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Original Research

Evaluation of root canal morphology of mandibular first molars in Kashmiri population by clearing technique an in –vitro study

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ABSTRACT:
Aim of the current study was to evaluate the root canal anatomy of two- and three-rooted mandibular first molars in Kashmir population by clearing and staining technique. Two hundred mandibular first molars were collected. The most prevalent canal configuration in the mesial root was Vertucci type IV (38%),and in distal root type I (37%) An additional configuration, Gulabivala type (2-1-2-1), was found as a rare entity (1%) in mesial root.While preparing first molar the clinician must always look for a second canal in the distal root of Indian mandibular first molars.
Key words: Root canal anatomy, mandibular first molars.

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INTRODUCTION

The major objectives of root canal therapy are to perform adequate biomechanical preparation and to fill the entire root canal system three dimensionally. Inability to locate, prepare, or fill all root canals may lead to post treatment disease of treated teeth. [1,2] Therefore, clinicians shouldhave a thorough knowledge of the common root and root canal morphology and its possible variations to improve the predictability of root canal therapy.

A number of *in vivo* and *in vitro* techniques have been used Since the beginning of the 20th century, to study the external and internal anatomy of different teeth groups. The *in vivo* techniques include clinical evaluation during root canal treatment, retrospective evaluation of patients′ records, radiographic examination using conventional, and advanced radiographic techniques such as cone beam computed tomography (CBCT). The*in vitro* techniques include root sectioning, canal staining and tooth clearing, microscopic examination, and radiographic examination using conventional radiographs and three-dimensional techniques such as micro-computed tomography (m-CT). [3,4]

Diaphonization or clearing is an established technique to study the internal anatomy of human teeth. It allows for three-dimensional evaluation of the intricacies of the root canal system.[5-6]. Endodontic treatment is aimed at the removal of microorganisms and necrotic tissue from the root canal spaces. This requires thorough cleaning and shaping followed by three-dimensional obturation of the entire root canal system. A clinician can achieve proper disinfection only when he has appropriate knowledge about the canal morphology and the aberrancies associated with it. The study of root canal anatomy has anthropological significance.[8] It is well accepted that genetics influences the root canal morphology with some features being more common in certain races while absent in others. The root and canal anatomy of mandibular first molars has been extensively studied with wide variations reported among different populations.[9] This can be attributed not only to the racial divergence but also to the differences in study designs

Limited information is available regarding the canal morphology of mandibular first molars in Kashmiri population Hence, there was a need to study the peculiarities in the canal morphology of Kashmir mandibular molars. Thus, the aim of the current study was to evaluate the root canal anatomy of two- and three-rooted mandibular first molars in Kashmir population by clearing and staining technique.

MATERIALS AND METHODS

Two hundred mandibular first molars were collected from the Department of Oral and Maxillofacial Surgery of the Government Dental College and Hospital, Srinagar India. It was ensured that the teeth belonged to indigenous Kashmiris, and no teeth from other minority ethnicities were included. The age, gender, and cause of extraction were not recorded.

Access opening was done, and the pulp tissues removed by immersing in 5.25% sodium hypochlorite for 1 h. The teeth were rinsed under running water and allowed to dry for 24 h. A 30‑gauge endodontic irrigation needle was used to inject Indian ink (Sigma‑Aldrich, Mumbai, India) into the root canal system with the root apex attached to the central suction system. The injection and evacuation of the ink were repeated thrice at 1‑min interval until all the ink exited through apical foramina. The ink was allowed to dry for 4–5 h. Green inlay wax (GC Corporation, Tokyo, Japan) was used to seal the access cavity to prevent or minimize ink dissolutionduring decalcification. the specimens were first decalcified at room temperature in 5% nitric acid (Qualigens Fine Chemicals, Mumbai, India) that was changed daily for3-4 days. the acid was agitated thrice daily with glass rod, and the end point of decalcification was determined by periodic radiographs. After completion of decalcification, the specimens were washed under running tap water for 4 hours to remove traces of nitric acid. the specimens were dehydrated using ascending concentrations of ethyl alcohol (Zermo Fisher Scientific India Pvt Ltd., Mumbai, India) starting with 70% for 12 hours, followed by 90% for an hour and 3 rinses of 1 hour each for 100%. the dehydrated specimens then were placed in methyl salicylate (Rankem Fine Chemicals Ltd., New Delhi, India) which made them transparent after approximately 2 hours. cleared enough to obtain relevant information about their root canal morphology

the cleared teeth were evaluated with a stereomicroscope under 7.5x magnifications. the canal configurations were categorized using Vertucci's classification [7] as follows

Type I. A single canal extends from the pulp chamber to the apex.
Type II. Two separate canals leave the pulp chamber and join short of the apex to form one canal.
Type III. One canal leaves the pulp chamber, divides into two within the root, and then merges to exit as one canal.
Type IV. Two separate and distinct canals extend from the pulp chamber to the apex.
Type V. One canal leaves the pulp chamber and divides short of the apex into two separate and distinct canals with separate apical foramina.
Type VI. Two separate canals leave the pulp chamber, merge in the body of the root, and redivide short of the apex to exit as two distinct canals.
Type VII. One canal leaves the pulp chamber, divides and then rejoins within the body of the root, and finally redivides into two distinct canals short of the apex.
Type VIII. three separate and distinct canals extend from the pulp chamber to the apex.

RESULTS

Number of roots and root canals

The results of this study are summarized in (Tables 1, 2). Of the 200 mandibular first molars, 80% had two roots, and 5.3% had extra distal roots (distolingual root or radix entomolaris). In addition, 65% of the cases had three root canals (mesiobuccal, mesiolingual and distal), and 25% had four root canals (mesiobuccal, mesiolingual, distobuccal and distolingual) while rest had two (1%) and five (9%) canals.

