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## Root canal morphology in mandibular premolars in Kashmiri population: A clearing sectional *in vitro* study

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### Abstract

**Background and objectives:** The aim of this study was to get data of internal anatomy of first and second mandibular premolars and to access percentage variations of root canal morphology of mandibular premolars in Kashmiri population based on Vertucci's classification by clearing technique.

**Methodology:** A total of 100 extracted intact permanent mandibular premolars (50 each mandibular first premolar and mandibular second premolar) with fully formed apices were collected. Access cavity was prepared with endo access bur, all samples were placed in 5% sodium hypochlorite for 48 hours, after that all samples were washed in running water for 2 hours. After washing, all samples were transferred to 5% nitric acid, for decalcification, for 72 hours, with the acid being changed every 24 hours and stirred once every 8 hours. All samples were washed in running water and dehydrated using ascending grades (70%, 80%, 90% and 100%) of isopropyl alcohol for 2 days. Finally, they were rendered transparent by immersion in methyl salicylate for 15 minutes and then India ink dye was injected into the access cavity. The anatomy of the root canal was observed and classified based on the Vertucci's classification.

**Results:** In mandibular first premolar, type 1 was found in 50%, type 2 was 6%, type 3 was 6%, type 4 was 20%, type 5 was 10% and type 6 was 4% and type 7 was found in 4% of the sample. Whereas, in mandibular second premolar, type 1 was found in 70% out of all samples, type 4 was 6%, type 5 was 24%. Type 2, type 3, type 6, type 7 and type 8 were not found in this study.

**Conclusion:** Mandibular first premolar showed higher variation compared to mandibular second premolar.

**Keywords:** Root canal morphology, mandibular premolar, Clearing technique, Vertucci's classification

### Introduction

A thorough understanding of the root canal anatomy of the human dentition is a prerequisite for conventional endodontic procedures. A consistent, high level of success in endodontic treatment depends on root canal anatomy and morphology and that the entire root canal system must be debrided, disinfected and filled. [1] The mandibular premolars from endodontic perspective exhibits higher failure rates, which to a large extent can be attributed to the highly variable root canal morphology and the inability to access extra canals. [2] The wide range of studies conducted on root canal anatomy, from the early work of Hess and Zurcher [3] to more recent, demonstrating anatomic complexities of the root canal systems, have all emphasized on the fact that a root with tapering canal and a single foramen is an exception rather than a rule. Wein categorized the root canal system into four basic types [4]. Vertucci<sup>5</sup> found numerous complex canal systems and identified eight pulp canal configurations. All races and ethnic groups have some degree of dental anatomic variations. Asian populations present one of the widest variations in coronal shape, external root form and internal canal space morphology. Canal staining and tooth clearing is generally considered the gold standard in studying the root canal morphology [6]. The other different techniques to study the morphology of human permanent teeth are use of radiography, placing instrument in the canals to determine canal configuration, cutting the teeth in different levels, polyester resin cast replicas of the pulp space, and clearing and injection of dye. [7] A CT scan allows 3D reconstruction of root canal systems. [8]

Amongst all the teeth, mandibular premolars are quite difficult to treat, and has high flare up and failure rates, the major contributory factor is attributed to the Variations in root canal anatomy.<sup>[9, 10]</sup> Though a few studies on these teeth have been carried out in India, no study on the variations in root canal anatomy of Mandibular premolars has been carried out in the Kashmir, India, where the failure rate of endodontic treatment of these teeth is quite high.

