

Root Canal Configuration of One-rooted Mandibular Canine in an Iranian Population: An In Vitro Study

Pejman Bakianian Vaziri¹ • Shahin Kasraee² • Hamid Reza Abdolsamadi¹ • Shermin
Abdollahzadeh¹ • Farzad Esmaeili³ • Shahrzad Nazari⁴ • Mohammad Vahedi^{1*}

1. Assistant Professor, Department of Oral Medicine, Faculty of Dentistry, Hamadan University of Medical Sciences, Iran

2. Assistant Professor, Department of Operative Dentistry, Faculty of Dentistry, Hamadan University of Medical Sciences, Iran

3. Assistant Professor, Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Tabriz University of Medical Sciences, Iran

4. Assistant Professor, Department of Endodontics, Faculty of Dentistry, Hamadan University of Medical Sciences, Iran

*Corresponding author: vahedi_md@umsha.ac.ir

Abstract

Background and aims. A perfect endodontic treatment necessitates proper understanding of the morphology of canal and pulpal variations. This in vitro study was conducted to demonstrate the internal anatomy of mandibular canine teeth in an Iranian population.

Materials and methods. The samples consisted of 100 extracted mandibular permanent canines. The roots of the teeth were molded in acrylic boxes. The crowns of the teeth were cut and 2 mm cross sections were made from CEJ to the apex. Sections were examined using stereomicroscope to reveal the number and location of root canals.

Results. From 100 evaluated teeth, 12 (12%) had 2 canals from which 5 had type II canal configuration and 7 (7%) had type III. 88% of the specimens had one canal and none were seen to be of type IV.

Conclusion. The findings of this study emphasize the importance of dentist's knowledge of variations in root canal morphology, since leaving a canal untreated is one of the main reasons of endodontic failures. When treating mandibular canines, the existence of a second canal should be taken into consideration.

Key words: Mandibular canine, root canal configuration, root canal therapy.

Introduction

The main purpose of endodontic therapy is a thorough mechanical and chemical cleansing of the entire pulp cavity and complete obturation with an inert filling material.¹ A clear knowledge of the anatomy of root canal systems is an essential prerequisite to carrying out root canal preparation. Many of the problems encountered during root canal treatment occur be-

cause of inadequate understanding of the pulp space anatomy.²

Ingle et al³ have suggested that apical perforation is the main cause of endodontic failures. The main reasons for this failure are incomplete obturation or the presence of an untreated canal. A canal is often left untreated because the dentist fails to recognize its presence. Thus, dentists must have a proper knowledge of root canal morphol-

ogy and the variations of the root canal system before successfully treating a tooth.^{1,4} It is important to be familiar with variations in tooth anatomy and characteristic features among racial groups, as such knowledge can aid in locating, negotiation and management of canals.⁵

A number of studies have shown different trends in the shape and number of roots and root canals among different races.⁴⁻⁸ These variations appear to be genetically determined,^{5,7} and are important in tracing the racial origins of populations.⁵ Many investigations have examined the configurations of the root canal systems of human teeth. These have included various methods such as the use of polyester resin impressions, creating transparent samples and the use of radiographs in both in vivo and in vitro studies.^{1,4-8} Since there are differences in selection of materials and methods used as well as classification of canal configurations, different opinions have arisen about canal morphology.¹

The purpose of this study was to evaluate root canal morphology and the prevalence of second root canal in mandibular permanent canines within an Iranian subpopulation.

Materials and Methods

In this descriptive in vitro study, 100 extracted mandibular permanent canines were evaluated. These teeth were collected from different dental clinics in Tehran, Iran. The age and gender of the patients and the reasons for the extraction were not recorded.

Teeth were immediately placed in 5.25% sodium hypochlorite for 30 minutes after extraction to be disinfected and to remove any organic tissue on the external root surfaces. Then, the teeth were washed under running water for 2 hours. The absence of

any obliterated canals in the samples was verified by preoperative radiographs. A box was made for each tooth using rose wax so that it covered from the CEJ to the apex and there was at least 1 mm space between the root surface and the walls of the box. Holding the tooth crown, the box was placed on a vibrator and fast-setting clear acrylic resin with relatively low viscosity was poured to fill it. Once resin was set, the boxes were immersed in boiling water for 5 minutes and then rinsed under running cold water for 10 minutes. Thus, wax was removed and the teeth were surrounded in acrylic boxes from the CEJ to the apex. No endodontic instrument was used to explore the canals. The crowns of the teeth were cut and 2 mm cross sections were made from CEJ to the apex using diamond disks (D&Z, Diamant, Germany). Depending on the tooth's length 3 to 6 sections were made. The sections were examined using a digital stereomicroscope (Olympus, Tokyo, Japan) at $\times 40$ magnification. The existence of a second canal, canal type and the position of apical foramen according to Vertucci¹ were recorded. In a blind manner, two observers examined the samples separately. The samples were re-evaluated if there were any discrepancies and finally the results were recorded in common accord.

Results

In the present study, 100 mandibular permanent canines were evaluated. The data relating to the existence of a second canal and canal type according to Vertucci's classification¹ are presented in Table 1.

From 100 teeth evaluated, 12 (12%) had 2 canals from which 5 canals were of type II (having 2 orifices, 2 separate canals and one apex) and 7 were of type III (having one orifice, 2 separate canals and one apex).