Root canal configuration

Most of the mesial roots had two canals (80%) with type IV (50%) and type II (20%) being the most common configuration. Nearly half of the distal (37%) and all the distolingual (100%) roots had one canal. Type I (37%) followed by type II (21%) and type IV (12%) was the mostcommon configurations found in distal roots.

Lateral canals and intercanal communications

Lateral canals and intercanal communications were more common in mesial roots. In the mesial roots, intercanal communications were more common in cervical (13%) and middle thirds (11%). In the distal roots, cervical third (7%) had more intercanal communications compared to middle (3%) and apical thirds (5%). Lateral canals were more common in the apical third of mesial (8%) and distal roots (5%)

MANDIBULAR FIRST MOLAR; NUMBER OF ROOTS AND CANALS

Number of teeth	Number of roots			Number of canals per tooth		
200	2	3	2	3	4	5
	160	40	2	130	50	18
	80%	20%	1%	65%	25%	9%

Mandibular first molar: Root canal configuration, intercanal communications, and lateral canals

features	Mesial root	Distal root	Distolingual root
No. of roots Root canal configurations %	200	200	29
Type 1	2 1%	74 37%	29 100%
Type 11	40 20%	42 21%	
Type 111	16 8%	8 4%	
Type 4	76 38%	24 12%	
Type 5	3 1.5%	4 2%	
Type 6	16 8%	2 1%	
Type 7		1 .5%	
Type 8	30 15%	1 5%	
Type 2-3-2-1	2 1%	14 7%	
Type 3-1	1 .5%	6 3%	
Type 3-2	4 2%	8 4%	
Type 4-3-3-2	2 1%	16 8%	
Type 4-3-1	8 4%	-	

Intercanal communications			
%	26 13%	14 7%	
Cervical third	22 11%	6 3%	
Middle third	16 8%	10 5%	
Apical third			
Lateral canal %			
Cervical third	6 3%		
Middle third	14 7%	22 11%	
Apical third			

DISCUSSION

The root canal anatomy is a widely studied subject right from the 19th century. The first detailed and comprehensive description of the root canal anatomy was published in 1842 in the form of drawings of sectioned teeth.[10] Awide variety of techniques have been employed in understanding the canal morphology including radiographic examination,[12,13] sectioning of roots,[11,12] staining and clearing techniques,[13-7] computed tomography,[11] spiral computed tomography,[14] cone-beam computed tomography (CBCT),[15] and micro-computed tomography (micro-CT).[16] Although contemporary studies have reported an increaseduse of three-dimensional imaging systems such as CT, CBCT, and micro-CT,[11-16] canal staining and clearing has been the most commonly used technique evaluating the canal morphology.[9] These newer radiographic techniques help in proper visualizing the canal anatomy in an easy and noninvasive manner. Nevertheless, the staining technique has always stood the test of the times in providing valuable results.

In the present study,80% of the teeth were found to have two roots, and 20% had three roots [see table}In this study, it was found that 25% of mandibular first molars hadfour canals. These results are slightly similar to those of Hartwell and Bellizzi [18], who reported 35.1% of teeth and had four canals. This value is lower than the findings of several earlier authors [17, 18, 19, 20], but higher than that reported by Skidmore and Bjorndal [21], Zaatar et al. [22], Sperber and Moreau [23], Gulabivala et al. {24], and Reuben et al. [25]. Owing to the high percentage of two distal canals, classical triangular access preparation during root canal treatment should be extended towards the distolingual direction in a rectangular form to improve canal identification.

In mesial root, type IV configuration was most prevalent (38%) followed by type II (20%), type 111 and type VI (8%), and type V (1.5%) configuration. This is consistent with the findings of most of the earlier studies [21, 1, 24 , 18–6, 26, 23, 20], except the studies by Zaatar et al. [22] and Al-Nazhan [19] which reported type II being the most prevalent followed by type IV. In the present study, one mesial root showed an additional configuration type (2-3-2-1) as described by Gulabivala et al. [24] Identification, preparation, and obturation of type IV, type II, and type VI are relatively straightforward. However, identification of canals in type V, where the canal further divides within the root, is more difficult. The presence of Gulabivala's type (2-3-2-1) needs extra efforts, because failure to debride and disinfect this complex anatomy might have a direct effect on the treatment outcome. The most prevalent configuration in the distal root was type I (37%) followed by type II (21%), type IV (12%) , type III (4%)type V (2%), . However, type III and type V configurations in distal root need extra efforts to negotiateand prepare. One of the two canals, the one most continuous with the large main passage, is usually amenable to adequate enlarging and filling procedure, the preparation and filling of the other canal is often extremely difficult [1].In the three rooted molars, all distolingual roots possessed type I (100%) canal configuration

in the present study intercanal communications were most common in the cervical third in both mesial and distal roots 13% and 7% respectively followed by middle third and apical third in mesial root and apical third and middle third in distal root.The lateral canals were more common in apical third followed by middle third.

CONCLUSION

While preparing first molar the clinician must always look for a second canal in the distal root of Indian mandibular first molars. The most prevalent canal configuration in the mesial root was Vertucci type IV (38%),and in distal root type I (37%) An additional configuration, Gulabivala type (2-1-2-1), was found as a rare entity (1%) in mesial root. As isthmi and apical deltas were observed in high percentage in mesial and distal root, efficient delivery and activation of irrigants are more essential. Variations in the number of roots or canals and teeth with unusual root canal configurations have a definite impact on treatment. To achieve long-term success, clinician must use all the armamentaria at their disposal to locate and treat the entire root canal system

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