

Study of Internal Morphology of Root-Canal Treated Single-Rooted Mandibular Second Molars in a Greek Population

SUMMARY

Background/Aim: To determine the prevalence of single-rooted mandibular second molars in a Greek population and examine their internal morphology with the aid of intraoral periapical radiography. **Material and Methods:** Clinical records of 531 root-canal treated permanent single-rooted mandibular second molars were collected from the Postgraduate Clinic of the Department of Endodontology, Dental School, Aristotle University of Thessaloniki, Greece and from private dental clinics in the same city. The clinical records, along with the radiographic examination, were evaluated to determine the overall frequency of single-rooted mandibular second molars together with the number of root canals and their course. The root canals were categorized using Vertucci's classification with the addition of 3 further types where appropriate. **Results:** Out of 531 mandibular second molars; 102 (19.2%) presented a single root; 427 (80.4%) presented two roots; 2 (0.4%) presented three roots. In a total of 102 single-rooted mandibular second molars 31 (30.3%) presented with Type I, 18 (17.6%) with Type II, 14 (13.7%) with Type IV, 7 (7%) with 3 additional root canal types and 32 (31.4%) with a C-shaped root canal system. **Conclusions:** One out five mandibular second molars was single-rooted in a Greek population. The internal morphology of these teeth can be very complex with regard to the numbers and courses of root canals.

Key Words: Greek Population, Internal Morphology, Single-Rooted Mandibular Second Molar

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Introduction

Knowing the morphology of the root canal system and its possible permutations are important determinants for the success rate of endodontic treatment¹. A wide variety of possibilities exists concerning the number of roots and the forms of root canals in any given tooth group.

Second mandibular molars present with varying anatomic features regarding the number of roots and the prevalence of different root canal configurations in each root. The most frequent morphology of these teeth is the two-rooted type, resembling the morphology of the first mandibular molar, with an incidence of 57.4%- 95.7%^{2,3} with the three- and four-rooted variants being considered

rare according to the literature: ranging from 0.4%- 9.0%^{3,4} and 0.2% - 0.9%^{3,5} respectively. Single-rooted mandibular second molars show a remarkably wide range of incidence, varying from 1.3% to 41.2%^{2,5} (Table 1).

Although a large number of studies have investigated the morphology of second mandibular molars, there is little information in the literature concerning the internal morphology of single-rooted second mandibular molars. A very limited number of studies in the extant literature have investigated the possible root canal configurations of single-rooted mandibular second molars^{2,4-8}.

The aim of the present paper was to determine the prevalence of single-rooted mandibular second molars in a Greek population and to examine the number and course of their root canals.

Table 1. Number of Roots in Mandibular Second Molars in Different Populations.

Author (year)	Population	Sample Size	1 Root (%)	2 Roots (%)	3 Roots (%)	4 Roots (%)
Gulabivala et al 2001 ⁶	Burmese	134	26.9	73.1	-	-
Gulabivala et al 2002 ⁷	Thai	60	10.0	90.0	-	-
Ahmed et al 2007 ⁹	Sudanese	100	14.0	86.0	-	-
Peiris et al 2007 ¹⁰	Sri Lankan	100	6.0	94.0	-	-
Rahimi et al 2008 ¹¹	Iran	139	9.3	86.3	4.3	-
Al-Qudah & Awawdeh 2009 ⁸	Jordanian	355	12.7	87.4	-	-
Neelakantan et al 2010 ⁴	India	345	7.5	83.4	9.0	-
Zhang et al 2011 ¹²	Chinese	157	22.3	76.5	1.2	-
Demirbuga et al 2013 ⁵	Turkish	925	1.3	94.4	3.5	0.9
Silva et al 2013 ¹³	Brazilian	226	9.5	87.0	3.5	-
Nur et al 2014 ¹⁴	Turkish	1165	10.0	90.0	-	-
Torres et al 2015 ¹⁵	Chilean	112	8.9	86.6	3.6	0.9
Torres et al 2015 ¹⁵	Belgian	112	14.3	83.9	0.9	0.9
Celikten et al 2016 ³	Turkish Cypriot	421	3.5	95.7	0.4	0.2
Kim et al 2016 ²	Korean	1920	41.2	57.4	0.7	-
Akhlagi et al 2016 ¹⁶	Iran	150	13.3	86.7	-	-

Material and Methods

A total of 531 cases of root-canal treated mandibular second molars were collected. Of these cases, 182 originated from the Postgraduate Clinic of the Department of Endodontology, Dental School, Aristotle University of Thessaloniki, Greece over the period 2011-2016, and 349 from private dental clinics in the same city. The patients were adult men and women of Greek nationality.

