



## **Anatomic Variations and Anomalies in Mandibular First Premolar Teeth**

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### **Authors' contributions**

*This work was carried out in collaboration between all authors. Author BS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript.*

*Authors KN and SHS managed the analyses of the study. Author PM managed the literature searches. All authors read and approved the final manuscript.*

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### **ABSTRACT**

Mandibular Premolars have been reported with complex anatomical variations making them one of the most difficult teeth to manage endodontically. A clear knowledge and understanding of the anatomy of human teeth is an essential requirement for all dental procedures especially in the case of root canal treatment that deals with the management of tooth's internal anatomy. The purpose of this article is to call attention to the internal and external variations associated with the mandibular first premolar, an awareness of which will contribute to increased success of endodontic therapy.

**Keywords:** Premolar; teeth; anatomical variations.

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## 1. INTRODUCTION

The anomaly is a medical term meaning “irregularity” or “different from normal”. The simultaneous occurrence of multiple anomalies involving single, groups of teeth or entire dentition with associated medical anomalies may be inherited genetically or may be associated with specific syndromes [1].

In order to perform endodontic treatments skillfully and effectively, dentists ought to know tooth anatomy very well, especially the internal anatomy. A lack of knowledge of the internal anatomy and its variations will undoubtedly lead to an error in localization, instrumentation, and obturation of a root canal.

For each tooth in the permanent dentition, there is a wide range of variation reported in the literature with respect to the frequency of occurrence of the number and the shape of canals in each root, the number of roots [2,3] and the incidence of molar root fusion [4,5].

Variations also result due to ethnic background and age and gender of the population studied [6]. The expected root canal anatomy dictates the location of the initial entry of access, it dictates the size of the first file used, and it contributes to a rational approach to solving the problems that arise during therapy. Therefore a thorough knowledge of the root canal anatomy from access preparation to obturation is essential to give highest possible chance for success [7].

Much of the knowledge of the anatomy of the root canals is based on the exhaustive work of the Hess. He made vulcanite corrosion preparations of almost 3000 permanent teeth. These preparations showed in minute detail the extensions, ramifications, and branching as well as the shape, size, and number of a root canal in different teeth. Through the years subsequent anatomic studies have contributed to our knowledge of the anatomy of the pulp cavity.

These anatomical variations contribute to a good number of failures in root canal therapy as may be the case in the undetected extra canal, curved canal or an extra large canal etc. A clear understanding of the root morphology and canal anatomy, as well as its associated anomalies, is a prerequisite for successful endodontic therapy.

The purpose of this article is to call attention to the internal and external variations associated

with the mandibular first premolar, an awareness of which will contribute to increased success of endodontic therapy.

## 2. EXTERNAL ROOT MORPHOLOGY

- The mandibular first premolar is typically a single-rooted tooth that is wider buccolingually and narrower mesiodistally.
- Two-rooted varieties do occur fairly frequently [8] (Fig. 1).
- Developmental depressions or grooves are frequently found on both the mesial and the distal surfaces of the root resulting in an ovoid or hourglass-shaped root. The depression on the distal root surface has been described as being deeper than the mesial root depression [9].
- The overall average length of the mandibular first premolar is 22.5 mm with an average crown length of 8.5 mm and an average root length of 14 mm [10].

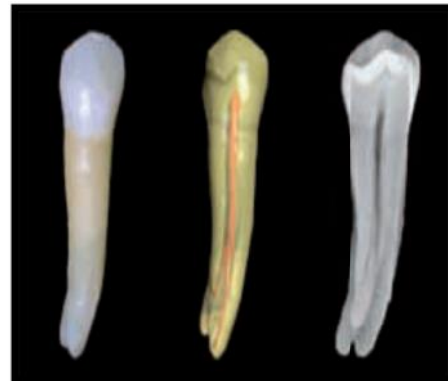


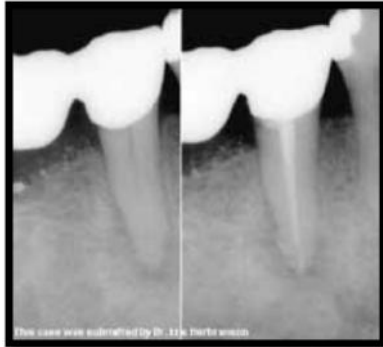
Fig. 1. Two rooted mandibular premolar

## 3. ROOT NUMBER AND FORM

- The mandibular first premolar is normally a single-rooted tooth, as shown in Figs. 2 and 3 (Table 1); however, eight anatomical studies did reveal an incidence in approximately 1.8% of bifurcated teeth (Fig. 4) [11,12,13].
- Trope et al. [14] found significant ethnic variations in the root anatomy when comparing African American and Caucasian patients. Their study found an incidence of two root canals of 5.5% in the Caucasian and 16.2% in the African American group of patients.
- Three-rooted mandibular first premolars are rare but are occasionally found in case

reports [15] (Figs. 5, 6 & 7). Scott and Turner [16] describe the accessory root as "Tome's root." Their anthropological

review of ethnic differences indicates that aboriginal Australians and sub-Sahara African population.



