International Journal of Medical and Health Research
ISSN: 2454-9142; Impact Factor: RJIF 5.54
Received: 22-11-2019; Accepted: 23-12-2019
www.medicalsciencejournal.com
Volume 6; Issue 1; January 2020; Page No. 100-102

Root canal morphology of mandibular first premolars in Rajouri district of Jammu & Kashmir: An *In-vitro* study

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Abstract
Aim: Mandibular first premolar shows frequent variations in root canal morphology which could influence the success of endodontic treatment. The aim of the present study was to assess the root canal morphological variations of mandibular first premolar teeth in Rajouri district population by decalcification and clearing technique.
Methodology: Two hundred extracted mandibular first premolar teeth were collected from Rajouri district population. Decalcification and clearing procedures performed and then the teeth were assessed for tooth length, number of cusps and roots, number and shape of canal orifices and root canal configuration.
Results: The mean length of mandibular first premolar teeth was found to be 20.8 mm. Majority of mandibular first premolar teeth were found to have single root followed by 2 roots. Root canal system of mandibular first premolars was found to be predominantly Type I followed by Type V.
Conclusion: Mandibular first premolar teeth were mostly found to have one root and Type I root canal configuration.

Keywords: Mandibular first premolar, Root canal configuration, *in-vitro*

Introduction
The root canal therapy is intended to thoroughly shape and clean the root canals and remove all pulp remnants and complete obturation with an inert filling material. The root canal system is varying for each tooth and possess multiple complex configurations where canals may branch, divide, and rejoin [1]. The most common reason for failure of endodontic treatment is the inadequate elimination of pulpal tissue and microorganisms from the root canal system. Therefore, it is utmost important that the clinician should have extensive knowledge of root canal configurations and morphology of each tooth and its possible variations to ensure successful endodontic treatment. 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 [2].
The mandibular first premolar is known to have most difficult and complicated anatomy. Mandibular first molar is challenging for endodontic treatment because of chances of which could be overlapped in preoperative radiograph or fine ribbon-shaped canal system.[3]The study conducted by University of Washington depicted higher failure rate of 11.4% for endodontic treatment of Mandibular first premolars [4]. Additional canals could be present if the mandibular first premolar is presented with radicular grooves on the proximal aspects of the root [5, 6].
Few investigation regarding varying anatomy of mandibular first premolar has been conducted in India but no study has been shown the variation in Rajouri district of Jammu & Kashmir (J&K), where the reports indicates higher failure rate of endodontic treatment with respect to mandibular first premolar. Therefore, the aim of the present study was to assess the anatomical variations of root canal morphology of mandibular first premolar in Rajouri district population of J&K by using decalcification and clearing technique.

Methodology
A total of 200 permanent extracted mandibular first premolars were collected from the dental sections of District and 5 Sub-district hospitals of Rajouri district. No age and sex criteria were applied while collecting the teeth.
Inclusion criteria was collection of intact teeth which was extracted because of 1) Orthodontic treatment, 2)Periodontal diseases, 3) Periapical diseases, 4)Extreme mobility. The exclusion criteria were 1) Grossly decayed teeth 2) Fractured teeth 3) Endodontically treated teeth 4) Teeth with extensive restoration.
Teeth were cleaned thoroughly using ultrasonic scaler and attached tissues and calculus was removed. These teeth were then preserved in 10% of formalin solution. Length of teeth was measured using Electronic Vernier Caliper (Mitutoyo digital calipers) from the tip of the crown to the apex of the root. For curved roots, tangents were drawn along the curved portion of the tooth and final length was measured by connecting the points of drawn tangent.
Oval shaped access cavities were prepared using round diamond point with high speed air Rotor handpiece (NSK Standard, NSK Company, Japan) with air-water spray. Shape of root canal and number of the orifices were recorded using an Operating Microscope (Seiler i Q 100-180, Seiler Precision Microscopes, St. Louis, U.S.A.) at 12Xmagnification. The prepared teeth were then placed in 5.2% of sodium hypochlorite solution for 24 hours. Decalcification of teeth was then done and was made transparent by the method reported by Robertson *et al.* [7] After placing the teeth in Sodium hypochlorite solution, they were washed with running water for 2 hours followed by

placing them in 5% of Nitric Acid solution for 72 hours. Nitric Acid solution was changed every 24 hours. Teeth were again washed with running water and placed in ascending percentage of Isopropyl alcohol i.e. 70%, 80%, 90% and 100% successively for 12 hours each, for a total duration of 48 hours for dehydration.

Teeth were then placed in Methyl Salicylate which made them transparent. Methylene Blue Dye was then injected into the decalcified and transparent teeth via the access opening until the dye exits through the apical foramen and the entire pulp space were colored. These prepared teeth were then observed under Dental Operating Microscope at 12X magnification and root canal systems were identified according to Vertucci's Classification [8].

