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Anatomic Variations And Anomalies in Mandibular Central Incisors

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Abstract: *Majority of the anatomical studies have found that Mandibular Central Incisors are single rooted teeth with single canal. Permanent Mandibular Central Incisor is rarely affected by tooth shape anomalies of crown and root. This Paper aims in providing anatomical variations and anomalies in mandibular Central incisor teeth as failure to recognize unusual root canal anatomy may lead to unsuccessful endodontic treatment. Hence it is mandatory for a dentist to be updated with this kind of variations and anomalies in teeth.*

Keywords: *Central Incisors, Teeth, Anatomical Variations*

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I. Introduction

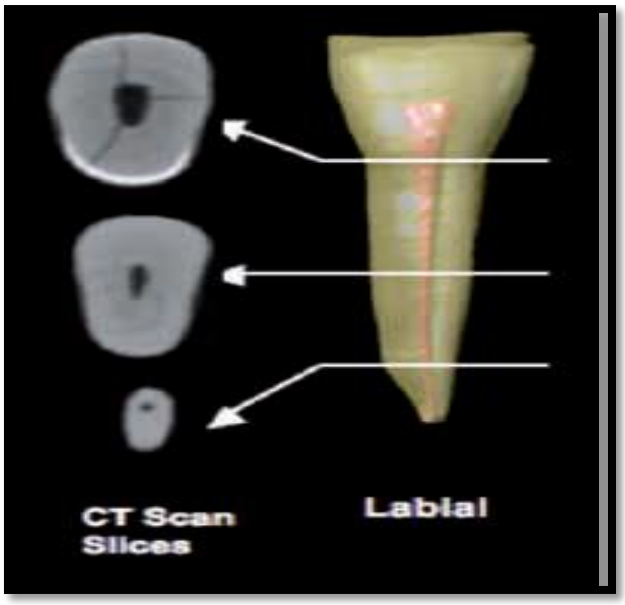
Anomaly is a medical term meaning "irregularity" or "different from normal". The simultaneous occurrence of multiple anomalies involving single, groups of teeth or entire dentition with associated medical anomalies may be inherited genetically or may be associated with specific syndromes.[1] In order to perform endodontic treatments skillfully and effectively, dentists ought to know tooth anatomy very well, especially the internal anatomy. A lack of knowledge of the internal anatomy and its variations will undoubtedly lead to an error in localization, instrumentation and obturation of a root canal. For each tooth in the permanent dentition, there is a wide range of variation reported in the literature with respect to the frequency of occurrence of the number and the shape of canals in each root, the number of roots[2,3] and the incidence of molar root fusion.[4,5] Variations also result due to ethnic background and age and gender of the population studied. [6] The expected root canal anatomy dictates the location of the initial entry of access, it dictates the size of the first file used, and it contributes to a rational approach to solving the problems that arise during therapy. Therefore thorough knowledge of the root canal anatomy from access preparation to obturation is essential to give highest possible chance for success. [7] Much of the knowledge of the anatomy of the root canals is based on the exhaustive work of the Hess. He made vulcanite corrosion preparations of almost 3000 permanent teeth. These preparations showed in minute detail the extensions, ramifications and branching as well as the shape, size and number of root canal in different teeth. Through the years subsequent anatomic studies have contributed to our knowledge of the anatomy of the pulp cavity.hese anatomical variations contribute to good number of failures in root canal therapy as may be the case in undetected extra canal, curved canal or an extra large canal etc. A clear understanding of the root morphology and canal anatomy as well as its associated anomalies is a prerequisite for successful endodontic therapy.The purpose of this paper is to show and understand the various wide range of tooth anatomical variations in mandibular Central Incisors premolars which pose a threat to successful endodontic treatment.

II. External Root Morphology

[1]. The mandibular central incisor is single-rooted **(Figures 1-3)**. The external form of the root is broad labiolingually and narrow mesiodistally.
[2]. Longitudinal depressions are present on both the mesial and the distal surfaces of the root. A cross section of the root is ovoid to hourglass in shape due to the developmental depressions on each side [8,9]
[3]. The overall average length of the mandibular central incisor is **21.5 mm** with an average crown length of **9 mm** and an average root length of **12.5 mm** [10]

(Figure-1)

(Figure-2)



(Figure-3)

2.1 External Root Morphology Of Mandibular Central Incisors

2.2 Root Number And Form

1. Mandibular central incisors is a single – rooted tooth **(Table 1)**.[11,12]
2. Variations from this form have either not been reported or not found in a review of the literature

2.3 Canal System

1. The canal system is either ovoid or ribbonshaped.[13]
2. All the anatomical studies found the majority of mandibular central incisors to have a single canal. **Table 2** shows that the anatomical studies found a single canal in 73.6% of the teeth
3. studied. Two canals were found in 26% of the specimens.[14-20] The incidence of three or more canals was quite rare (0.4%).
4. A single apical foramen was found in 96.4% of the teeth in the studies. Therefore, even when two separate canals have been found, the majority of these canals will join and exit in a single foramen **(Figures 5 and 6)**.

