

Cone Beam computed tomographic evaluation of root canal morphological characteristics of mandibular first premolars among patients reported to a Dental Hospital in Islamabad

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ABSTRACT

Objective: To evaluate the frequency of root canal morphological patterns of mandibular first premolars analyzed by cone-beam computed tomography (CBCT) scans among patients reported to a dental hospital in Islamabad

Study Design: Retrospective cross sectional analytical study.

Place and Duration: From 1st January 2018 to 31st December 2019 at Operative Dentistry Department in Islamic International Dental Hospital, Islamabad.

Methodology: Cone-beam computed tomography (CBCT) scans (PLANMECA, Finland) were used with image size 13 x 9cm (651 x 651 x 451 cm³), voxel size 200µm to include mandibular anatomy with 96 KV radiation dose, exposure time of 12.078 seconds and current of 9 MA. Slice thickness of 0.200mm was recorded. Axial, coronal and sagittal planes were used to evaluate root canal anatomy of mandibular first premolars. Root canal configurations as per Vertucci's classification were recorded.

Results: Out of 150 cone-beam computed tomography (CBCT) scans, 206 mandibular first premolars met the inclusion criteria. Total number of teeth having one root and one canal was 99.03%, whereas teeth having two roots and two canals were two and probability of such morphology was very rare i.e. 0.97% only. The most common type of morphology on the basis of Vertucci's classification was type I i.e. 87.4% followed by type V in 9.18%, type III in 2.42%, type IV in 0.96% of the subjects.

Conclusion: In a sample of patients visited a dental hospital, majority of mandibular first premolars had one root and type I canal configuration. No significant difference was found between gender and root canal morphology. CBCT is a reliable tool in assessing root canal morphology.

Keywords: Root canal, Morphology, Pre-molar, Cone-beam computed tomography, Vertucci's classification.

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INTRODUCTION

The success of root canal treatment depends upon adequate

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cleaning, shaping and obturation of root canal system¹. Inadequate knowledge about anatomy of root canal system of teeth can result in failure². Therefore complete knowledge of root canal system is essential for better success rate³. The canals left untreated will lead to the presence of persistent microorganisms and necrotic tissue, which may result in the development of periapical pathology.³

Based on branching of root canal system, different classifications have been described in the past that includes the Weine^{3,4}, Vertucci⁴, and Gulabivala³ classifications. Vertucci's classification is widely accepted and it includes 8 categories as shown in figure 1.

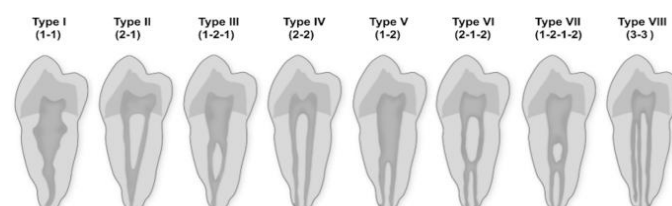


Figure 1: Vertucci's Classification (1984) of canal configuration⁴

Root canal treatment of mandibular premolar teeth is reportedly very challenging due to anatomical variations in the number of roots and types of canal configurations.⁵

Mandibular 1st premolars normally have one root with a canal. However multiple canals have been reported in mandibular 1st premolars ranging from 11.5 to 46% of teeth⁶. The presence of additional roots is associated with different morphological traits such as crown dimension, inter-orifice distance of canals, furcation level, periodontal supporting tissues and distance to the buccal cortical bone⁷.

Various techniques are being used to evaluate root canal systems⁸. Most commonly used techniques are cross sectioning⁹, clearing technique¹⁰, conventional radiography¹¹ and digital radiography¹². In some studies Cone-beam computed tomography (CBCT) is used as diagnostic tool for determining root canal morphology¹³. CBCT gives information about extra root canals, canal type, apical deltas and accurate measurements of root canal system in 3 dimensions i.e. axial, coronal and sagittal planes¹⁴.

Regional and racial predispositions contribute to great internal anatomic variations in root canal system of mandibular 1st premolars¹⁵. In local literature, a number of studies have been published using different techniques to assess root canal system. However, none of these studies used CBCT as an assessment tool.

