ROOT CANAL MORPHOLOGY OF MAXILLAR AND MANDIBULAR MOLARS

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ABSTRACT

Introduction: Diagnosis, treatment planning and knowledge of root canal morphology and its' frequent variations is a basic requirement for endodontic success. The success of root canal therapy is dependent on the clinician's knowledge of root canal morphology with goal to precisely locate all canals, properly clean, shape and obturate the canal space.

Aim: The aim in our study was to to determine the root canal morphology in maxillary and mandibular molars.

Material and method: A total of 160 human teeth were evaluated. Upper and lower human molars with completely formed apices were used. These teeth were obtained from the Dental Medicine at our institution. The dental specimens were collected and analyzed in accordance to the guidelines set forth by our institution's Ethics Committee. Evaluation included number of root canals, lateral canals, position of lateral canal and position of apical foramen. All specimens were analyzed by Vertucci classification.

Results: The most common root canal morphology demonstrate anatomical complexities of root canal system. The root apex were most commonly located in the center in all groups followed by distal and buccal locations.

Conclusion: More than one canal were found in mesiobuccally roots of second maxillary molars. The additional canals were found in mandibular mesial roots. The prevalent location of the root apex and the foramen was the central position followed by the distal position.

***Key Words**: Anatomic root apex, dental anatomy, morphology*

Introduction

The main goal of root canal treatment is thorough mechanical and chemical cleaning of the pulp cavity and its complete filling and opturation with an inert material (Kuttler 1958). Hess & Zurcher in the most recent studies demonstrated anatomic complexities of the root canal system. It was established that a root with a tapering canal and a single foramen is the exception rather than the rule. Namely, Hes (1925) announced wide variation and complexity of the root canal system, and Weine (1969), forty years later made the first clinical classification of more than one root canal in a single root teeth, by using only mesiobuccally root of maxillary molars as a mode (Figure1). Weine categorized the root canal systems in any root into four basic types. Vertucci et al. utilizing cleared teeth which had their pulp cavities stained with hematoxalin dye, found a much more complex canal system and identified eight pulp space configurations.

Weine suggested that root canal systems 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.

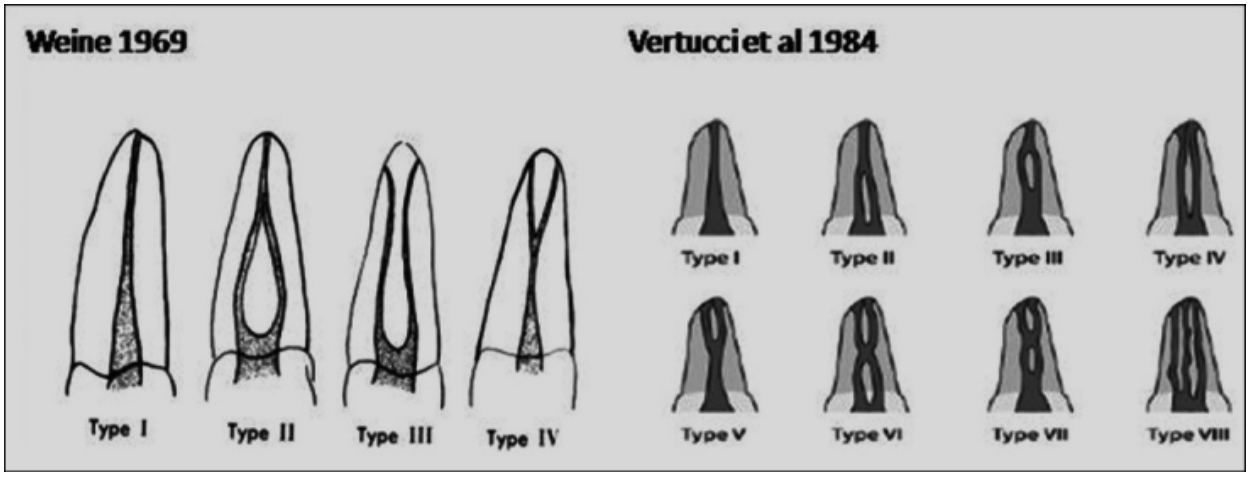

Figure 1. Root canal anatomy of permanent teeth according to Wene (1969) and Vertucci et al. Classification (1984)

More widely used classification had been proposed by Vertucci (1984), where the variations in the number of channels present in a root can be divided into **eight types**:

- **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 clinician is confronted daily with a highly complex and variable root canal system. All available armamentaria must be utilized to achieve a successful outcome. Prior to beginning treatment, the dentist cannot precisely determine the actual number of root canals present. Pulp chamber floor and wall anatomy provides a guide to determining what morphology is actually present. Krasner and Rankow in a study of 500 pulp chambers, determined that the cemento-enamel junction was the most important anatomic landmark for determining the location of pulp chambers and root canal orifices. They demonstrated that specific and consistent pulp chamber floor and wall anatomy exists and proposed rules for assisting clinicians identify canal morphology. The relationships expressed in these rules are particularly helpful in locating calcified canal orifices. These rules are:

1. 'Rule of symmetry 1:

Except for maxillary molars, the orifices of the canals are equidistant from a line drawn in a mesiodistal direction through the pulp chamber floor.'

