

ORIGINAL RESEARCH

Root Canal Morphology of Mandibular Central Incisors in Nellore Population

¹Lenin Babu Thota, ²Gunaranjan T, ³Vamsee N Krishna, ⁴Meela Sridhar, ⁵Arunodaya EC Reddy
⁶Koppolu Madhusudhana

ABSTRACT

Aims: To investigate the root canal morphology of mandibular central incisors in Nellore population using a canal staining and tooth-clearing technique.

Materials and methods: One hundred extracted mandibular central incisors were collected from dental clinics in Nellore. Following the preparation of access cavities, pulp tissue was removed and the canal systems were stained. The teeth were decalcified with 10 and 5% nitric acid, dehydrated with ascending concentrations of alcohol, and rendered clear by immersion in methyl salicylate. Cleared teeth were examined by the eye and the following features were evaluated: (i) number and type of root canals; (ii) presence and location of lateral canals; (iii) location of apical foramina; and (iv) frequency of apical deltas.

Results: The majority of mandibular central incisors had a single canal (72% of teeth possessed a Type I canal system). Although 28% of the roots possessed two canals, only 5% had two separate apical foramina.

Conclusion: The prevalence of two canals in this group of mandibular central incisors was 28% and is within the range of previous studies performed on populations of different racial origins.

Keywords: Clearing technique, Mandibular central incisors, Morphology, Root canal.

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INTRODUCTION

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 because of inadequate understanding of the pulp space anatomy. This applies to mandibular incisor teeth as many dentists fail to recognize the presence of a second canal.

Current knowledge of pulp space anatomy is based on research findings and individual case reports. Many studies have examined the root canal systems of mandibular incisors. Rankine–Wilson and Henry (1965)¹ filled the root canals of mandibular anterior teeth with radiopaque material, sectioned them in a horizontal plane, and exposed radiographs. They reported two canals in 40.5% of mandibular incisors. Later, Vertucci (1974)² used the clearing technique to study the root canal morphology of 300 extracted mandibular anterior teeth. Two canals were found in 30% of mandibular central incisors and in 25% of mandibular lateral incisors. Mauger et al (1998)³ evaluated the canal morphology at different root levels in 100 mandibular incisors and reported that 98 to 100% of the teeth had one canal in the area 1 to 3 mm from the apex.

There is a lack of consistency in the reported prevalence of second canals in mandibular incisors.²⁻⁶ The differences may be related to study design (*in vivo* vs *ex vivo*), the technique of canal identification (radiographic examination, sectioning, and clearing), or racial divergence. Many studies have reported that root canal systems vary according to race.^{5,7-9} Descriptions of the frequently occurring root canal systems of permanent teeth are based largely on studies conducted in Europe and North America, and relate to teeth of mainly Caucasoid origin. These descriptions may not be fully applicable to teeth of Indian origin.

The purpose of this study was to examine the root canal morphology of mandibular incisors in a Nellore population using a canal staining and root clearing technique and thereby assess if the variations in root canal morphology were similar in Andhra Pradesh population.

MATERIALS AND METHODS

One hundred extracted mandibular central incisors were randomly collected from general dental clinics in Nellore. The gender, age of patients, and reasons for extraction were not recorded. The teeth were placed in 3% sodium hypochlorite for 30 minutes, after which any remaining soft tissue or calculus was removed by scaling. Access cavities were prepared with a high-speed hand piece and the pulp tissue removed by immersion in 3% sodium

^{1-3,5}Senior Lecturer, ^{4,6}Professor

^{1,2,5,6}Department of Conservative Dentistry and Endodontics Narayana Dental College, Nellore, Andhra Pradesh, India

³Department of Conservative Dentistry and Endodontics Mamata Dental College, Khammam, Telangana, India

⁴Department of Oral and Maxillofacial Surgery, HKDET's Dental College, Bidar, Karnataka, India

Corresponding Author: Lenin Babu Thota, Senior Lecturer Department of Conservative Dentistry and Endodontics Narayana Dental College, Nellore, Andhra Pradesh, India e-mail: thotaleninbabu@gmail.com

hypochlorite overnight, before placement in an ultrasonic bath. The teeth were then rinsed in running tap water for 2 hours and dried overnight. Indian ink was injected into the pulp chamber with an endodontic irrigating syringe with gauge 27 needle. The ink was drawn through the canal system by applying negative pressure to the apical end of the tooth with the use of a central suction system. Excess ink was then removed from the surface of the tooth with gauze soaked in alcohol. The stained teeth were air dried and decalcified with 10% nitric acid for 3 days followed by 5% nitric acid for 3 to 5 days. The acid solution was changed every day. The teeth were washed under running tap water for 4 hours, dried, and dehydrated using ascending concentrations of ethyl alcohol (70, 96, and 99%) for 12 hours each. Finally, the dehydrated teeth were placed in methyl salicylate, which rendered them transparent after about 2 hours.

The transparent specimens were examined by the naked eye, and the following observations were made:

- Number and type of root canals
- Presence and location of lateral canals
- Location of apical foramina
- Frequency of apical deltas.

The canal configurations were categorized according to Vertucci's classification as follows (Table 1):

Type I: Single canal from orifice to apex.