Table 1. The root canal configuration of mandibular canines in the studied population

Mandibular canine	No. of canals		Type of root canals ¹				
	I	II	I	II	III	IV	V
Percentage	88	12	88	5	7	0	0

Table 2. Distribution of the second root canal in the mandibular canine in different studies

Study	Year	Sample size	Method	Percentage of second canal
Pineda & Kuttler ¹⁴	1972	187	Radiography	18.5
Green ¹¹	1973	100	Vertical section	13
Vertucci ¹	1974	100	Clearing & staining	22
Hession ¹⁰	1977	9	Transfusion of contrast medium (CM) & radiography	11
Bellizzi & Hartwell ⁹	1982	195	Radiography preceded by RCT	4.1
Kaffe et al ¹²	1985	400	Radiography (in vivo)	13.75
Calışkan et al ⁴	1995	100	Clearing & ctaining	19.5
Sert et al ⁵	2004	200	Clearing & staining	24
Present study	2006	100	Transversal section & stereomicroscope	12

Among the teeth with type III canal, 4 samples had a bean-shaped orifice dividing into two canals which were separated with a thin wall and joined near the apex. 2 samples (type III) had one orifice in the pulp chamber which was separated into two canals 1 mm further and joined in 4 mm from the apex (Table 2). The last tooth with type III canal had an oval orifice which changed to a sand watch appearance in sections #2 and #3 where two canals were separated by a thin dentinal isthmus. In section #4, it had a bean-shaped appearance and 2 canals united in 4 mm from the apex. Among the five teeth with type II canals, three samples had 2 canals with 2 orifices in buccal and lingual which united in 2 mm from the apex. The other two teeth had an orifice with sand watch appearance and 2 canals separated with a thin wall and united near the apex.

No lateral canal was found in the specimens and all had one apical foramen. In six teeth, the apical foramina were not located at anatomical apex. In 4 of the latter, it was located buccally and in 2 of them lingually. Except these cases, the other specimens had one canal which was straight with no curves.

Discussion

In the present study, performed on 100 extracted mandibular canines in an Iranian

subpopulation, the existence of the second canal was 12%. This is in agreement with the results of Hession¹⁰ (11%), Green¹¹ (13%) and Kaffe et al¹² (13.75%). It is, however, higher than the results of Bellizzi & Hartwell⁹ (4.11%) and Ingle et al³ (6%) while it is lower than the results of Vertucci¹ (22%), Calışkan et al⁴ (19.5%) and Sert et al⁵ (24%). In Vertucci's¹ study, 22% of the evaluated mandibular canines had 2 canals, of which 14% were type II, 2% type III and 6% type IV. In the present study, 5% were type II, 7% type III, and none were of type IV (0%). The percentage of a second canal was reported to be 24% in the study of Sert et al.⁵ This is two times the amount found in our study. The existence of types II, III and IV in the latter study was estimated 16%, 6.5% and 1.5%, respectively. Except for type III, the prevalence of other canal types was different from the present study. One-canal mandibular canines (type I) was estimated 88% in the present study which is higher than 78%, 80.5% and 76% reported in the similar studies.^{1,4,5} In Calışkan et al's⁴ study, 4% of mandibular canines were type II which is similar to the present study. They, however, reported 1.96% type IV canal configuration which was not seen in our study. Comparison of the present study with similar previous studies according to the samples size, methods and results is presented in Table 2.

Lambrianidis et al¹³ stated that differences between the results of morphological studies may be due to the differences in method of classification system, sample size and ethnic background of evaluated teeth. In the present study, sample size was chosen similar to previous studies for more precise evaluation.^{1,4,5} Considering the low prevalence of the studied subject, higher sample size would result in more accurate findings and can be generalized.

In a number of studies, clearing technique with demineralization and staining has been used.^{1,4,5} Others have used only radiography.^{12,14} Hession¹⁰ used radiography following infusion of an opaque material to the studied root canals. In the present study transversal sections were made and then evaluated using a stereomicroscope at high magnification. Different methods may be a reason for difference in the results of the studies. In almost all of the mentioned studies,^{1,4,6} the classification of Vertucci was used; however in certain cases it was accompanied with other classifications. We also used Vertucci's classification.

In the present study, none of the mandibular canines had lateral canal (0%) while the prevalence was reported to be 30%, 33.33%, and 29% in other studies.^{1,4,5} One of the most important causes of this controversy seems to be the different techniques used in the studies. The staining technique used in the mentioned studies increases the possibility of finding lateral canals compared to evaluating sections made without staining as we did in our study.

In 6% of cases of the present study, apical foramina were not located in anatomical apices (4 buccally and 2 lingually). In the remaining cases, apical foramina were located in anatomical apices; however, their lateral or central position could not be

evaluated due to the used technique. In Vertucci's study¹ apical foramina were located centrally in 15% of the cases and laterally in 85%. Sert et al⁵ reported 47.5% of apical foramina in anatomical apices and 52.5% out of it. Another important cause of differences in results of these studies is the race of populations under study. Genetic model is varied among populations and also affects tooth structure.^{7,8,13,15} Various studies have been carried out in different parts of the world on different races and used different methods.^{1,4-8,10,13,15} For this purpose, the present study was performed to estimate the existence of the second canal in mandibular canines in an Iranian population.

The researchers' judgment in exploring the second canal can play a major role in the achieved results. This bias can occur in studies using only radiography where one may interpret a radiolucent area as a second canal while others may not have the same judgment. Lambrianidis et al¹³ also stated that varied results can be due to the differences in genetic model and race in the studied population, sample size, techniques, classification systems and the researchers' judgment and diagnosis.

Conclusion

The results of the present study revealed that 12% of mandibular canines had two canals of which 5% were type II and 7% were type III. These findings emphasize the importance of dentist's knowledge of variations in root canal morphology, since leaving a canal untreated is one of the main reasons of endodontic failures. When treating mandibular canines, the existence of a second canal should be taken into consideration.

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