EVALUATION OF APICAL FORAMEN LOCALISATION OF UPPER AND LOWER MOLARS

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SUMMARY

The success of nonsurgical root canal therapy is dependent on a thorough knowledge of the root and root canal morphology in order to locate all canals and properly clean, shape, and obturate the canal space in three dimensions. Great variation were shown in the scientific literature with respect to the number of roots and internal canal morphology of teeth. When considering the anatomy of all human teeth, the incidence of the number of roots and the number of canals varies greatly in the literature. The root and root canal morphology of teeth are highly variable and can be extremely complex.

Numerous factors contribute to variations found in the root and root canal studies reported. These factors include ethnicity, age, sex, unintentional bias in selection of clinical examples of teeth (specialty endodontic practice versus general dental practice) and study design (in vitro versus in vivo). An earlier paper by the authors has explored some of the various methods used and possible reasons for variations in results. A digital stereomicroscope with integrated software was used to provide accurate measurement of a large number of teeth.

Key words: *tooth morphology, anomalies, mandibular molar, maxillary molars, number of canals, number of roots, root canal morphology*

Anatomical variation constitutes an expression that can be defined as all morphological alteration which do not determine functional impairment to the individual and that can be visualized in internal or external structures/organs. The dental anatomical variations, specifically, have been studied in determined dental specialties, such as Operative Dentistry, which seek to reconstruct the anatomy of the tooth crown as closest as the natural tooth; Endodontics, which explores the interior of the teeth aiming to enable the cleaning of the root canal system; and Oral and Maxillofacial Surgery, in which the morphology and the tooth positioning directly interfere in the election of the tooth extraction technique,

In dentistry, the anatomical variations have been studied in different structures comprising the oral and maxillofacial system (teeth, bone, muscles, vessels, nerves, glands, etc.) aiming to understand which can be considered as normal or abnormal, subsidizing the correct diagnosis and treatment planning. Knowledge of apical anatomy is necessary for the successful surgical and non-surgical endodontic treatment.

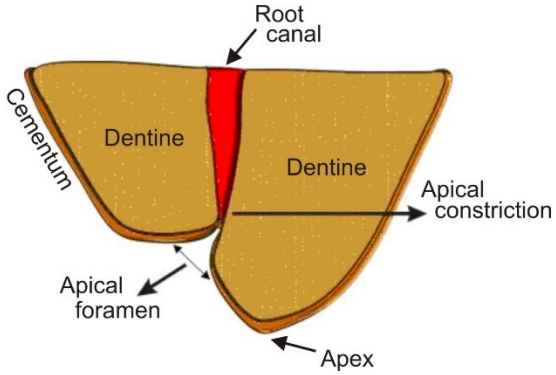

Figure 1. Apical foramen

In everyday clinical practice, the physiological foramen is the most consistent anatomical characteristic and the point of reference as the apical endpoint in root canal treatment. It is a

structure or region that the clinician cannot observe directly, highlighting its importance as more positional than morphological, despite its relevance, which is consistent with the paucity of literature associated with the morphological characteristics of the foramen. The aim in our study was to to determine the morphologic shape and position of the root apex and the major foramen in maxillary and mandibular molars.

Material and method

A total of 100 human upper and lower molars with completely formed apices were evaluated. Each root specimen was measured at each root apex by using an electronic microscopy and SEM analysis at magnification 20x - 200x. The anatomic parameters evaluated were the shapes of peripheral contours of major apical foramen (rounded, oval, asymmetric, semilunar) and the root apex (rounded, flat, beveled, elliptical). The location was classified as center, buccal, lingual, mesial, or distal surface for both root apex and the major apical foramen (**Figure 2, 3**).

Results

The results of the internal canal morphology revealed that a single canal was present in 77% of the teeth. Two or more canals were found in 23% of the teeth studied. A single apical foramen was found in 80% of the teeth, whereas 20% had two or more apical foramina.

MORPHOLOGY OF ROOT APEX					
	ROUNDED	FLAT	BEVELED	ELIPTICAL	N
MAXILLARY MOLARS	**15**	**14**	**6**	**15**	**50**
MANDIBULAR MOLARS	**20**	**8**	**4**	**18**	**50**
MORPHOLOGY OF MAJOR FORAMEN					
	ROUNDED	OVAL	ASIMETRIC	SEMILUNAR	N
MAXILLARY MOLARS	**28**	**12**	**7**	**3**	**50**
MANDIBULAR MOLARS	**25**	**10**	**7**	**8**	**50**
LOCATION OF THE ROOT APEX					
	CENTRELIZED	BUCCAL	LINGUAL	MESIAL	DISTAL
MAXILLARY MOLARS	**38**	**4**	**3**	**3**	**2**
MANDIBULAR MOLARS	**33**	**7**	**4**	**3**	**3**
LOCATION OF MAJOR FORAMEN					
	CENTRELIZED	BUCCAL	LINGUAL	MESIAL	DISTAL
MAXILLARY MOLARS	**18**	**2**	**5**	**5**	**20**
MANDIBULAR MOLARS	**22**	**3**	**2**	**2**	**21**