### Materials and Methods

The present *in vitro* research study was conducted in the Department of Conservative dentistry and Endodontics, Government dental college and hospital Srinagar. A total of 100 extracted intact permanent mandibular premolars (50 each mandibular first premolar and mandibular second premolar) from patients belonging to Kashmiri population with following inclusion criteria:-

Teeth extracted for

(i) Orthodontic treatment, (ii) Periodontal diseases, (iii) Periapical diseases, (iv) Extreme mobility teeth with fully formed apices

The exclusion criteria were

(i) Grossly decayed or carious teeth, (ii) Fractured teeth (iii), Teeth with crazy shapes, (iv) Root canal treated teeth, (v) Teeth with full coverage restoration

All 100 teeth samples were cleaned of any attached soft tissue debris or calculus and stains by means of an ultrasonic scaler (Satelec, France). Teeth were then stored in 10% formalin until analysis. Access cavity was prepared using

Endo access bur (Dentsply) and the shape of the canal orifice was observed with the magnifying glass (2X zoom). After that all samples were placed in 5% sodium hypochlorite for 48 hours, all samples were washed in running water for 2 hours. After washing, all samples were transferred to 5% nitric acid for decalcification for 72 hours, and stirred once every 8 hours with the acid being changed every 24 hours. All samples were then washed in running water and dehydrated using ascending grades (70%, 80%, 90% and 100%) of isopropyl alcohol for 2 days. Finally, they were rendered transparent by immersion in methyl salicylate for 15 minutes and then India ink dye was injected into the access cavity. The anatomy of the root canal was observed with the naked eye and all the samples were classified based on the Vertucci's classification.

### Observations and Results

In this study, morphology of mandibular first and second premolars was determined by clearing technique based on Vertucci's classification.

In mandibular first premolar, 50% of samples show type 1 (Fig. 1), type 2 was 6%, type 3 was 6% (Fig. 2), type 4 was 20% (Fig. 3), type 5 was 10% and type 6 and type 7 are found in 8% and type 8 were not found in study (Graph 1).

In mandibular second premolar, 70% of samples show type 1 (Fig. 5), type 4 was 6% (Fig. 6), type 5 was 24% (Fig. 7). Type 2, type 3, type 6, type 7 and type 8 were not found in this study (Table 1). parametric Z-test of mandibular first and second premolars show the variation was high in mandibular first premolar (75%) than mandibular second premolar (37.5%) with a p-value of 0.103.