To provide greater understanding of challenges that mandibular 1st premolar present during treatment, this study was designed by using CBCT scans to investigate different variations of morphological patterns of mandibular first premolars. The objective of our study was to evaluate the frequency of root canal morphological patterns of mandibular first premolars analyzed by cone-beam computed tomography (CBCT) scans among patients reported to a dental hospital in Islamabad.

METHODOLOGY

This retrospective cross sectional analytic study was conducted from 1st January 2018 to 31st December 2019 at Department of Operative Dentistry in Islamic International Dental Hospital, Islamabad. The sample of this study consisted of 150 CBCT scans of patients seeking routine dental checkup at the hospital. Patients with closed apical foramina of mandibular 1st premolars, age group (20 to 40 years) were included in this study. Scans with periapical pathology, indirect restorations, open apex and blurred images were excluded.

CBCT scans (PLANMECA, Finland) were used with image size 13 x 9cm (651 x 651 x 451 cm³) and voxel size of 200µm to include mandibular anatomy with 96 KV radiation dose, exposure time of 12.078 seconds and current of 9 MA were used. Slice thickness of 0.200mm was detected. Axial, coronal and sagittal planes were used to evaluate root canal anatomy of mandibular 1st premolars.

CBCT images were analyzed with in-built software named PLANMECA ROMEXIS Version 4.6.0.R viewer in an APPLE Mac book Air laptop with 13 inches LCD screen, with the resolution of 1366x768 pixels in a dark room. The contrast and brightness of the image was adjusted using the image-processing tool in the

software to ensure optimal visualization of the root and root canal systems.

All CBCT images were independently evaluated by running intra class correlation (ICC). Three-Dimensional images were obtained from the software and the following variables were recorded: root anatomy and configurations of canal morphology according to Vertucci's classification.¹²

Data Analysis: Data analysis was done using SPSS v23.0. Frequencies and percentages were described for the gender wise number of root/roots and canal morphologies in the mandibular first premolars as per Vertucci's classification were assessed. Chi-squared test was applied for checking the significant association. An arbitrary value of ≤ 0.05 was considered to be significant.

RESULTS

A total of 206 mandibular first premolars were evaluated from 150 CBCT scans. Of them, 101 (49.02%) belonged to male and 105 (50.98%) belonged to female.

Table – I: Frequency of number of roots in mandibular first premolars (N=206)

Number of roots	Frequency (n)	Percentage
1	204	99.03%
2	2	0.97%
Total	206	100%

The most common root anatomy was one root (99.03%) in most of the mandibular first premolars. Only one tooth had two roots (0.97%).

TABLE – II: Frequency of Vertucci's classification in mandibular first premolar (N=206)

Vertucci's classification	Frequency (n)	Percentage
Type I	180	87.4%
Type III	5	2.42%
Type IV	2	0.96%
Type V	19	9.18%
Total	206	100%

The most common type of morphology on the basis of Vertucci's classification was type I i.e. 87.4% followed by type V in 9.18%, type III in 2.42%, type IV in 0.96% of the subjects.

Table – III: Gender wise cross tabulation regarding number of roots in mandibular first premolar (N=206)

Number of Roots	Gender		Total	p-Value
	Male, n (%)	Female, n (%)		
One	100 (48.5%)	104 (50.4%)	204 (9.5%)	0.977
Two	1 (0.485%)	1 (0.48%)	2 (90.5%)	
Total	101	105	206	

Total number of males having one root were 100 (48.5%) whereas, female having one root were 104 (50.4%). Males and

females having two roots were 1 (0.485%) each. As p-value= 0.97, so, no significant association was found in number of roots and gender (male and female).

Table – IV: Gender wise cross tabulation regarding Vertucci's classification in mandibular first premolars (n=206)

Vertucci's Classification	Gender		Total	p-Value
	Male, n (%)	Female, n (%)		
Type I	87 (42.23%)	93 (45.14%)	180 (87.4 %)	0.850
Type III	2 (0.97%)	3 (1.45%)	5 (2.43%)	
Type IV	1 (0.48%)	1 (0.48%)	2 (0.96%)	
Type V	11 (5.34%)	8 (3.84%)	19 (9.18%)	
Total	101	105	206	

Vertucci's classification of canal configuration found in male were 87 (42.23%) in type I, 2 (0.48%) in type III, 1 (0.48%) in type IV and 11 (5.34%) in type V. Vertucci's classification found in female were 93 (45.14%) type I, 3 (1.45%) type III, 1 (0.48%) type IV and 8 (3.84%) type V.