Table 1	**Mandibular Central Incisor**		
Number of Roots	**Number of Studies Cited**	**Number of teeth**	**One root**
	6	**1284**	**100%(1284)**

Table 2 Mandibular Central Incisor							
Number of Canals and Apices	**Number of Studies Cited**	**Number of teeth (Canal Studies)**	**One Canal**	**Two Canal**	**Three or more canals**	**One canal at Apex**	**Two or more canals at Apex**
	14	**3113**	**73.6%(2290)**	**26% (810)**	**0.4% (13)**		
	9	**1652**				**96.4% (1593)**	**2.7%(59)**

Table 3 Pooled Data for Mandibular Central and Lateral Incisors							
Number of Canals and Apices	**Number of Studies Cited**	**Number of teeth (Canal Studies)**	**One Canal**	**Two Canal**	**Three or more canals**	**One canal at Apex**	**Two or more canals at Apex**
	4	**1660**	**77.4% (1285)**	**22.55% (373)**	**0.1% (2)**	**96.9% (1608)**	**3.1%(51)**

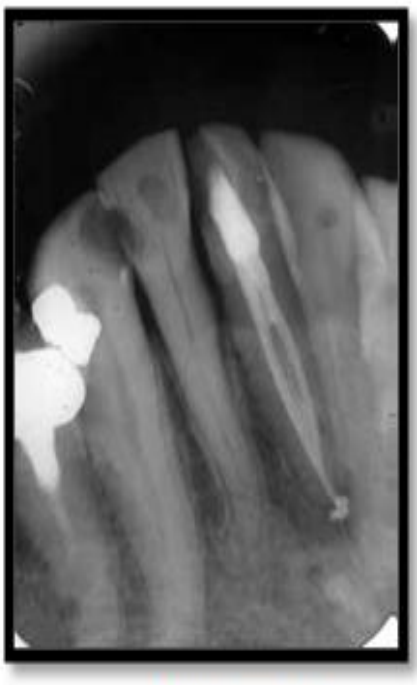
1. **Table 3** provides data from four studies that pooled mandibular central and lateral incisors.[21]These data are reported to provide a comparison between the separate data reported for each of these teeth. The rationale reported for pooling data from these two teeth was that they were anatomically very similar.
2. A study by Green in 1956 on the root apices of anterior teeth found that the average diameter of the major foramen in the 200 pooled mandibular incisors was **0.3 mm**, while the accessory foramina were **0.2 mm** in diameter. Approximately 12% of the pooled mandibular incisors
3. Exhibited accessory foramina. The average distance of the apical foramen from the anatomical root apex was found to be **0.2 mm**.[22]

2.4 Variations And Anomalies

1. Only few anomalies are reported for this tooth in the literature.
2. The case reports of anomalies include an example of two canals and two separate foramina,[23] dens invaginatus,[24] fusion[25], gemination[25], and examples of dens evaginatus that includes a lingual talon cusp [26] and a labial talon cusp.

(Figure-4)

Mandibular right central incisor with 1 root and 1 canal



(Figure-5)

Mandibular left central incisor with two canals and one apex

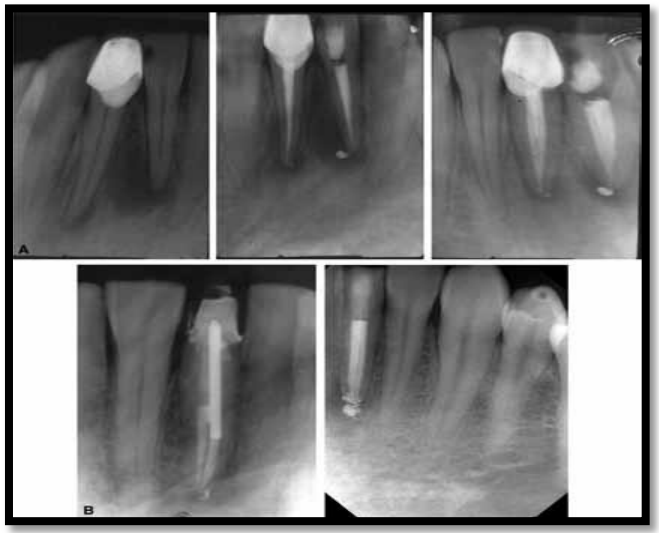
(Figure-6)

Mandibular central incisor with two canals, connecting apical third web-canal and one apical foramen.

