

## ORIGINAL ARTICLE

### Root Canal Morphology of Mandibular Incisors in Kashmiri Population- An In-Vitro- Study

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#### ABSTRACT

**Aim:** The aim of this study was to examine root canal morphology of permanent mandibular incisors in Kashmiri population by using canal staining and tooth-clearing technique. **Materials and Methods:** Two hundred extracted mandibular incisors, collected from Kashmiri population were selected for this study. Following pulp tissue removal, the teeth were decalcified with 5% nitric acid, dehydrated with ascending concentrations of alcohol and rendered clear by immersion in methyl salicylate. After staining of the canal systems with India ink, cleared teeth were examined under 5X magnification and the following features were evaluated: (i) number and type of root canals; (ii) presence and location of lateral canals and intercanal communications; (iii) location of apical foramina; and, (iv) Bifurcation of canals. **Results:** The majority of mandibular incisors had a single canal (61.5% of teeth possessed a Type I canal system). Although, The two canals were found in 38.5% of teeth, only 10.5% of canals exited in two separate foramina (Type V). **Conclusion;** The prevalence of two canals in this group (of Kashmiri population) of mandibular incisors was 38.5% and is within the range of previous studies performed on populations of different racial origin.

**Key words;** Morphology, root canal, clearing technique, Vertucci's classification.

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#### INTRODUCTION:

The proper Knowledge of the anatomy of root canal systems is an essential prerequisite for successful endodontic treatment. 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. Studies on the internal and external anatomy of teeth have shown that anatomic variations can occur in all groups of teeth and can be extremely complex. [1] Rankine-Wilson and Henry (1965)<sup>2</sup> 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)<sup>3</sup> 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)<sup>4</sup> 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. 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 Caucasian origin. These descriptions may not be fully applicable to teeth of non- Caucasian origin. The purpose of this study was to examine the root canal morphology

of mandibular incisors in a Kashmiri population using a canal staining and root clearing technique.

#### MATERIALS AND METHODS:

Two hundred extracted mandibular I incisors were randomly collected from the dental section of Government District Hospital Kulgam. The gender, age of patients, and reasons for extraction were not recorded and no attempt was made to differentiate between central and lateral incisors. The teeth were placed in 5% sodium hypochlorite for 30 minutes, for removal of organic debris after which any remaining soft tissue or calculus was removed by scaling. Access cavities were prepared with an endo access bur in a high-speed hand piece and the pulp tissue was removed by immersion in 5% solution of sodium hypochlorite overnight. 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 a magnifying glass of 5X magnification and the following observations were made:

1. number and type of root canals,
  2. presence and location of lateral canals and intercanal communications,
  3. location of apical foramina, and
  4. bifurcation of canals.
5. Canals were categorized into the first five types of

Vertucci's classification<sup>5</sup> as follows:

**Type I:** A single canal is present from the pulp chamber to the apex.

**Type II:** Two separate canals leave the pulp chamber, but join to form one canal to the site of exiting.

**Type III:** One canal leaves the pulp chamber, divides into two within the root, and then merges to exit in one canal.

**Type IV:** Two separate and distinct canals are present from the pulp chamber to the apex.

**Type V:** Single canal leaving the pulp chamber but dividing into two separate canals with two separate apical foramina ,

**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.

## RESULTS

The Results of this investigation indicate that 38.5% of the teeth exhibit two canal system. Of the teeth with two canals, Type III configuration was most common followed by Type V and Type II. It was found that 61.5% of mandibular incisors possessed a single root canal. The two canals were found in 38.5% of teeth, only 10.5% of canals exited in two separate foramina (Type V). Out of all the canals showing two canal configuration, around 28% joined and exited in single foramen (Type II and III) and remaining 10.5% exited in two separate foramina (Type V). The apical foramen was found to coincide with the apical root tip in 47% of teeth and lateral canals were observed in around 18%

of the cases. Apical ramifications were seen in around 7% of the teeth. out of which 71.4% were with two rami, 28.5% with three rami, and none with four rami. In teeth with two canals, bifurcations were seen maximum in middle third (72.7%) followed by in cervical third 26.1% and in apical third 1.1 %.