As p-value =0.850 so, no significant association was found between Vertucci's classification in mandibular first premolar and gender (male and female)

DISCUSSION

Endodontic treatment success requires an understanding and complete knowledge of root canal anatomy and morphology¹⁶. Reasons for failure include untreated canal, incomplete cleaning, shaping and obturation. Chances of procedural errors are high in tooth with atypical morphology. These errors include perforations, zipping, ledge formation and missed canals¹⁷. Different techniques are used to evaluate root canal anatomy⁵. Recently cone beam computed tomography (CBCT) has been used for assessing root canal morphology¹⁸.

The CBCT is a three-dimensional advanced diagnostic tool that allows the imaging in axial, coronal and sagittal planes¹⁹. With respect to the tooth morphology, the number of roots, and their morphological features can be observed in three dimensions. All three planes can be viewed in thin slices increasing its accuracy in detecting small changes in canal anatomy, which was previously not possible²⁰. In CBCT software, several tools are available to enhance image quality and provide better visibility. Therefore, CBCT can be considered a reliable tool to use in modern day dentistry¹⁸⁻¹⁹.

Several studies had focused on root canal anatomy but most didn't consider genetic/ethnic origin of population¹⁷. It is critical to consider population's ethnicity for better treatment outcome as root canal morphology depends on it¹⁹⁻²¹. According to Vertucci's study¹⁶, almost 100% of mandibular first premolars had one root in North American population. Trope et al²⁰ reported one root in 94.5% of the teeth in Euro Americans and two roots in 5.5% of the teeth while Yang et al²² reported frequency of single root to be in 99.3% and 0.7% for two roots in Asian population. This current study records the frequency of one root in mandibular first premolar to be 99.03 % whereas two roots in 0.97% while Vertucci²¹ and Yang²² et al observed

two roots in only 0.5% of the subjects that are comparable to our study.

Root canals have different types or configurations depending upon Vertucci's classification^{16,23-25}. According to a study by Burklein et al²³, most prevalent canal type among mandibular first premolar was type V that was 55.5% and second most common type was type I that was 21.9%. While Hussam et al³ reported type I canal configuration (88%) in most of the mandibular first premolars. According to Vertucci's classification¹⁶, type 1 was more prevalent than other types. Hasseni et al²⁶ showed type I in (62.2%) followed by type V (20.2%) and type III (10.9%). In comparison, this study showed canal type 1 in 87.4% of the cases, type III in 2.42%, type IV in 0.96% and type V in 9.18% of the subjects. That is comparable to study by Hussam et al³.

Use of CBCT warrants the precise detection of pulp anatomy, canal orifices location and configurations in all three planes. A thorough and detailed knowledge of anatomic complexities in human teeth is essential and is linked with increased success of treatment outcome²⁴. That's why unusual canal morphology and additional canals should be kept in consideration when initiating root canal treatment in mandibular 1st premolars²⁵.

To our knowledge, the current study is the first on assessing canal morphology of mandibular 1st premolar among patients under CBCT in Islamabad Population. In a sample of patients studied, majority of mandibular first premolars had one root and type I canal configuration. However, prevalence of more than one root and different canal configurations were detected in different ethnic studies. There was no difference in terms of gender for root canal morphological characteristics. This study identified root canal morphology of mandibular 1st premolar and its variations, which can be helpful in obtaining better success rate in endodontic treatment.

CONCLUSION

In a sample of patients visited a dental hospital, majority of mandibular first premolars had one root and type I canal configuration. No significant difference was found between gender and root canal morphology. CBCT is a reliable tool in assessing root canal morphology.

LIMITATIONS

This study has few limitations that images were assessed from a single diagnostic centre. Further studies with larger sample size and inclusion of different ethnicities are recommended for better judgment of mandibular 1st premolars.

AUTHOR'S CONTRIBUTION

Muzaffar MA: Conceived idea, Designed methodology, Data analysis and Manuscript writing

Mahboob Z: Manuscript writing, Data collection and analysis

Hamza A: Final critical review of manuscript

Hussain A: Data collection, Literature review

Hanif F: Data collection and compilation

Naeem R: Data collection

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