

Root Canal Morphology of Permanent Mandibular Second Molar in a South Indian Population using Computed Tomography

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ABSTRACT

Aim: To examine the root canal morphology of mandibular second molars in a South Indian population, using spiral computed tomography (CT).

Materials and methods: One hundred ten extracted mandibular second molars were scanned by spiral CT scanner and analyzed for number of roots, number of root canals per root and root canal configuration in each root.

Results: The total of 91.91% of the molars had two roots and 4.55% were three rooted. Single roots were also found (5.45%) and occurrence of four roots was rare (0.91%). Three root canals were found in 62.73% of the teeth, followed by two canals in 20.02%. C-shaped canals were seen in 4.55% of teeth.

Conclusion: In the teeth examined, there was a predominance of two roots and three canals. Type IV canal configuration was common in mesial roots and Type I in distal roots. Three roots and C-shaped canals were also recorded.

Keywords: C-shaped canal, Mandibular second molar, Spiral computed tomography, Vertucci's classification.

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INTRODUCTION

Successful root canal treatment depends on adequate debridement and filling of the entire root canal system. But the relative simplicity and uniformity of the external surfaces of roots often masks their internal complexity. The anatomic configuration of roots and canals of

mandibular first and second molars is diverse.¹⁻⁵ To date, a number of studies have reported that root canal systems vary according to race.^{6,7} From the consistency of certain anatomical features in tooth type as well as different races, it is apparent that such features are genetically determined.^{8,9} It is clear that knowledge of canal numbers and divisions may contribute to the predictability of overall treatment.¹⁰ It is, therefore, considered important to be familiar with variations in tooth/canal anatomy and characteristic features in various racial groups.² Such knowledge can aid in location and negotiation of canals as well as their subsequent management.

Many investigations have examined the configurations of root canal system using techniques, such as radiographs, decalcification, sectioning, replication and computer-aided techniques.¹¹⁻¹⁴ Sectioning and decalcification, being destructive techniques, result in loss of vital information during the process. Further, several clinical studies have highlighted the role of computed tomography (CT) as an objective analytical tool to ascertain root canal morphology during root canal treatment.^{15,16} The use of CT can provide additional and beneficial information not available from periapical and panoramic radiographs. Hence, the aim of this study was to examine the root canal morphology of mandibular second molar teeth in a South Indian population, using spiral CT.

MATERIALS AND METHODS

One hundred and ten extracted mandibular second molar teeth were collected from oral Surgery Department of a Dental College in Coimbatore. Teeth were immediately washed after extraction and stored in 10% formalin until collection was completed. All attached soft-tissue and calculus were removed using an ultrasonic scaler. Teeth were soaked in 2.5% sodium hypochlorite solution overnight before placement in an ultrasonic bath; then rinsed thoroughly under running tap water for and dried overnight.

The teeth were randomly mounted onto the wax sheet and were scanned by a spiral CT scanner-axial view (1 mm slice). Observations were made on the following aspects; (i) The number of roots and root canals (ii) The number of root canals per root (defined as the highest number of

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canals visualized), (iii) Root canal configuration in each root using *Vertucci* classification with additional classes according to the number of orifices, canals and apical foramina.^{1,3} The images were analyzed, all parameters assessed and results were tabulated.

RESULTS

Number of Roots and Root Canals

The data for number of roots and root canals are given in Table 1. The majority (91.91%) of 110 mandibular second molars had two roots. Three-rooted teeth were confined to 4.55% of the teeth. Single roots were also found (5.45%). Occurrence of four roots was rare (0.91%). Three root canal system (62.73%) was found in majority of the mandibular second molars, followed by two canals in 20.02%. A total of 4.55% of teeth had C-shaped canals.

Number of Root Canals in Individual Roots

The data for number of root canals in the individual roots are given in Table 2. The majority (77.36%) of mesial roots of the mandibular second molars had two root canals; whereas a majority (85.85%) of distal roots had a single canal. Single canals in mesial roots were seen only in 24.53% and two canals in distal root were seen only in 16.04% of the teeth.