2.5 Clinical Significance And Management

The entry point for access should be just above the cingulum with the bur angled perpendicularly to the surface of the entry point.

1. As these teeth are narrow mesiodistally, the main concern is the width of the preparation. No more than a #1/2 round bur or a long thin cylindrical diamond is used to initiate the access, followed by a cylindrical diamond bur to extend only as a slot in a labiolingual dimension. The main point being that unnecessary extension toward the mesiodistal surface is avoided. Even the thinnest bur will provide an adequate width once collateral hand movement is taken into account. The disadvantage is of course that visibility is restricted and therefore the use of microscopes becomes paramount.
2. Once the chamber or the canal is found, the access can be precisely widened for each individual tooth according to its SLA projection.
3. The other point is that 40% of mandibular incisors have two canals— buccal and lingual with only 2 to 3% having separate apical foramina **(Figure7)**. The lingual is by far the harder to locate because the angulation of these teeth in the jaws is proclined. It is natural for the hand to angle the bur toward the buccal (thereby running the risk of gouging the labial wall). The lingual canal lies 1 to 3 mm away from the buccal, directly under the cingulum. Even when two canals are present, there is often a fin or a groove with pulp tissue between them **(Figure 7)**.



(Figure-7) Radiographs illustrating variations of lower incisors with two canals. (A), Although usually both canals exit from a common apex, they can, (B), have two separate or a figure eight-shaped foramen**.**

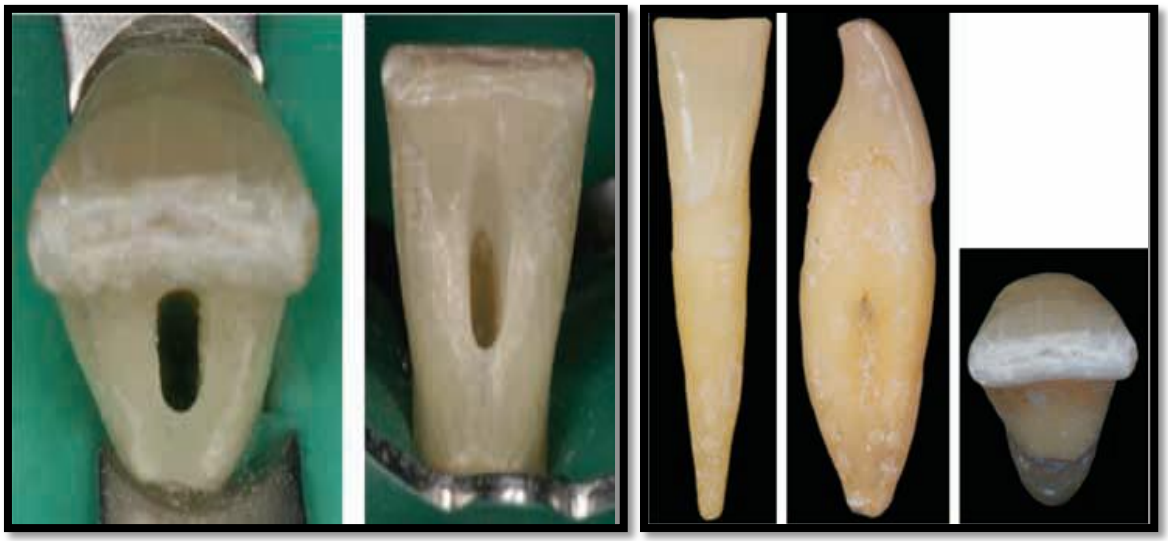


Figure 8 : Example of a mandibular incisor showing labial, mesial, and incisal views. , The access preparation can be assessed from a more incisalview and a lingual view. Note how the lingual extension of the access preparation extends well into the cingulum