2. 'Rule of symmetry 2:

Except for maxillary molars, the orifices of the canals lie on a line perpendicular to a line drawn in a mesiodistal direction across the center of the floor of the pulp chamber.

3. 'Rule of color change:

The color of the pulp chamber floor is always darker than the walls.'

4. 'Rule of orifices location 1:

The orifices of the root canals are always located at the junction of the walls and the floor.'

5. 'Rule of orifices location 2:

The orifices of the root canals are located at the angles in the floor–wall junction.'

6. 'Rule of orifices location 3:

The orifices of the root canals are located at the terminus of the root developmental fusion lines.'

Several articles have suggested different methods for studying the root canal morphology. They are describing demineralization and techniques of root-channels cleaning, sections of extracted teeth with root canals with different fillings, endodontic approach with radiographic examination, macroscopic examinations, and advanced methods such as computed tomography technique. The aim in our study was to to determine the root canal morphology in maxillary and mandibular molars in our population.

Material and method

A total of 160 human teeth were evaluated. Upper and lower human molars with completely formed apices were used. These teeth were obtained from the Dental Medicine, Department of Oral and Maxillofacial Surgery and Dental Implantology at the Faculty of Medical Science. The dental specimens were collected and analyzed in accordance to the guidelines set forth by our institution's Ethics Committee. Evaluation included number of root canals, lateral canals, position of lateral canal and position of apical foramen. All specimens were analyzed by Vertucci classification.

A total of 80 maxillary molars and 80 mandibular molars with intact crowns (for clear identification), in each group were selected according to strict inclusion and exclusion criteria as described by Marroquin et al. (2004). Primary teeth and roots with fractures, resorption, or underdevelopment (40·magnification) or that had received any previous endodontic treatment were discarded.

Preparation, classification and demineralization of the teeth: The standard methods of preparation and cleaning of teeth and then storage in 10 % formalin was applied. Principe of work and procedures of sampling teeth:

- Teeth stand 30 min in 5.25 % hypochlorite,
- Rinse the tooth
- Cleaning the teeth of soft tissues without damaging their surface
- Categorization of teeth by Woelfel.
- Collection of teeth in 10 % formaldehyde
- Forming of cavities with cylindrical diamond borer (D + Z, Diamant, Germany)
- Setting teeth in 5:25 % hypochlorite for 48 hours.
- Rinse teeth with running water for 4 hours.
- Demineralization (on two sets of teeth was applied with method demineralization) with nitric acid (method of immersion of the teeth in 5% nitric acid for 5 days, with daily change of the solution). Demineralization can be roetngenological confirmed with insertion of a needle into the crown.
- Rinse teeth with running water for 4 hours.
- Dehydration of teeth with ethyl alcohol with increasing concentration, starting with 80% ethyl alcohol overnight, 90% ethyl alcohol for one hour, and 100% ethyl alcohol for one hour.
- Immersion of teeth in methyl salicylate (Merck, Darmstadt, Germany) for two hours. - Ink injection in root canal
- Perform longitudinal sections
- Examination by magnification - with magnifying glasses (Lumagny ®, No 7540, Hong Kong) at × 5 magnification.
- Categorization according to the classification of Vertucci.

Results and discussion

All the results are presented in tables 1 and 2. The anatomic variations present in these teeth are listed in Tables 1 and 2.The percentage of type of upper molars canals by Vertucci classification in Table 1 showed that 42.5% mesiobuccal canal of maxillary first molars and 50% of mesiobuccal second molars were Type I. Out of total 37% of mesiobuccal canals of first upper molar and 35% of mesiobuccal canal of second upper molars were Type II. There were 20% of maxillary first molars and 15% of second molars have got two canals at apex in mesiobuccal canal.

The percentage of type of lower molars canals by Vertucci classification in Table 2 showed that 17.5% mesiobuccal canal of mandibular first molars and 25% of mesiobuccal second molars were Type I. Also, 87.5% of distobuccal mandibular second molars were Type I canal. Out of total 20% of mesiobuccal canals of first lower molar and 35% of mesiobuccal canal of second lower molars were Type II. But, 5% of distobuccal canals of second lower molars were Type II. There were 60% of mandibular first molars and 40% of second molars have got two canals at apex in mesiobuccal canal, and 7.5 % of second lower molars have got two distobuccal canal at the apex. Precisely, 47.5% of mesiobuccal canals of first lower molars, 30% of mesiobuccal canals of second lower molars and 5% of distobuccal canal were Type IV. Also, 5 % of mesiobuccal canals of first lower molars, 10 % of mesiobuccal canals of second lower molars and 2.5 % of distobuccal canal were Type V. Finally, 7.5 % of mesiobuccal canals of first lower molars were Type VI and 16% of mesiobuccal canals of second lower molars were Type VII.

