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Cone-Beam computed tomography study of root and canal morphology of mandibular premolars in Kashmiri population

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Abstract
Aim: The current study's goal was to employ CBCT to determine the accurate root anatomy, as well as root canal configuration, of mandibular first and second premolars in Kashmiri Population.
Materials and Methods: CBCT scans data of the patients who were scanned for some diagnostic purposes were collected. The collected data were subjected to a retrospective examination. All of the data related to patients who were scanned at the Bright X-rays CBCT centre between Jan 2018 and December 2021 were evaluated.
Results: Table 1 shows the number of roots on the right and left sides in relation to gender and tooth location. Of the 250 teeth assessed, 243 mandibular premolars had one root (97.2%), whereas 7 (2.8%) were two-rooted. There was no statistically significant difference ($p > 0.05$) between gender and the number of roots or tooth position and the number of roots.
Conclusion: The prevalence of multiple canals in mandibular first premolars was mainly of Type V, and mandibular second premolars had a low rate of canal variation. Root canal bifurcation occurred at the middle or apical third in most bicanal mandibular premolars. CBCT scanning can be used in the management of mandibular premolars with complex canal morphology.

Keywords: Cone-beam computed tomography, Kashmiri population, mandibular premolar, morphology

1. Introduction
A thorough knowledge of root canal morphology is essential for successful endodontic treatment. Neglecting to probe, prepare, and fill all of the canals can lead to failure of endodontic treatment [1]. As a group, the mandibular premolars are among the most difficult teeth to treat endodontically [2], because they have a high incidence of multiple roots or canals. A possible explanation for this difficulty may be the extreme variations in root canal morphology that occur in these teeth. Furthermore, the incidence, location, and morphology of root canal systems may vary in different ethnic or regional populations.
The root canal shape varies from tooth to tooth. Many studies revealed that the root canal is a complicated system that divides and connects canals along the way to the apex, rather than a single canal that runs continuously from opening to apex [3-5].
The aim of endodontic therapy is to achieve thorough shaping and cleaning of all pulp spaces and their complete obturation with an inert filling material. A thorough grasp of pulp anatomy is required for root canal treatment effectiveness, and a lack of this information might result in treatment failure [6, 7]. Endodontic performance necessitates a detailed knowledge of the pulp's natural and atypical arrangements, as well as possible alterations. Forming a mental image of the dental pulp from the coronal part to the apical foramen is critical for an operator. Every canal has irregular and secret areas that must be considered during endodontic care.
Mandibular first and second premolars have similar morphology, and these single-rooted premolars have single root canal types. On the other hand, reports show that root canal morphology in premolars is more difficult than it appears on simple radiographs. Extra canals and a number of canal configurations can be found in several roots [8, 9].
Mandibular first and second premolars are among the most problematic teeth to treat in the mouth.

The most possible explanation is that clinicians failed to notice the various differences in canal morphology that these teeth may have. A disproportionate number of cases may result in flare-ups and/or failures if the entire root canal system is not found and properly handled [8, 9]. For the identification and proper treatment of teeth with various anatomical differences, a detailed understanding of root canal anatomy, careful radiographic analysis, and proper adjustment of the traditional access cavity preparation tend to be necessary. Before beginning root canal care, it is important to consider the possibility of root canal morphology variations [10].

Cone-beam computed tomography (CBCT) is a noninvasive tool that can help clinicians analyze maxillofacial anatomy in sagittal, axial, and coronal sections while also providing high-quality 3D diagnostic images without overlapping structures [13]. The number of canals, as well as their separation or convergence from one another, can all be imagined in 3D. For these purposes, CBCT is recommended for accurate root canal system evaluation [14]. The effectiveness of root canal care is based on a detailed understanding of both normal and abnormal root canal anatomy. Working knowledge of such information is needed for proper shaping, cleaning, and obturation of the root canal system in three dimensions [14, 15]. The occurrence of missing roots or canals in teeth that required retreatment was 42%, according to Hoen and Pink [16]. Number of roots and root canals of mandibular premolars varied, and the internal root canal shape might be extremely diverse [17]. The broad variety in root canal anatomy of these teeth makes conducting effective endodontic procedures the most complicated of all [18].