## DISCUSSION

**Table 1: Number and percentage of canal system types in mandibular incisors (n=200) in the study**

Type	No. Of Samplas	Percentage
I	123	61.5%
II	15	7.5%
III	41	20.5%
V	21	10.5%

**Table 2: Distribution of apical foramen in mandibular incisors (n=200) in the study**

Various methods have been used to study root cana l morphology including radiographic examination,6 root sectioning,[7] staining and clearing techniques,[8] direct observation with microscope,[9] sectioning and macroscopic observation,[10] stereo microscope,[11] spiral computed tomography,[12] and cone beam computed tomography.[13,14] vertucci[1] used the clearing technique to study the root canal morphology of extracted mandibular anterior teeth. It has been reported that fine details of the root canal system can be visualized by staining and clearing.[8] This technique also makes canal negotiation with instruments unnecessary, thereby maintaining the original form and relation of canals, and provides a three-dimensional view of root canal.[1]

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.1,15,16,17-18 Vertucci2 examined the root canal morphology of 300 mandibular anterior teeth and reported a second canal in 27.5% of mandibular incisors. Miyashita et al18 reported that 12.4% of mandibular incisors contained two canals, but only 3% had two foramina. Sert et al<sup>16</sup> 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 the Department Of Oral and Maxillofacial Surgery Government Dental College Srinagar. Therefore, the sample may not be fully representative of the whole Kashmiri population.

In this study it was found that 38.5% of the teeth exhibit two canal system. Of the teeth with two canals, Type III configuration was most common followed by Type V and Type II. It was found that 61.5% of mandibular incisors possessed a single root canal. The two canals were found in 38.5% of teeth, only 10.5% of canals exited in two separate foramina (Type 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 38% of mandibular incisors. This proportion is not found clinically by practitioners during root canal treatment.19 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. None the teeth were seen with Type IV canal system, which may be due to smaller number of samples examined in the present study and any conclusion drawn needs to be based on study of a larger population.

**Location Number of samples**

Location	No. Of Samples	Percentage
At the Apex	94	47%
Buccal	66	33%
Lingual	27	13.5%
Proximal	13	6.5%

**Table 3: Distribution of lateral canals in mandibular incisors in the study**

Location	No. Of Samples	Percentage
Cervical Third	10	5%
Middle Third	16	8%
Apical Third	10	5%

**Table 4: Distribution of apical ramification in mandibular incisors in the study**

Number of rami	No. Of Samples	Percentage
Two	10	5%
Three	4	2%
Four	0	0%

**Table 5: Distribution of position of canal bifurcation in mandibular incisors in the study**

Location	No. Of Samples	Percentage
Cervical Third	46	26.1%
Middle Third	128	72.7%
Apical Third	2	1.1%

**Table 6: Distribution of intercanal communications in mandibular incisors in the study**

Samples	Number of samples with intercanal communications	Percentage
All Samples n=200	56	28%
Two Canal Systems N=76	53	69.7%

The apical foramen was found to coincide with the apical root tip in 47% of teeth. This is higher than reported in previous studies that demonstrated that the apical foramen coincided with the anatomical apex in 17–46% of cases.[16,19,20] In the present study, total apical foramen count stands at 221 (n=200), which is because of type V canal configuration and apical ramifications. This finding may be of significance in working length determination which often depends on the average position of the apical constriction relative to root apex. In the present study, lateral canals were observed in around 18% of teeth and were found most frequently in the middle of the canal [Table 3]. Lateral canals in the apical third account for 5%. This is consistent with the findings of Miyashita *et al.*[20]; however, much lower than that reported by Vertucci. [21] Anastomoses were found only in type III canals which accounts for 2.5% of all the teeth. Apical ramifications were seen in around 7% of the teeth out of which 71.4% were with two rami, and 28% with three rami, and none with four rami. In teeth with two canals, bifurcations were seen maximum in middle third (72%) followed by the cervical third 26.1%; and, the apical third 1.13%. This requires an individualized procedure for preparation and filling in each of these conditions to obtain the most desirable results. The anatomy of pulp space of mandibular incisors in an Indian population show high incidence of complexity which includes variations in canal configuration, number of canals and

presence of isthmus.[9] Intercanal communications were observed in 28% of all teeth, and in 69.7% 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.

**CONCLUSION**

Within the limitations of the present study, it can be concluded that overall, 38% of mandibular incisors in this Kashmiri population had two canals. In the teeth with two canals, the Type III canal system was the most prevalent followed by Type II. Type V was the least prevalent. None of the teeth exhibited Type IV canal configuration in the present study. The high percentage of intercanal communications and centrally located apical foramina is of clinical relevance.

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