Statistical analysis

Data were tabulated and examined using the Statistical Package for Social Sciences Version 20.0 (IBM SPSS Statistics for Mac, Armonk, NY: IBM Corp, USA). Descriptive statistical analysis had been carried out in the present study. Results on categorical measurements are presented as frequency distribution.

Results

A total of 200 mandibular first premolar samples were taken and assessed for root canal anatomy and morphological variations.

Tooth length: The mean length of tooth was found to be 20.8 mm with the longest tooth having 24mm and shortest tooth having 16mm.

Number of Roots: One eighty six teeth (93%) were found to have one root and two roots were found in 14 teeth had two roots [7%]. Mesial invagination of roots was found in 22 teeth (11%) (Table 1).

Canal Orifice: In the mandibular first premolar teeth one canal orifice was found in 174 teeth (87%) and two canal orifices were found in 26 teeth (13%).

The shape of the canal orifice was found to be round in 62 teeth (36%), oval in 126 teeth (63%) and flattened ribbon in 12 teeth (6%) (Table 2).

Canal Type: According to Vertucci's classification of canal types, Type I canal system was found in 121 teeth (60.5%), Type II in 6 teeth (3%,), Type III in 13 teeth (6.5%) and Type IV in 23 teeth (11.5%), Type V in 34 teeth (17%), Type VI in 2 tooth (1%) and Type VII in 1 tooth (0.05%) (Table 3).

Discussion

One of the common causes for failure of root canal treatment in mandibular first premolar relies on the anatomical variations in root canal system. In the Rajouri district, the failure rate was found to be on the higher side. As no previous study has been performed to examine the variation in anatomy of root canal in Rajouri district, the present study was conducted to assess the variation of root canal anatomy in mandibular first premolars.

Various methods have been used to assess root canal morphology of mandibular first premolars which includes radiographic examination [9], canal staining and clearing technique [10], cross sectioning of teeth [11], micro-computed tomography [6], and latest method cone beam CT [12]. The decalcification and clearing technique has provided the most detailed information with accuracy and also is a simple and inexpensive method used by majority of studies.

In the present study, the mean length of mandibular first premolar teeth was found to be 20.8 mm. The results were found to be comparable as presented Velumurgan & Sandhya [13] which stated the average length of the teeth to be 21.6 mm. The present study stated that majority of mandibular first premolar teeth were found to have single root followed by 2 roots. These results were found to be in accordance with the results presented by Zillich & Dawson [14] and Vertucci *et al*. [8] Mesial invagination of the root which is a consequence of invagination of Hertwig's epithelial root sheath was found to be present in 22 teeth which was consistent with the finding of Robinson *et al*. [15] who found invagination in 15% mandibular first premolars using spiral computed tomography.

According to Vertucci's classification, Root canal system of mandibular first premolars was found to be predominantly Type I (Single canal extends from pulp chamber to apex) followed by Type V (One canal leaves pulp chamber, divides short of apex into two), IV (Two separate canals extend from pulp chamber to apex),III (One canal leaves pulp chamber and divides into two canals in the root, and finally merge into one and exit),II (Two separate canals leave pulp chamber and join short of apex to form one canal),VI(Two canals leave pulp chamber merge in the root and divide again short of apex to exit as two distinct canals) and VII (One canal leaves pulp chamber, divides and then rejoin in root and finally divides into two canals short of the apex). Type VIII (Three separate canals extend from pulp chamber to the apex) was not found to be present in any of the sample. These findings were found to be comparable with the findings depicted by Velumurgan & Sandhya [13].

Table 1: Number of roots in mandibular first premolar samples (n=200)

Teeth	One rooted	Two rooted	Mesial invagination of root
Number	186	14	22
%	93	7	11

Table 2: Number and shape of orifice in mandibular first premolars (n=200).

Teeth	One orifice	Two orifice	Round orifice	Oval orifice	Flattened ribbon
Number	174	26	62	126	12
%	87	13	31	63	6

Table 3: Canal system type based on vertucci classification

Type of canal	Canal pattern	N	%
Type I	1	121	60.5
Type II	2-1	6	3
Type III	1-2-1	13	6.5
Type IV	2-2	23	11.5
Type V	1-2	34	17
Type VI	2-1-2	2	1
Type VII	1-2-1-2	1	0.05
Type VIII	3-3	0	0

Conclusion

Within the limitation of the present study, it can be concluded that mandibular first premolar teeth present a wide variety of root anatomy, with one root and one canal being found in majority of cases. The thorough knowledge and interpretation of varying anatomical features of mandibular first premolar could paves the way for successful endodontics in mandibular first premolar.

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