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Root Canal Morphology of Human Mandibular First Permanent Molars in an Iranian Population

Shahriar Shahi [1*] • Hamid Reza Yavari [2] • Saeed Rahimi [1] • Reza Torkamani [3]

1. Associate Professor, Department of Endodontics, Faculty of Dentistry, Tabriz University of Medical Sciences
2. Assistant Professor, Department of Endodontics, Faculty of Dentistry, Tabriz University of Medical Sciences
3. Dentist, Private Practice, Orumieh, Iran
** Corresponding author. E-mail: shahriar_shahi@yahoo.com*

Abstract

Background and aims. The knowledge of variations in root canal morphology is critical for a successful endodontic treatment. The purpose of this study was to investigate variations in the root canal system of human mandibular first permanent molars in an Iranian population.

Materials and methods. In this study, 209 mandibular first molar teeth were decalcified, dye-injected, and cleared in order to determine the number and configuration of the root canals.

Results. The results demonstrated that 65.56% of the mandibular first molars under study had three, 31.57% had four and 2.87% had two canals.

Conclusion. According to the results of this study and considering variations in the root canal systems of the mandibular first molars, it seems that great care should be taken in the root canal treatment of these teeth.

Key words: **Canal configuration, mandibular first molar, root canal system.**

Introduction

The aim of endodontic treatment is chemomechanical cleansing of the root canal and its hermetic obturation with an inert material. Ingle et al[1] have suggested that apical percolation is the main cause of endodontic failures. The main reason for this failure is incomplete canal obturation or the presence of an untreated canal. For successful endodontic therapy, the dentist should be aware of the variations in the root canal morphology.

To date, a number of studies have reported differences in root canal systems due to racial divergence.[2-5] A variation that has received particular attention is the three-rooted mandibular molar. Surveys of populations of Mongoloid origin indicate a high prevalence of three-rooted mandibular molars.[2] The frequency of this trait ranges from 6 to 44%.[3,6,7] The two-rooted mandibular first molars usually have three canals. Two root canals are located in the mesial root and one root canal in the distal root. Hess[8] reported that the prevalence of three root canals in mandibular permanent molar teeth was 78%. In 40-45% of two-rooted mandibular first permanent molars the mesial root has two root canals with one apical foramen.[9-11] Skidmore & Bjorndal[9] demonstrated the prevalence of two root canals in the distal root of mandibular first permanent molars to be almost 30% in an in vitro study. A clinical study on 251 root-canal-treated mandibular first permanent molars of a Saudi Arabian subpopulation revealed that 6% of the teeth had three roots, of which 58% had four root canals (two mesial and two distal) and 42% had three root canals (two mesial

and one distal).[4] Wasti et al[5] concluded that the prevalence of four root canals in two-rooted mandibular first permanent molars was 47%. Ahmed et al[12] reported that 59% of the mandibular first permanent molars of Sudanese had four root canals. Ghoddusi et al[13] reported a mandibular first molar with four distal canals in one case.

Since there are differences in selection of materials, methods, and classifications used, different opinions on root canal morphology have arisen.[9] The purpose of this in vitro study was to investigate variations in the root canal system of mandibular first permanent molar teeth in Tabriz, North-West of Iran.

Materials and Methods

In this descriptive study, two hundred and nine mandibular first molars were collected from a large supply of recently extracted teeth from clinics at Tabriz Faculty of Dentistry and private offices in Tarbiz, Iran. Teeth that demonstrated fully-formed roots and intact external morphology were selected for the study. The teeth were collected in a period of one year and were stored in 10% formalin. Each tooth was cleaned of any adherent soft tissues, bone fragments and calculus by scaling and polishing. An endodontic access cavity was then prepared in each tooth with diamond fissure burs (D&Z, Wisbaden, Germany). The pulp chamber was gently dried to allow examination of pulpal floor. The anatomic dark lines in the floor of the pulp chamber were examined with a DG16 endodontic explorer (Hu Freiday, Chicago, IL, USA) to identify the root canal orifices. After locating the orifices, the teeth were placed in 5.25% sodium hypochlorite solution (Golrang, Tehran, Iran) for 48 h to dissolve debris and pulp remnants. All the specimens were then thoroughly rinsed in running water for 4 h to clean root canals of any debris. Once washed, the teeth were demineralized for 3 days in 5% nitric acid (Merck, Darmstadt, Germany) at room temperature. The nitric acid solution was renewed every day. After demineralization, the teeth were rinsed in running water for 4 h. India ink (AB Chemi, Glasco, England) was injected into the root canals before dehydration of the teeth. The dehydration process consisted of a series of ethyl alcohol (Ararat, Tehran, Iran) rinses starting with 80% solution over night, followed by 90% for 1 h and then 100% ethyl alcohol rinse for one hour. The dehydrated teeth were placed in methyl salicylate (BP.63, Poland) for 2 h to render them transparent.[5] The cleared teeth were examined using a magnifying glass (Lumagny, no. 7540, Hong Kong) at ×5 magnification. The root canal configuration was assessed and recorded according to the classification of Vertucci[14] (1984) as follows:

- Type I: A single root canal extending from the pulp chamber to the apex.
- Type II: Separate root canals leaving the pulp chamber and joining short of the apex to form one canal.
- Type III: One root canal leaving the pulp chamber before dividing into two canals within the root and then merging to exit as one single canal.
- Type IV: Two separate root canals extending from the pulp chamber to the apex.
- Type V: One root canal leaving the pulp chamber and dividing short of the apex into two separate and distinct root canals with separate apical foramina.
- Type VI: Two separate root canals leaving the pulp chamber, merging in the body of the root, and again dividing short of the root apex to exit as two separate and distinct canals.
- Type VII: One root canal leaving the pulp chamber, dividing and rejoining within the body of the root canal and finally re-dividing into two distinct canals short of the apex.
- Type VIII: Three separate and distinct root canals extending from the pulp chamber to the apex.

Results

Out of 209 mandibular first permanent molars studied, 206 teeth (98.56%) were two-rooted and 3 teeth (1.44%) had three roots. Out of 209 teeth studied, 137 teeth (65.56%) had three canals, 66 teeth (31.57%) had four and 6 teeth (2.87%) had two canals.

Table 1. Distribution of the root canal number and configuration in the 209 mandibular first permanent molars studied

	Number of root canals			Root canal configuration (Vertucci [14])							
	1	2	3	I	II	III	IV	V	VI	VII	VIII
Mesial roots	2.86%	96.19%	0.95%	2.87%	40.67%	0.48%	52.15%	3.83%	0%	0%	0%
Distal roots	65.57%	34.43%	0%	68.42%	11.96%	1.91%	17.22%	0.49%	0%	0%	0%

Type I configuration was seen in all mesial roots with a single canal. Out of 206 two-rooted mandibular first molars, mesial roots with two canals were of type II (41.87%), type III (0.49%), type IV (53.69%) or type V (3.94%) canal configuration. Out of 209 mandibular first permanent molars studied, distal roots were of type I (68.42%), type II (11.96%), type III (1.99%), type IV (17.22%) or type V (0.48%) canal configurations. Accessory canals were seen in 34.78% of the mesial roots and 26.14% of the distal roots. The distribution of root canal number and configuration in mesial and distal roots is presented in Table 1.

Discussion

In the present study, root canal configuration of mandibular first permanent molars was studied in an Iranian subpopulation in Tabriz. Root clearing and canal staining method has been found to be an excellent approach for three-dimensional evaluation of root canal morphology. It was anticipated that examination of the fine details including intercanal communications and lateral canals would require adequate ink penetration. It was, however, found that the quality of clearing was sufficient to visualize such details. The clearing technique used in this study provided a three-dimensional view of the root canals.

The prevalence of three roots in mandibular first permanent molars was 1.44% in the present study. This was reported 2.02% in Vertucci's study,[14] which is comparable to our results. However, Gulabivala et al[15] reported the prevalence of three-rooted mandibular first molars to be 13% in a Thai population. This difference could be attributed to the racial/ethnic differences among the populations under study.

There was no incidence of type VI, VII, or VIII canal configuration in the distal and mesial roots in the studied population. Wasti et al[5] found type VI configuration in mandibular first molars to be 6% in mesial and 3.3% in distal roots in South Asian Pakistanis. This also could be related to the racial/ethnic differences between the two populations. On the other hand, the results of the present study are consistent with the results of Skidmore & Bjorndal,[9] Pineda & Kuttler[10] and Vertucci.[14] This agreement was especially seen in type IV canal configuration.

In the present study, the prevalence of two root canals in the distal root was found to be relatively high. Three canals in mesial roots were observed in 0.95% of cases. In addition, three canals with separate foramina were not seen in any of the teeth studied.

It seems that race and ethnicity are important factors in differences observed in root canal configuration between the current study and the studies of Wasti et al[5] and Gulabivala et al.[15] Sert & Bayirli[16] also concluded that both gender and ethnic origin should be considered during preoperative evaluation of root canal therapy. Therefore, further studies are warranted in different parts of the world to prove that there is a relationship between the racial/ethnic differences and the anatomic differences in the mandibular first permanent molars.

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