Type II: Two canals leaving the pulp chamber but joining shortly before apex.

Type III: One canal dividing into two within the body of the root and then again forming one canal.

Type IV: Two canals exiting into two apices.

Type V: One canal leaving the chamber dividing into two with two apices.

Type VI: Two canals leaving the chamber merging in the body and then redividing into two apices.

Type VII: One canal leaving the chamber, dividing, and then rejoining in the body of the root and finally redividing into two apices.

Type VIII: Three canals from chamber to apex.

The percentage of each type of canal configuration was directly compared with each other (Fig. 1).

RESULTS

Table 1: The canal configuration

Type of canal	Number of teeth	Percentage
Type I	72	72
Type II	8	8
Type III	15	15
Type IV	3	3
Type V	2	2
Type VI	0	0
Type VII	0	0
Type VIII	0	0

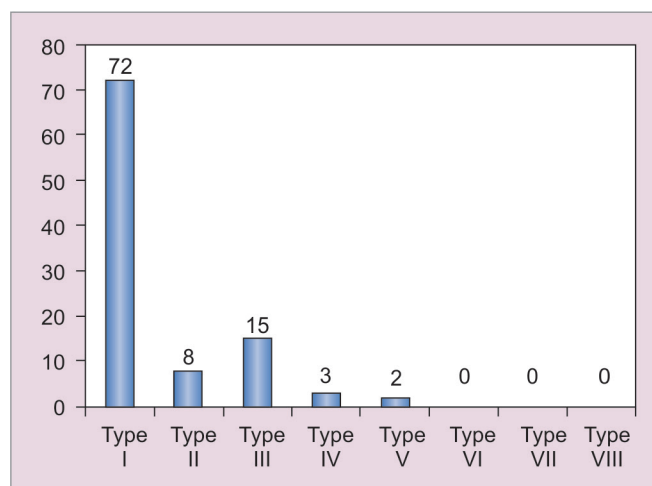


Fig. 1: Percentage of each type of canal configuration

DISCUSSION

A variety of techniques have been used to study root canal morphology including radiographic examination,⁴ root sectioning,³ and staining and clearing techniques.¹⁰ It has been reported that fine details of the root canal system can be visualized by staining and clearing¹¹ and this method was used in the present study.

The literature on mandibular incisors reveals that 11 to 68% of mandibular incisors possess two canals, although many merge into one canal in the apical 1 to 3 mm of the root.^{2,3,6,12-14} Vertucci² examined the root canal morphology of 300 mandibular anterior teeth and reported a second canal in 27.5% of mandibular incisors. Miyashita et al¹⁴ reported that 12.4% of mandibular incisors contained two canals, but only 3% had two foramina. Sert et al⁶ noted that two canals were present in 68% of mandibular central incisors. The differences between these morphology studies may be related to variations in examination methods, classification systems, sample sizes, and ethnic background of tooth sources. This study examined the root canal morphology of extracted mandibular incisors collected from dental clinics within Nellore. Therefore, the sample may not be fully representative of the Nellore population. However, root canal morphology may not vary in a state with people of the same ethnic origin. Therefore, the data presented in this paper is expected to apply to the Andhra Pradesh population.

It was found that 72% of the mandibular incisors possessed a single root canal. Although two canals were found in 28% of teeth, only 5% of canals in the teeth exited in two separate foramina (Types IV and V). Therefore, the frequency of two canals in the present study was within the range of previous reports.

The results of this investigation indicate that two canals occur in about one-fourth (28%) of mandibular incisors. This proportion is not found clinically by

practitioners during root canal treatment.¹⁵ This is due to failure of the dentist to recognize the presence of the second canal and the need for access cavities to have appropriate inciso-gingival extension to facilitate the location of lingual canals. Of the teeth with two canals, the Type III configuration was most prevalent, followed by Types II, IV, and V. Preparation and filling of Types I and IV canal systems is relatively straightforward because each of the canals in these configurations is separate and distinct between the orifice and apex. However, Type II, III, and V systems are different because there are areas in the root where the two root canals share space and others where the canals are separate. This requires an individualized procedure for preparation and filling in each of these conditions to obtain the most desirable results.

In the present study, lateral canals were observed only in 6% of teeth and were found most frequently in the apical third of the canal. This is consistent with the findings of Miyashita et al (1997)¹⁴ but much lower than that reported by Vertucci.¹⁶ Intercanal communications were observed in 20% of all teeth and in 70% of teeth with two canals. The high percentage of intercanal communications in teeth with two canals may be of clinical significance, because it may be difficult to debride and fill these communications adequately. The apical foramen was found to coincide with the apical root tip in 75% of teeth. This is higher than reported in previous studies that demonstrated that the apical foramen coincided with the anatomical apex in 17 to 46% of cases.^{6,17-19} This finding may be of significance in working length determination, which often depends on the average position of apical constriction relative to root apex. If the position of the foramen is more apical than previously reported, then the position of the apical constriction and working length determination may vary accordingly.

CONCLUSION

Overall, 28% of mandibular incisors in this Nellore population had two canals. In the teeth with two canals, the Type III canal system was the most prevalent and Type V was the least prevalent.

The high percentage of intercanal communications and centrally located apical foramina is of clinical relevance.

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