Root Canal Configuration

The data for the type of canal system are given in Table 3. The root canal configurations of mandibular second molars were considered based on *Vertucci's* classification. Most of the mesial roots of mandibular second molars had two canals (74.62%) and demonstrated a wide variation of canal configurations. The most common were type IV (48.23%) and type I (27.3%). The majority of distal roots of molars had one canal (82.81%) with a prevalence of type I (82.81%) and type IV (11.83%), being the most common. However, as high as 19.11% of mesial and 2.73% of distal canals had type II pattern and 2.73% of mesial canals had type III pattern. A total of 0.91% of teeth had type V canal pattern in both mesial and distal roots. Interestingly, 4.55% (n = 5) of the teeth examined had C-shaped canal configuration which divided into three canals apically (Fig. 1).

DISCUSSION

The root canal morphology of the second mandibular molar has been reported in studies conducted in Europe, North America and Australia (Table 4).^{5,7,16-20} patients of Asian descent have different percentages of canal configurations than ethnic groups of these continents.^{2-4,21-27}

Table 1: Number of roots and root canals in mandibular second molars of a South Indian population

Tooth (n = 110)	No. of roots %				1 canal %	2 canals %	3 canals %	4 canals %	C-shaped %
	1	2	3	4					
Mandibular 2nd Molar	5.45	91.91	4.55	0.91	4.55	20.02	62.73	12.74	4.55

Table 2: Number of root canals in individual roots mandibular second molars of a South Indian population

Tooth (n = 106)	One canal %	Two canals %
Mandibular 2nd Molar	M = 24.53 D = 85.85	M = 77.36 D = 16.04

(C-shaped canals excluded)

Table 3: Root canal pattern (*Vertucci's* classification) mandibular second molars

Tooth (n = 110)		Type I (%)	Type II (%)	Type III (%)	Type IV (%)	Type V (%)	Type VI (%)	Type VII (%)	Type VIII (%)	C-shaped canal
Mandibular 2nd molar	M	27.3	19.11	2.73	48.23	0.91	—	—	—	4.55
	D	82.81	2.73	—	11.83	0.91	—	—	—	—

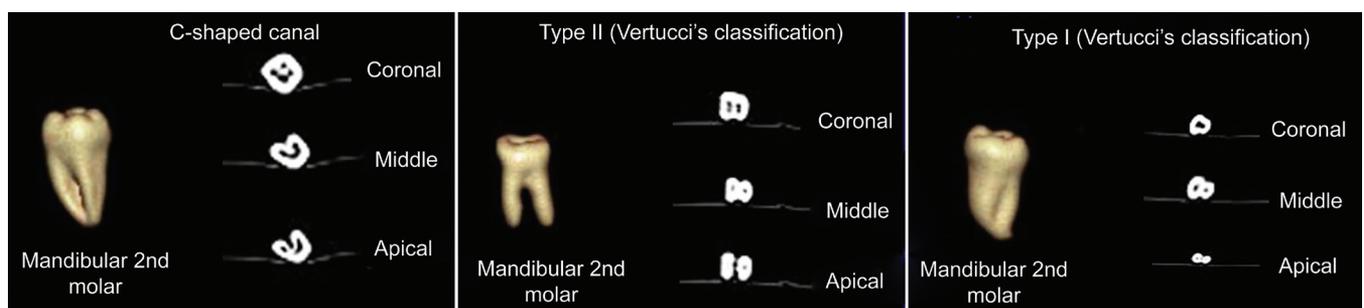


Fig. 1: Reconstructed images of second mandibular molars taken with Spiral CT

Table 4: Studies of apical canal configurations of mandibular second molar

Authors	Method used	Country	Year	Root	One canal (%)	Two canals (%)	Three canals (%)	Other (%)
Vertucci ¹	Clearing	USA	1984	M	65	35	—	—
				D	95	4	—	—
Weine et al ⁶	Radiographic with file	USA	1988	M	56	40	—	1.3 One canal
				D	94.6	1.3	—	2.7 C-shaped
Manning ¹⁸	Clearing	Australia	1999	M	73.5	24.5	2	—
				D	98.3	1.7	—	—
Sert and Bayirli ⁷	Clearing (men)	Turkey	2004	M	70	30	—	—
				D	96	4	—	—
	Clearing (women)	Turkey	2004	M	61	39	—	—
				D	93	7	—	—

These descriptions may not be fully applicable to teeth of Indian population. A variety of techniques have been used to study root canal morphology including radiographic examination, root sectioning and staining and clearing techniques.^{4,6,14} Spiral CT is a nondestructive method of reliably assessing root canal morphology and also provides a permanent record for future referral and hence was the technique used for our study.