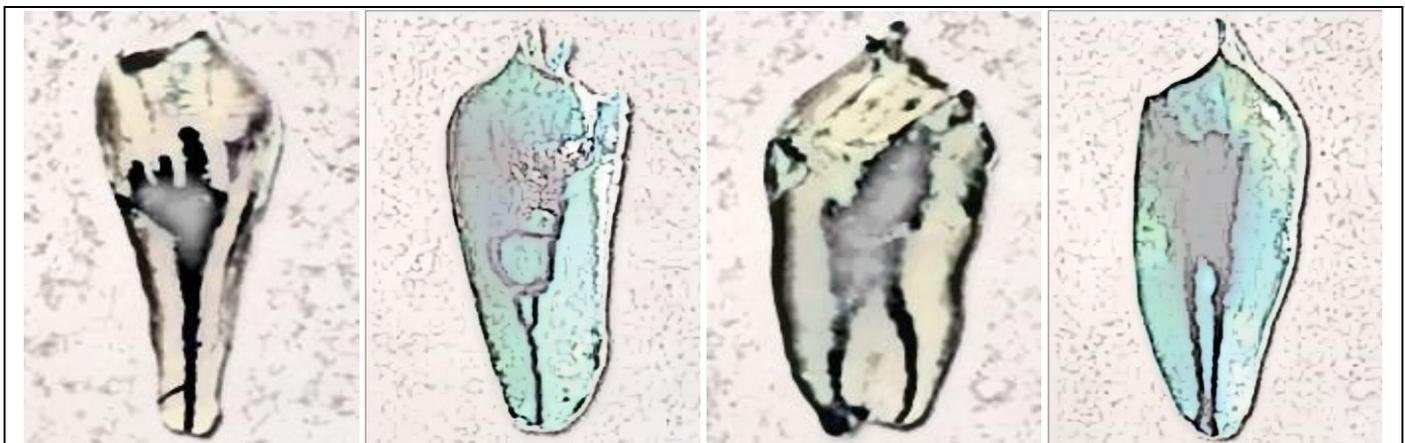


Fig 1: Type 1

Fig 2: Type 3

Fig 3: Type 4

Fig 4: Type 6

### Discussion

Most of the times the predominant causes of the failure of root canal treatment in mandibular premolars is due to the variations in root canal anatomy. In Kashmiri population the failure rate of mandibular premolars has been quite high with the variations in root canal anatomy being one of the attributable causes. Since no other previous study on the root canal morphology of these teeth had been conducted, this study was taken up. Although many studies on root canal anatomy have been carried out using macroscopic section<sup>[11]</sup>, radiography,<sup>[12]</sup> direct observation with microscope,<sup>[13]</sup> decalcification and clearing,<sup>[14, 15]</sup> 3D reconstruction,<sup>[16]</sup> computed tomography,<sup>[17, 18]</sup> decalcification and clearing technique has provided the most

detailed information along with being simple and inexpensive. In this study the average length of mandibular first premolar teeth was found to be 21.2 mm whereas Cohen & Hargreaves<sup>[19]</sup> and Velumurgan & Sandhya<sup>[18]</sup> reported the average length of the teeth as 21.6 mm. All the mandibular first premolar teeth examined in this study were found to have 2 cusps which is in keeping with the established external morphology of this tooth.<sup>[20, 21]</sup>

According to Vertucci's classification,<sup>[5]</sup> Root canal system of mandibular first premolars was found to be predominantly (67.39%) Type I (Single canal extends from pulp chamber to apex). Vertucci's reported Type I canal system in 70%, Velmurugan & Sandhya<sup>[11]</sup> in 72%, while Zillich & Dawson<sup>[22]</sup> reported an incidence ranging from

67.2% to 86.3%. Type II canal system (Two separate canals leave pulp chamber and join short of apex to form one canal) was found in 7.97% teeth whereas Vertucci<sup>[5]</sup> reported 0%, Velmurugan & Sandhya<sup>[1]</sup> 6% and Rahimi *et al.*<sup>[23]</sup> 5.6%. Type III Canal system (One canal leaves pulp chamber and divides into two canals in the root, and finally merge into one and exit) was found in 3.62% teeth which was similar to 4% in the findings of Vertucci<sup>4</sup> and 3% of Velmurugan & Sandhya.<sup>[1]</sup> Type IV canal system (Two separate canals extend from pulp chamber to apex) was found in 2.89% mandibular first premolars, Vertucci<sup>[5]</sup> reported this system in 1.5% teeth, Velmurugan & Sandhya<sup>1</sup> in 10% and Rahimi *et al.*<sup>[23]</sup> in 22%. Type V Canal system (One canal leaves pulp chamber, divides short of apex into two) was found in 17.39% teeth, Vertucci<sup>[5]</sup> found this system in 24% teeth while Velumurgan & Sandhya<sup>1</sup> reported an incidence of 8%. Type VI canal system (Two canals leave pulp chamber merge in the root and divide again short of apex to exit as two distinct canals) was found in 0.72% teeth. Types VII (One canal leaves pulp chamber, divides and then rejoin in root and finally divides into two canals short of the apex) and VIII (Three separate canals extend from pulp chamber to the apex) were not identified in any of the teeth.

The difference in the incidence of I, II, III, IV, V, canal system in the present study and those reported by Vertucci<sup>[5]</sup>, Velmurugan & Sandhya<sup>1</sup> and Rahimi *et al.*<sup>[23]</sup> could be attributed to racial difference since this study was carried out on a Kashmiri population whereas Vertucci<sup>4</sup> carried out study on Caucasian population, Rahimi *et al.*<sup>[23]</sup> in Iranian population and Velmurugan & Sandhya on South Indian population.<sup>[1]</sup>

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