The patients' case histories (clinical examination and intraoral periapical radiographs) were reviewed by the first three authors in order to record the prevalence of single-rooted mandibular second molars. The different root canal configurations of these teeth were categorized according to the Vertucci's classification¹⁷ together with additional classes.

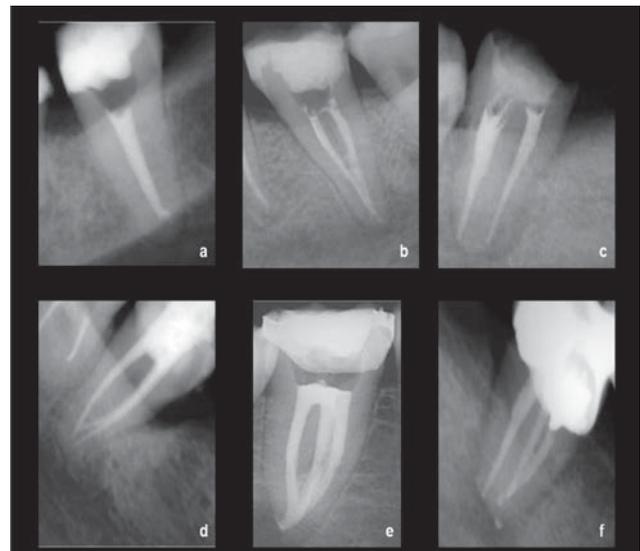


Figure 1. Representative radiographs of the different canal configurations of root-canal treated mandibular second molars. Types: I (a), II (b), IV (c), 2-3 (d), 3-1 (e) and 3-2 (f).

Results

On a total of 531 mandibular second molars:

- 102 (19.2%) presented a single root;
- 427 (80.4%) presented two roots;
- 2 (0.4%) presented three roots;

Table 2. Different Root Canal Configurations in Single-Rooted Mandibular Molars Recorded in the Present Study.

Total	Root Canal Type (%)						C-Shaped
	Vertucci's Classification			Additional Types			
	I (1-1)	II (2-1)	IV (2-2)	(2-3)	(3-1)	(3-2)	
102 (100%)	31 (30.3%)	18 (17.6%)	14 (13.7%)	3 (3.0%)	1 (1.0%)	3 (3.0%)	32 (31.4%)

Within a total of 102 single-rooted mandibular second molars, the following variations in the root canal number and course were recorded (Table 2):

- 31 samples presented a single canal from the pulp chamber to the apex (Figure 1a);
- 18 samples presented with two separate canals leaving the pulp chamber but joining to form one canal by the apex (Figure 1b);
- 14 samples presented two separate canals from the pulp chamber to the apex (Figure 1c);
- 3 samples with two separate canals from the pulp chamber, one of which bifurcated, resulting in three canals at the apex (Figure 1d);

- 1 tooth presented with three separate canals from the pulp chamber, which, however, joined to form one to the apex (Figure 1e);
- 3 samples presented with three separate canals from the pulp chamber, two of which joined to form two canals at the apex (Figure 1f);
- 32 samples presented a C-shaped canal system (Figure 2a, b).

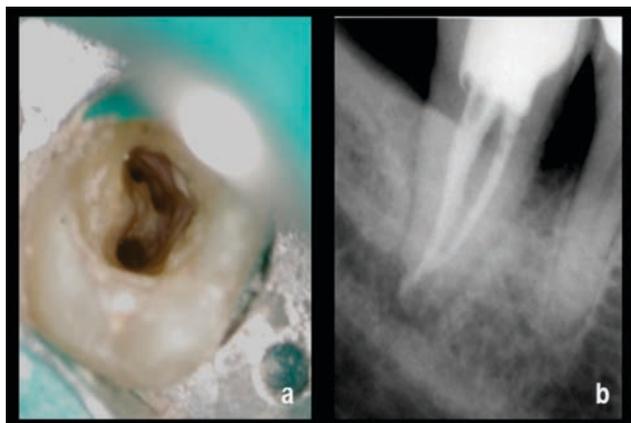


Figure 2. C-shaped mandibular second molar. Photo of the pulp chamber floor (a), postoperative radiograph (b).