**Fig. 2.** Mandibular right first premolar with a single root and single canal; a lateral canal is visible on the distal aspect of the apical third of the root



**Fig. 3.** Mandibular left first premolar exhibiting a single root and single canal: lateral canals emanating from the main canal in the middle third of the root are present



**Fig. 4.** Extracted mandibular right first premolar with a main buccal and vestigial mid-root lingual root



**Fig. 5.** Mandibular right first premolar exhibiting 3 canals in a single root. canal systems filled and apical third separation of root tips



**Fig. 6.** Mandibular left premolar with 3 canals and 2 roots



**Fig. 7.** Rare three-rooted mandibular first premolar

**Table 1. Mandibular first premolars anatomy**

Number of roots	Number of studies cited	Number of teeth	One root	Two roots	Three roots	Four roots
	8	4462	97.9% (4369)	1.8% (81)	0.2% (10)	0.2% (10)
Number of canals and apices	Number of studies cited	Number of teeth (Canal Studies)	One canal	Two or more canals	One canal at apex	Two or more canals at apex
	16	4733	75.8% (3586)	24.2% (1147)		
	10	2604			78.9% (2054)	21.1%(550)

**Table 2. Case reports of mandibular first premolar anomalies**

Reference	MFP teeth in study (n)	Other key information	Type of study	Anatomic variation
De Almeida-Gomes et al., 2006	1 (Brazil; 40-y.o. male)		Clinical RCT	Single main canal with an accessory canal
	1 (Brazil; 30-y.o. female)		Clinical RCT	Single main canal dividing into 2 separate canals and a third accessory canal; 2 apical foramina
Nallapati, 2005	1 (USA; 49-y.o. Caucasian Jamaican male)		Clinical RCT	Single main canal split into 3 separate canals and apical foramina
Moayed and Lata 2004	1 (India; 35-y.o. female)		Clinical RCT	3 canals (DB, DLI, and M) and an MB root bifurcation
Milano et al., 2002	1 (USA; 7-y.o. Hispanic male)		Radiographic Study	All first and second mandibular premolars exhibited 2 roots
Stecker and DiAngelis, 2002	2 (USA; 9-y.o. Hispanic female)	All erupted premolars in this patient (maxillary first and second premolars and the mandibular first premolars) exhibited dens evaginatus on the occlusal surface of the crown	Clinical and radiographic exam	Dens evaginatus
Aryanpour et al., 2002	1 (Belgium; 38-y.o. Caucasian female)	Two distinct crowns with two pulp chambers, two joined and one separate canal were present	Clinical RCT	Gemination

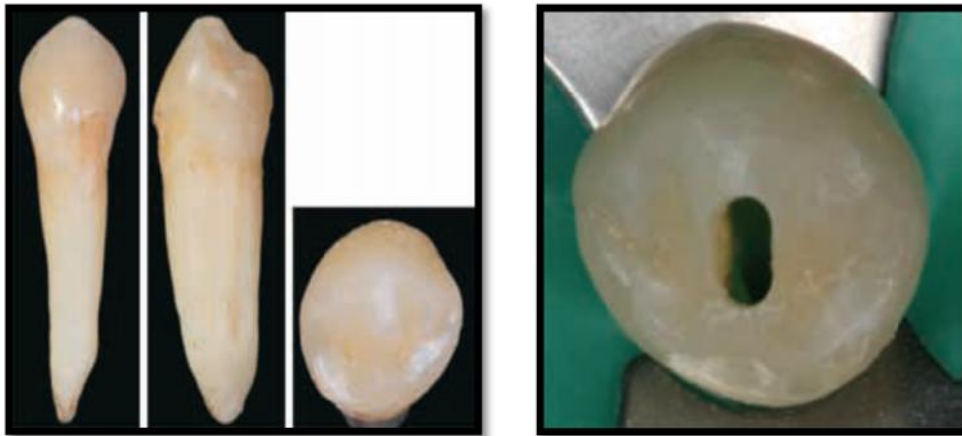
Reference	MFP teeth in study (n)	Other key information	Type of study	Anatomic variation
Prabhu et al., 1999	1 (India; 13-y.o. male)		Radiographic Study	All first and second mandibular premolars exhibited aberrant root development; multiple roots were present on each mandibular premolar
Hartup, 1997	1 (USA; 16-y.o. male)	Dens invaginatus and a bifurcated root were present	Clinical RCT	Type III dens invaginatus
Yang, 1994	1 (Australia; 20-y.o. s Asian male)		Clinical RCT	3 canals; MB, DB, and li
Tavano et al., 1994	1 (Brazil; 15-y.o. Caucasian female)	Clinical crown was larger than the contralateral first premolar	Clinical RCT	Dens invaginatus
Bramante et al., 1993	1 (Brazil; 15-y.o. Caucasian female)		Clinical exam and extraction	Dens invaginatus
Fischer and Evans, 1992	1 (USA; 29-y.o. female)	Mandibular second premolar had similar root configuration	Clinical RCT	3 roots and 3 canals
Chan et al., 1992	1 (China; 53-y.o. male)		Clinical Examination	3 roots and 3 canals; MB, DB, and Li roots
	1 (China; 20-y.o. male)		Clinical RCT	3 canals
England et al., 1991	1 (USA; 32-y.o. Caucasian female)	Failed RCT with silver point	Clinical RCT	2 canals in a single root
	1 (USA; 26-y.o. Caucasian male)		Clinical RCT	3 separate canals with fused root fused root
Hülsmann, 1990	1 (Germany; 35-y.o. male)		Clinical RCT	3 canals present
Doolittle et al., 1973	1 (USA; 20-y.o. female)	Single root with two canals and two separate apices		2 canals and 2 separate apices