Table 1. Type of canals in maxillary molars

Teeth	No of teeth	Type I 1 canal	Type II 2-1 canals	Type III 1-2-1 canals	**Total with one canal at apex**	Type IV 2 canals	Type V 1-2 canals	Type VI 1-2-1 canals	Type VII 1-2-1-2 canals	**Total with two canals at apex**	Type VIII three canals	**Total with three canals at apex**
Maxillary first molar N=40												
mesiobuccal	40 (100%)	17 (42.5%)	15 (37.5%)	0	32 (80%)	8 (20%)	0	0	0	8 (20%)	0	0
distobuccal	40 (100%)	0	0	0	40 (100%)	0	0	0	0	0	0	0
palatal	40 (100%)	0	0	0	40 (100%)	0	0	0	0	0	0	0
Maxillary second molar N=40												
mesiobuccal	40 (100%)	20 (50%)	14 (35%)	0	34 (85%)	6 (15%)	0	0	0	6 (15%)	0	0
distobuccal	40 (100%)	0	0	0	40 (100%)	0	0	0	0	0	0	0
palatal	40 (100%)	0	0	0	40 (100%)	0	0	0	0	0	0	0

Table 2. Type of canals in mandibular molars

Teeth	No of teeth	Type I 1 canal	Type II 2-1 canals	Type III 1-2-1 canals	Total with one canal at apex	Type IV 2 canals	Type V 1-2 canals	Type VI 1-2-1 canals	Type VII 1-2-1-2 canals	Total with two canals at apex	Type VIII three canals	Total with three canals at apex
Mandibular first molar 40												
mesiobuccal	40 (100%)	7 (17.5%)	8 (20%)	0	15 (37.5%)	19 (47.5%)	2 (5%)	3 (7.5%)	0	24 (60%)	1 (2.5%)	1 (2.5)
distobuccal	40 (100%)	0	0	0	40 (100%)	0	0	0	0	0	0	0
Mandibular second molar 40												
mesiobuccal	40 (100%)	10 (25%)	14 (35%)	0	24 (60%)	12 (30%)	4 (10%)	0	16 (40%)	16 (40%)	0	0
distobuccal	40 (100%)	35 (87.5%)	2 (5%)	0	37 (92%)	2 (5%)	1 (2.5)	0	0	3 (7.5%)	0	0

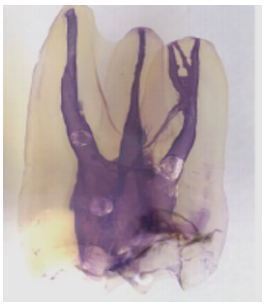

Figure 1. **Maxillary first molar with two canals separating into three in mesiobuccal root**

Figure 2. Maxillary second molar with two palatal canals

Figure 3. Mandibular first molar with three mesial canals

Diagnosis, treatment planning and knowledge of root canal morphology and its' frequent variations is a basic requirement for endodontic success. The success of root canal therapy is dependent on the clinician's knowledge of root canal morphology with goal to precisely locate all canals, properly clean, shape and obdurate the canal space. The presence of an untreated canal may be a reason for failure. A canal may be left untreated because the dentist fails to recognize its presence. It is extremely important that clinicians use all the armamentaria at their disposal to locate and treat the entire root canal system. It is humbling to be aware of the complexity of the spaces we are expected to access, shape, clean and fill. We can take comfort in knowing that even under the most difficult circumstances our current methods of root canal therapy result in an exceptionally high rate of success.

Maxillary molars generally have three roots and can have as many as three mesial canals, two distal canals and two palatal canals. The mesiobuccally root of the maxillary first molar has generated more research and clinical investigation than any root in the mouth. It generally has two canals but a third canal has been reported. When there are two, they are called mesiobuccally (MB-1) and second mesiobuccal (MB-2).

Mandibular molars usually have two roots. However, occasionally three roots are present with two or three canals in the mesial and one, two, or three canals in the distal root. De Moor et al. reported that mandibular first molars occasionally have an additional distolingual root. The most common root canal morphology demonstrate anatomical complexities of root canal system. The root apex were most commonly located in the center in all groups followed by distal and buccal locations.

Conclusion:

More than one canal were found in mesiobuccally roots of second maxillary molars. The additional canals were found in mandibular mesial roots. The prevalent location of the root apex and the foramen was the central position followed by the distal position.

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