The current study's goal was to employ CBCT to determine the accurate root anatomy, as well as root canal configuration, of mandibular first and second premolars in Kashmiri population

Method

The patients who had CBCT scanning done for some other diagnoses were examined. The collected data were subjected to a retrospective examination. All of the data related to patients who were scanned at the Bright X-rays CBCT Centre in Srinagar Kashmir between Jan 2018 and December 2021 were updated. A database including 300 CBCT images was examined.

Accurate CBCT images of mandibular premolars that had totally grown roots in individuals aged 18–60 years satisfied the inclusion criteria and were included in the current investigation.

Teeth with periapical disorders and low-quality CBCT scans were excluded. Additionally, teeth having calcification or resorption of roots were also omitted. Furthermore, endodontically treated teeth, postcoronal restorations, metallic restorations, crown restorations, and scan artifacts were all left out. Anatomical symmetry was evaluated by comparing images from both sides with teeth. After analyzing 300 scans for inclusion/exclusion criteria, the final specimen size for this investigation was 250 mandibular premolars.

The Newtom giano hr CBCT equipment was utilized for the scans (NewTom Giono Imola, Italy).

The X-ray generator has a voltage range of 60–90 kV, a current range of 2–15 mA, and a frequency range of 140 kHz. This machine's specifications included a CMOS sensor with Dental Volumetric Reconstruction (DVR), a scan period of 3 to 15 seconds, fields of view (FOV) of 4 × 4, 5 × 5, 8 × 5, and 8 × 8 cm, and a voxel size of 75m minimum. -e pictures were analyzed using the CS 3D Imaging Software (Carestream Dent LLC, Atlanta, USA).

Four examiners received calibration training prior to the evaluation. To verify the accuracy of the findings of this study, we randomly selected 20 CBCT images to evaluate inter examiner reliability by detecting root canal counts and identifying the kind of root canal type based on Vertucci classification. The reliability of intra examiner and inter examiner was examined.

The results were evaluated using version 22.0 of the Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA). The total number of roots, root canal configuration, unilateral and bilateral events, and root canal configuration were all studied. The incidence and similarity of the left and right sides, as well as women and men, were investigated. The findings were evaluated by using the chi-square test. At the threshold of $p > 0.05$, statistical significance was determined.

Results

Table 1: Number of roots for gender and tooth position in the studied sample

Number of roots	Gender		Total	Tooth position		Total
	Male	Female		Left side	Right side	
One root n (%)	126(50.4)	117 (46.8)	243(97.2)	120(48.0)	123 (49.2)	243 (97.2)
Two roots n (%)	4(1.6)	3(1.2)	7(2.8)	4 (1.6)	3 (1.2)	7(2.8)

Table 2: Number of roots for gender and tooth position in mandibular first and second premolars

	Number of roots	Gender		Total	Tooth position		Total
		Male	Female		Left side	Right side	
First premolar	One root n (%)	62(49.2)	59 (46.8)	121 (96.0)	63(50.8)	58(46.0)	121 (96.0)
	Two roots n (%)	3 (2.4)	2 (1.5)	5 (4.0)	3(2.4)	2(1.6)	5(4.0)
2nd premolar	One root n (%)	64(51.6)	58(46.8)	122 (98.4)	57(46.0)	65(51.6)	122 (98.4)
	Two roots n (%)	1(0.8)	1(0.8)	2 (1.6)	1(0.8)	1(0.8)	2 (1.6)

The total number of mandibular first premolars that were included in the present study was 126 (50.4%). However, for mandibular second premolars, the number of scanned teeth was 124(49.6%).

Table 1 shows the number of roots on the right and left sides in relation to gender and tooth location. Of the 250 teeth assessed, 243 mandibular premolars had one root (97.2%), whereas 7 (2.8%) were two-rooted. There was no statistically significant difference ($p > 0.05$) between gender and the number of roots or tooth position and the number of roots.

