essential diagnostic tool in detecting complex canal variants. Michetti et al.[19] reported a strong correlation between CBCT-acquired data and histological sections of teeth in the identification of root canals. As mandibular premolars can exhibit a lot of variation in canal configuration and fewer studies are available for identification of the same in the North Indian population, the study was planned to evaluate the configuration of canals in mandibular premolars using CBCT in a defined group of North Indian population.

Vertucci has classified the canal configurations into eight types. In this study, three teeth showed the division of a single canal into three canals, so they were classified as type IX according to the classification given by Sert and Bayirli[14] who added 14 new classifications to Vertucci's existing eight classifications. The results of the present study exhibited more variability in the canal system in the mandibular first premolar as compared with the second premolar. Type I configuration was most prevalent in both the premolars in the study. The results are in accordance with previous studies in which type I was the most common configuration but with varied percentages (Table 4).

The difference can be attributed to racial and genetic variations which may influence root canal anatomy and morphology.[1] Another factor for varied results can be due to different methods for evaluation, such as clearing technique, staining, or micro-CT used in other studies. Also, the varying sample size in all the studies may influence the results.

In the present study, the occurrence of bilateral symmetry was seen and no gender difference was observed. Another study by Hajihassani also reported no difference in canal configuration in males and females in the Iranian population.[1] On the contrary, a study done by Evren et al. reported gender differences, with males having a significantly higher incidence of the extra canal, whereas females have a higher chance of one canalled premolar in the Turkish population. They also found a higher incidence of two canals on the left-side (9.5%) than on the right-side (5.9%). Type I configuration was prominent on the right-side.[12] In another radiographic study by Serman and Hasselgren, more women had multiple roots and canals than men in mandibular first premolar, whereas more men exhibited multiple roots or canals in the mandibular second premolar.[23,24] The difference could be again attributed to ethnicity and varying sample size.

Mandibular premolars can present with complex canal anatomy, so it is important to seek the presence of variant canal configurations. As CBCT cannot be used routinely for identifying the configuration during endodontic treatment, intraoral periapical radiographs should be taken from at least three different angulations to identify the presence of existing variation.

Conclusion

- The most prevalent configuration in mandibular premolars is type I. In the mandibular second premolar, the chances of variant configuration are less as compared with the first premolar.
- Bilateral symmetry in canal configuration is present.
- There was nonsignificant difference in gender for the type of canal configuration.

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