2.5 Related Studies

Table 4	Summary of studies Detailing Root and Root Canal Anatomy of Mandibular Incisors									
Author	**Year**	**Tooth**	**Number of Teeth**	**Method**	**One Coronal Canal**	**Two coronal canals**	**Three coronal canals**	**One apical Foramen**	**Two Apical Foramen**	**Three Apical Foramen**
Rankine-Wilson	**1972**	**Both**	**111**	**Radiographic ex vivo**	**59.50%**	**40.50%**		**94.60%**	**5.40%**	
Pineda	**1972**	**Central**	**179**	**Radiographic ex vivo**	**72.40%**	**26.60%**		**97.90%**	**2.10%**	
		Lateral	**184**	**Radiographic ex vivo**	**76.20%**	**23.80%**		**98.70%**	**1.30%**	
Madeira	**1973**	**Central**	**683**	**Dyed, rendered transparent by clearing agents**	**88.70%**	**11.30%**		**99.70%**	**0.30%**	
		Lateral	**650**	**Dyed, rendered transparent by clearing agents**	**88.20%**	**11.90%**		**99.30%**	**0.80%**	
Benjamin	**1974**	**Both**	**364**	**Radiographic ex vivo**	**58.60%**	**41.40%**		**98.70%**	**1.30%**	
Vertucci	**1984**	**Central**	**100**	**Decalcified, dye injected, cast in resin, microscope**	**70%**	**30%**		**97%**	**3%**	
		Lateral	**100**	**Decalcified, dye injected, cast in resin, microscope**	**75%**	**25%**		**98%**	**2%**	
Caliskan	**1995**	**Central**	**100**	**Dyed, decalcified, stereomicroscope x12**	**69%**	**29%**	**2%**	**96%**	**2%**	**2%**
		Lateral	**100**	**Dyed, decalcified, stereomicroscope x12**	**69%**	**31%**		**98%**	**2%**	
Kartal	**1992**	**Both**	**100**	**Dyed, decalcified, cleared, microscope**	**55%**	**44%**	**1%**	**92%**	**7%**	**1%**
Miyashita	**1997**	**Both**	**1,085**	**Ink dye, decalcified,naked eye**	**88%**	**12%**		**98%**	**2%**	
Sert	**2004**	**Central**	**200**	**Decalcified, ink dye**	**34%**	**65%**	**3%**	**87%**	**11%**	**2%**

		Lateral	**201**	**Decalcified, ink dye**	**36.80%**	**62.70%**	**0.50%**	**90%**	**9.50%**	**0.50%**
Bellizzi	**1983**	**Central**	**254**	**Radiographic in vivo**	**83.10%**	**16.90%**				
		Lateral	**163**	**Radiographic in vivo**	**79.80%**	**20.20%**				
Walker	**1988**	**Central**	**100**	**Radiographic ex vivo**	**78.00%**	**22.00%**		**99%**	**1%**	
		Lateral	**100**	**Radiographic ex vivo**	**68%**	**32%**		**99%**	**1%**	
Green	**1973**	**Both**	**500**	**Ground sections, microscope**	**79%**	**21%**		**96%**	**4%**	
Al-Qudah	**2006**	**Both**	**450**	**Decalcified, cleared, naked eye**	**74%**	**26%**		**91%**	**9%**	

III. Conclusion

1. Finding extra canals requires conviction that they are there and extending the access to look for them.

2. Although the two canals seldom exit as separate apices, bacterial by-products from the necrotic tissue in the unfilled canal can communicate with the periodontal ligament via lateral canals or through a poor apical seal.

3.1 Table Legends

1. Number of Roots in Mandibular Central Incisors
2. Number of Canals & Apices in Mandibular Central Incisors
3. Pooled Data for Mandibular Central & Lateral Incisors
4. Summary of studies Detailing Root and Root Canal Anatomy of Mandibular Incisors

3.2 Figure Legends

1. External root morphology of mandibular central incisors
2. External root morphology of mandibular central incisors
3. External root morphology of mandibular central incisors
4. Mandibular right central incisor with 1 root and 1 canal
5. Mandibular left central incisor with two canals and one apex
6. Mandibular central incisor with two canals, connecting apical third web-canal and one apical foramen.
7. Radiographs illustrating variations of lower incisors with two canals. (A), Although usually both canals exit from a common apex, they can, (B), have two separate or a figure eight-shaped foramen.
8. Example of a mandibular incisor showing labial, mesial, and incisal views. The access preparation can be assessed from a more incisal view and a lingual view. Note how the lingual extension of the access preparation extends well into the cingulum

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