This study, to investigate root and canal morphology of permanent mandibular second molars in South Indian population using spiral CT, was motivated by the lack of published work in this aspect. It details the various root canal morphological features of these teeth in this population. It also emphasizes the frequency of three roots in mandibular second molars, as well as the presence and clinical significance of various canal configurations. This is also particularly important when studying the less common anatomic variations, such as the C-shaped canals and branched canal configurations.

The predominance of two roots and three canals in South Indian mandibular second molars is similar to the observations by Vertucci.¹ However, a proportion was three-rooted. Majority of the teeth had two roots (91.91%). In general, two-rooted mandibular second molars had a single distal canal (82.81%) and two mesial

canals (74.62%) that exited through two apical foramina (48.23%). Single canals in mesial roots were seen in 24.53% and two canals in distal roots were seen in 16.04% of teeth. Neelakantan et al in their study on Indian mandibular second molars, found incidence of one canal in mesial root to be 8.4% and two canals in distal roots to be 17.9%. The most prevalent canal configuration noted in their study was type IV in the mesial root and type I in the distal root which was similar to our findings.²⁸

The presence of C-shaped canals was first documented in the endodontic literature by Cooke and Cox in three case reports.¹⁷ C-shaped canals have been reported to occur more frequently in Asians compared to other ethnic groups.^{18,19} Table 5 shows the findings of different studies on C-shaped canals in mandibular second molars in different populations. Studies on the root canal anatomy of mandibular second molars from Japanese, Chinese and Hong Kong Chinese populations found a high incidence of C-shaped roots and canals (14–52%).^{2,22–24} However, these findings cannot be generalized to all Asians since they belong to different ethnic groups. In the present study, the prevalence of C-shaped canals was 4.55% with canal systems that were complex and variable (types I, II). The type I canal with one C-shaped orifice and one apical foramen representing the true C-shaped canal occurred

Table 5: Prevalence of C-shaped roots/canals in mandibular second molars survey of available studies

Authors	Years	Origin	Total no. of teeth	Percentage of C-shaped roots/canals (%)
Kotoku	1985	Japanese	2922	28.4
Weine et al ⁷	1988	USA	75	2.7
Yang et al ²⁴	1988	Hong Kong/Taiwan	581	31.5
		Chinese		13.9
Manning ¹⁸	1990a	Mixed (99 Caucasian)	149	12.7
Weine et al ³⁰	1998	Mixed	811	7.6
Haddad et al ²⁵	1999	Lebanese	94	19.1
Gulabivala ³	2001	Burmese	134	22.4
Gulabivala ⁴	2002	Thai	60	10
Al-Qudah and Awawdeh ²⁶	2009	Jordanian	355	10
Zhang et al ²⁷	2011	Chinese	157	29
Neelakantan et al ²⁸	2010	Indian	345	7.5

most commonly.²⁰ Neelakantan et al, however, found the prevalence of C-shaped canals in the mandibular second molars to be 7.5% in the Indian population.

There are many clinical inferences to be drawn from the observations made in this study. A third root should normally be readily evident radiographically in about 90% of cases, but occasionally may be difficult to see radiographically because of its slender dimensions, an angled view (vertically and horizontally) may be helpful.²¹

Radiographic appearance of a C-shaped root in mandibular second molars may be diverse depending on the exact nature and orientation of the root. It may present as a single fused root or as two distinct roots with a communication.

Simple tubular (types I and IV) canals, such as in distal roots may be cleaned satisfactorily by mechanical preparation alone. Preparation of such canals could probably be effectively achieved using nickel-titanium rotary instruments. Branched canal configurations and intercanal ramifications may render complete debridement of canal systems difficult.²⁹ The use of sodium hypochlorite preferably agitated by ultrasonics may help to clean the uninstrumented parts of the root canal system.

The obturation of simple tubular or tapered canals may be achieved satisfactorily with cold lateral condensation of gutta-percha points. However, irregular canals or those with complex ramifications are more satisfactorily obturated using some thermoplasticized gutta-percha techniques.³⁰

CONCLUSION

In the root and canal morphology of 110 permanent mandibular second molars examined, there was a predominance of two roots and three canals. The most prevalent canal configuration in the mesial root was type IV and in the distal root was type I configuration. Three roots and C-shaped canals were also recorded. It is, therefore, important to be familiar with these variations in the root canal system because such knowledge can aid in the location and negotiation of canals as well as their subsequent management in clinical practice.

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