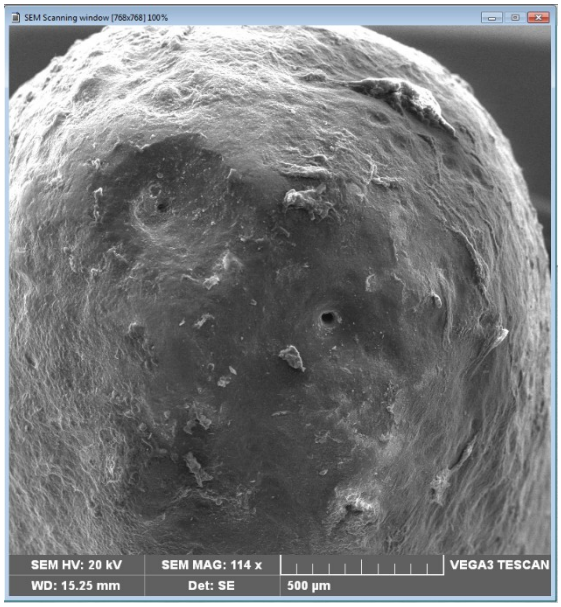

Figure 2. Maxillary first molar – buccodistal root

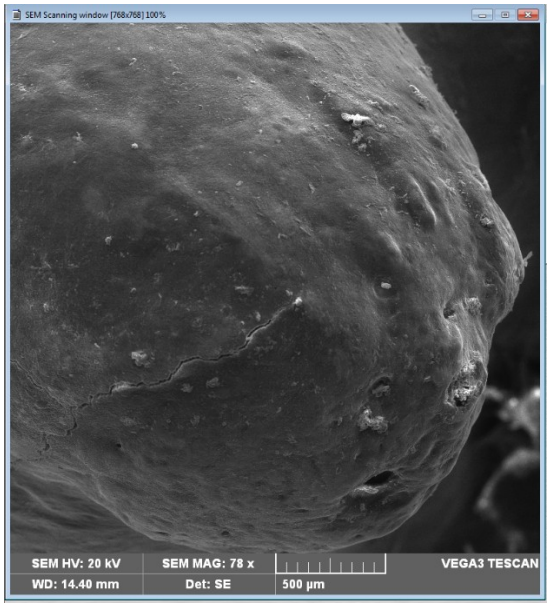

Figure 3. Mandibular third molar – mesial root

Discussion

Estimation of the diameter of the physiological foramen permits selection of the suitable instrument to penetrate the physiological foramen passively and achieve permeability in endodontic preparation. This means ensuring control of the possibility of the foramen, as well as estimating the caliber to obtain its full preparation.

The morphology of the physiological foramen is critical to endodontic treatment, since the instruments only allow one cleaning and round preparation; therefore, in order to:

- ensure a correct cleaning and sealing of the canal and foramen;
- The morphology of the foramen should be modified towards the round type or
- New techniques or instruments must be evaluated that can be adapted to non-round shapes.

Apical foramina can be asymmetrical under physiologic and pathologic conditions, such as tooth adaptation to functional activity. Constant remodeling of the root apex by external root resorption and cementum apposition appear to be the most common causes of deviation of the major foramen.

The success of endodontic therapy is strictly dependent on the accomplishment of all treatment steps, especially the complete removal of bacteria and bacterial products from the root canal system during the cleaning and shaping procedure. Variations in dental anatomy are found in all groups of teeth, and a knowledge of these variations, particularly in relation to the location and treatment of all canals, is the key to successful endodontic therapy, since the ability to find and properly treat all root canals may prevent future failures. Maxillary first molars are particularly noteworthy for anatomical variations of the root canals. Therefore, in order to achieve successful clinical results, a complete clinical and radiographic examination and a thorough knowledge of the morphology of these teeth are necessary.

Weine indicated that the root canal system can be classified into four types:

- type I is a single canal from the pulp chamber to the apex;
- type II describes two separate canals near the pulp chamber but converging to form a single canal near the apex;
- type III describes two separate canals emerging and ending in distinct apical foramina;
- Type IV is related to one canal emerging from the pulp chamber and dividing near the apex in two separate canals with separate foramina.

Another widely used classification is the one proposed by Vertucci, where the variations in the number of canals present in a single root can be divided into:

- type I, single canal;
- type II, two separate canals that converge near the apex;
- type III, a canal that is divided in two within the root, converging to a single canal near the apex;
- type IV, two separate canals from the pulp chamber to the apex;
- type V, a canal that is divided in two before the apex;
- type VI, two canals that converge within the root and are divided into two separate canals before the apex;
- type VII, a canal that is divided, then converges within the root and is again divided in two at the apex;
- Type VIII, three separate canals extending from the pulp chamber to the apex.

The differences between the results of scientific studies that observed that the foramen openings never coincided with the principal axial axis of the root or those of others that showed higher values can be attributed to the methodology. These other studies considered the case of a small portion of the foramen area extending to the center of the long axis as an apical deviation.

The second most frequent location for an eccentrically located apical foramen was towards the buccal aspect. Clinically, this anatomic position of the root apex may cause an incorrect measurement of the canal, with an error of about 2 or 3 mm and may still appear to be correct. At this point, the radiographic dissociation is of crucial importance. This technique will project the canal curvature onto a different plane.

With respect to the location of the root apex, the central and distal positions were the most commonly observed in all classes of teeth. The morphology of the root apex was categorized as round, flat, beveled, and elliptical. The most frequent root apex morphology in maxillary and mandibular teeth was the round shape for molars, incisive and premolars.

The complexity of the root and root canal morphology of the maxillary and mandibular molars may have been underestimated in the past. A thorough review of the literature reveals both complex root morphology as well as complex internal canal morphology. This finding deserves more emphasis in textbooks on the subject of endodontics and confirms an early paper on the complexity of root canal anatomy.

Conclusion: The most common morphology of the root apex the round shape, followed by oval and the most common shape of the major foramen was round, followed by oval. The root apex was most commonly located in the center in all teeth followed by distal and buccal locations.

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