Table 2 shows the number of roots in relation to tooth type. Of the 126 mandibular first premolars examined, 121 teeth

were single-rooted (96%), whereas 5 (4%) had two roots. For mandibular second premolars, 122 premolars had one root (98.4%), while 2 teeth had two roots (1.6%). There were substantial variations in the number of roots discovered across groups ($p > 0.05$).

Discussion

In mandibular second premolars, we also found that all had one root and most had only one canal, in agreement with the findings of Miyoshi *et al*. [11] However, these results are somewhat different to those reported in other studies. One study of a Chinese population in the Taiwan area found that only 54% of mandibular first premolars exhibited a single canal (vs 96%in this study), whereas 22% contained two canals (vs. 4% in this study) [12].

The cross-sectional morphology of the majority of canals in this study was oval in the coronal third, circular or oval in the middle third and circular in the apical third. Interestingly, the root canal bifurcation tended to occur in the middle or apical third in the vast majority of bicanal mandibular premolars (87% and 75% in first and second premolars, respectively), consistent with previous investigations [12, 13]. This indicates a high probability of variation in the root canal when the clinician detects a change of shape or direction in the middle apical sections of the canal.

The complex root canal anatomy of mandibular premolars may be disguised in routine straight-on or even oblique radiography in clinical situations. A previous study [14] has demonstrated the low sensitivity of mesiodistal or buccolingual angulated radiographs in detection of root canal morphology. Conventional intraoral periapical radiographs are an important clinical diagnostic tool for assessing canal morphology, but these radiographs are not completely reliable because of inherent limitations such as distortion and superimposition of dental structures [15]. The application of CBCT has been suggested in these cases to provide a 3D confirmatory diagnosis without causing any tooth damage. It offers high resolution and is well suited for endodontic applications as a complement to conventional radiography.[16] When uncertainty exists in the diagnosis of canal variations, or a change of shape/direction in the middleapical third of the canal is detected, periapical radiography associated with CBCT can be used to determine or confirm the presence and location of canal bifurcation.

The most common root morphology in mandibular second premolars in Kashmiri population was one root (98.4%), followed by double-rooted (1.6%). In addition, the majority of these samples had type I canal, followed by type II and lastly type IV configurations. Our results were consistent with earlier reports, which revealed that the prevalence of type I canal configuration in a Turkish population was 93.63% and 98.5%, respectively [17, 18].

The canal systems of mandibular first premolars in Kashmiri population showed a lot of variation and complexity. Mandibular second premolars had less variation in root and canal configuration than mandibular first premolars.

A CBCT scanner was able to detect these complex variations, which is important. It indicates that CBCT may be used as an additional method to increase the efficiency of root canal therapy in mandibular premolars with complex canal morphology. Increased failure rate that occurs when additional canals are missed during root canal therapy illustrates the importance of accurately assessing the presence of complex canal systems. When traditional radiography is inconclusive, CBCT scanning is extremely useful in detecting anomalous canal morphology.

This study has a few limitations that must be addressed. The age of the patients, as well as changes in FOV, should be taken into account in future research. Furthermore, the spatial resolution of the CBCT employed in this study was lower than that of micro- and nano-CT, which might have influenced the results. Further multicenter research employing improved methods such as micro-CT may be able to address the limitations of the current study.

Conclusion

Within the limitations of this study, it can be concluded that the patient's race is an irrefutable factor that determines the morphology of the root canal system. The root canal anatomy of mandibular premolars in Kashmiri population revealed significant differences. These findings suggest that practitioners should be aware of and avoid failures caused by additional missed canals. To achieve acceptable patient outcomes, practitioners must be aware of the intricacies of root canal architecture and employ the most upto- date and precise armamentarium.

The root and canal configuration of mandibular second premolars in Kashmiri population was less variable than that of mandibular first premolars. Significantly, a CBCT scanner was able to detect these complex variations. This suggests that CBCT has potential as an auxiliary tool in the evaluation of mandibular premolars with complex canal morphology to improve the quality of root canal therapy. The importance of accurately determining the existence of complex canal systems is reflected in the elevated failure rate that occurs when additional canals are missed during root canal therapy. CBCT scanning is of great value in detecting anomalous canal morphology when diagnosis by conventional radiography is inconclusive.

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