Discussion

The study of the information available in the literature about single-rooted mandibular molars leads to two basic observations. The first is that comparing the findings of different studies (Table 1), the range of the reported prevalence for these teeth is notably wide, with a minimum of 1.3% and a maximum of 41.2%. This could be attributed to the different methods of study, size of the sample and nationalities. This varying prevalence between different nationalities tends to increase in Chinese, Burmese and Korean populations^{2,6,12}. Comparing studies in the literature to the findings of the present paper, the prevalence of single-rooted mandibular molars in a Greek population is slightly higher than the mean value of the studies in the literature (13.2%).

The second observation concerns the internal morphology of single-rooted mandibular second molars. Some studies focus on the internal anatomy of two-rooted mandibular second molars, presenting possible canal configurations of the mesial and distal roots without providing sufficient information about the number and course of the root canals of the single-rooted variant^{9,10,15}. Other studies record the number of root canals in the root system without supplying any information about their relationship^{11–13}. The findings of the present study are comparable to the few studies that have investigated the internal anatomy of single-rooted mandibular second molars in detail. Four of these studies are ex-vivo and

use the clearing technique to investigate the root and root canal morphology^{4,6–8}, whereas two are in-vivo cone-beam computed tomography (CBCT) studies, which analyzed a significantly larger sample^{2,5}.

In the present study, the Vertucci root canal classification was selected for the categorization of the teeth. This stipulates eight basic types and is the most widely used categorization system for the description of possible canal configurations. In our study, Type I followed by types II and IV exhibited the greatest prevalence. In the aforementioned studies the most prevailing types were I and IV. Three additional types, not specified in the Vertucci system were also recorded in 7 teeth, which were also identified in four of the previous studies^{4,6–8}. Moreover, Types III, V, VI, VII, VIII, 3-4, 4-2 and 5-4 are further variations which have also been recorded in the literature^{2,4,6–8}, underlining the complexity of the possible root canal variants in single-rooted second mandibular molars.

C-shaped roots and root canals are anatomical variations found mostly in mandibular second molars. This term is used to describe the presence of a fin or web between root canals which results in a C-shaped canal cross-section¹⁸. In the present study, the presence of a C-shaped root was also confirmed from the case history recordings and the clinical diagnosis, since the radiographic appearance of such teeth may be confusing. For this reason, C-shaped teeth were not categorized in terms of root canal types, as in the majority of the cases the type of C-shaped root canals changes from the cervical to the apical third¹⁹. A limitation of this study is that the different cross-sectional root canal configurations cannot be visualized from radiographs, but could have been recorded with the CBCT technique.

C-shaped root canals are known to be common in Asians, but relatively rare amongst Europeans and Americans²⁰. Specifically, a recent study evaluated the prevalence of a C-shaped anatomy in different geographic regions of the world, finding the highest prevalence in China (44%) and the lowest in Brazil (6.8%)²¹. The present paper reported 32 C-shaped teeth out of 102 single-rooted mandibular second molars, which corresponds to 6% of the whole sample of mandibular second molars. This finding is compatible with another, earlier study conducted under the auspices of the Aristotle University Dental School in a Greek population, which assessed 480 clinical records of root-canal treated mandibular second molars and found a prevalence of 5% regarding C-shaped canals in mandibular second molars²².

In summary, the findings of the present paper underline the variations in root canal morphology of single-rooted mandibular second molars. The reported data may help clinicians consider the possibility of encountering anatomical alterations in such teeth, in order to enhance the success rate of endodontic treatments.

Conclusions

One out five mandibular second molars was single-rooted in a Greek population. The internal morphology of these teeth can be very complex with regard to the numbers and courses of root canals.

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