#### 4. CANAL SYSTEM

- Slowey has suggested that the mandibular premolars may present with the greatest difficulty of all teeth to treat endodontically [17]. A University of Washington study assessed the failure rate of nonsurgical RCT in all teeth. It was highest for the mandibular first premolar at 11.45% [18]. The possible reasons for a high failure rate are the numerous variations in root canal morphology and difficult access to a second canal.
- There is usually a straight line access to the buccal canal, while the lingual canal branches at a sharp angle, potentially resulting in a missed canal. A study by Kartal and Yanikoglu, using pooled data that included first and second premolars, reported a 27.8% incidence of mandibular premolars with more than one canal [19].
- Sherman and Hasselgren examined full mouth series of radiographs for 547 patients and found that 15.7% of patients had at least one mandibular first premolar with either a divided canal or a root [20]. The second premolars had an incidence of 7% in this study.
- The data from 16 anatomical studies of the canal system that included only mandibular first premolars (Table 2) resulted in a weighted canal in 75.8% of the teeth studied [21–25]. Two or more canals were found in 24.2% of the teeth.
- Ten anatomical studies assessed the canal number at the apex [26,27]. These studies found a single canal at the apex 78.9% of the time.
- Trope and colleague's study found significant ethnic differences between African American and Caucasian patients [28]. The incidence of two or more canals in the African American group of 400 patients was 32.8%, while the incidence in the Caucasian group of 400 patients was 13.7%.
- A study of 1,000 full mouth radiographic surveys by Amos in 1955 also found ethnic differences between African American and Caucasian patients [29]. Although the number of patients in each ethnic group was not identified. Amos reported that 16% of the Caucasian patients had bifurcated canals compared to 21.6% of the African American patients.



**Fig. 8.** Two examples of lower first premolars with two canals. C, Photographs of an extracted tooth demonstrate a C-shaped root cross section and suggest the impossibility of adequately cleaning and shaping the entire canal system



**Fig. 9. An Example of a mandibular first premolar showing buccal, mesial, and occlusal views. B, The access preparation can be assessed from an occlusal view**

## 5. VARIATIONS AND ANOMALIES

- Anomalies associated with mandibular first premolars include
  - gemination [30]
  - dens evaginatus [31]
  - dens invaginatus [32–34]
  - two roots [35] three roots (see Figs. 4,7)
  - two canals in a single root [36–39]
  - three canals with fused roots [40]
  - three canals in a single root [41] (Fig. 5)
  - three canals and two roots [42] (Fig. 6)
  - three canals and three roots [43] three canals
  - and one case of aberrant root development and multiple roots in all mandibular premolars [44]
- A study of 45 X-chromosome females in Finland found more than one canal in one or more of the mandibular premolars in almost half of the 87 patients studied. Separate canals were found in 23% of the mandibular first premolars and 25% of the mandibular second premolars [45]. The study concluded that X chromosomes have a gene or genes with a regulatory function in root development.

## 6. CLINICAL SIGNIFICANCE AND MANAGEMENT

- The entry point is in the middle of the central groove, and the bur is directed to the buccal. Again, the accessed shape is

an oval slot. As the crown is lingually inclined, the access cavity will result in the removal of more of the buccal cusp than the lingual.

## 7. CONCLUSION

- Although most mandibular first premolars have a single root, two-, three-, and even four-rooted forms have been reported as 2.1% incidence when grouped together.
- The majority of mandibular first premolar teeth have a single canal but there is a relatively high incidence, or one-quarter of mandibular premolars, that have two or more canals.
- A single apical foramen may be found in mandibular first premolar teeth in 4 of 5 cases, but two or more foramina may occur over 20% of the time.
- Although only reported in a few studies, variations in incidence of single canals versus two or more canals may occur because of race or gender

## CONSENT

It is not applicable.

## ETHICAL APPROVAL

It is not applicable.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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