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Evaluation of Root Canal Morphology of Maxillary 1st Molars Using Cone Beam Computed Tomography in Chennai Population

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Abstract

Aim: To determine the root canal morphology of maxillary 1st molar between different genders by using CBCT based on Vertucci's classification.

Materials and method: 40 Cone Beam Computed Tomography (CBCT) from different patients were selected randomly from Department of Oral Radiology of Saveetha Dental College and Hospital, Chennai, India. All the CBCT images of patients were examined for the root canal configurations in maxillary first molar between different genders according to Vertucci's classification. All root canal morphologies of maxillary 1st molars between different genders were investigated and compared.

Background and reason: CBCT is an alternative imaging technique which has been popular due to its ability to detect lesions and defects in the orofacial region and provide three-dimensional information about them. In the field of Endodontics, CBCT is a useful imaging technique to reveal the root canal configurations including irregularities, additional root canals and root fractures. Root canal morphologies of maxillary 1st molar of different genders in Chennai population were determined by using CBCT.

Results: The mesiobuccal roots are more likely to have Vertucci's type I or II canal configuration in both male and female whereas the palatal and distobuccal roots always have a Vertucci's type I canal configuration. There were no significant difference between both genders in relation to distance between ocllusal pit and pulp chamber, pulp floor to furcation as well as CEJ to pulp chamber.

Keywords: Cone Beam Computed Tomography, Vertucci's classification, maxillary molar, root canal morphology, mesiobuccal, distobuccal

INTRODUCTION

A thorough knowledge in variations of root and root canal morphology contribute in successful root canal therapy. The clinician should be aware of the variety root canal configurations and the existence of additional canals to ensure the complete instrumentation and root canal system disinfection (1, 2). The optimal outcome of the root canal treatment depends on the complete and thorough chemo-mechanical debridement of the root canal system. Thus, it is necessary to completely debride, disinfect, and obturate the root canal system to prevent and minimizing the risk of treatment failure (3). Hence, understandings the variations in root canal anatomy is very much important for successful endodontic treatment and diagnosis.

Maxillary first permanent molar has a complex root anatomy and canal morphology. Numerous studies have shown that maxillary first molar has three roots and four canals (4,5). The majority of maxillary first molars, about 95.9% present three roots (6). It is associated with mesiobuccal roots having two canals and a single canal in each of the distobuccal and palatal roots. (7,8). Additional anatomic variations also have been reported. This is including the C-shaped canals (9) as well as root fusion or two or more roots (6). The incidence of second mesiobuccal root canal in the mesial root has been reported with variation between 26% (10) and 93.5% 9 (11). The variations in the root canal morphology may result from ethnic background, age, and gender of the population studied (12,13,14).

Recent studies has revealed that the root canal system is a not a single canal that runs from the coronal region which is the orifice to the apex, yet it is a complex component as it splits and union of canals during its course to apex (15,1). During the course of root canal from the orifice in the pulp chamber and opens apically into periodontium through the apical foramen, there are variety of configurations in different teeth as well as in the same individual (16). Thus, root canal classification is needed to define the tooth in terms of the number of root, canal in each root and the course of canal from orifice to apex. In 1984, Vertucci FJ has elaborated the root canal configuration in mesiobuccal root of maxillary first molar studied by Weine FS et al (17) by including the configurations for three canals as well (1). Based on the Vertucci's classification, he classified the root canal systems into eight types as:

- Type I (1-1): Single canal runs from orifice to apex.
- Type II (2-1): Two canals arises from pulp chamber which unite in its course into one.
- Type III (1-2-1): One canal arises from pulp chamber and during its course splits into two. These two canals again unite into one before exiting from apex.

- Type IV (2-2): Two canals run separately from orifice to apex.
- Type V (1-2): One canal arises from floor of pulp chamber and during its course divides into two.
- Type VI (2-1-2): Two canals start from pulp chamber, during its course; they unite into one and then again divide into two before exiting from root apex.
- Type VII (1-2-1-2): One canal leave the pulp chamber which divide and again unite into in its course and finally divide into two before exiting from apex.
- Type VIII (3-3): Three canals leave the pulp chamber and run independently towards the apex.

Many methods have been used for the evaluation of the root canal morphology since years. These involved in vitro methodologies which include numerous sectioning techniques, root canal impression by using low viscosity resin (15) along with root canal staining and tooth clearing (1,18). However, these techniques are not reliable as the results cannot be reproduced and further evaluated as the samples are irreversibly destructed. Valuable information regarding tooth anatomic variations can be obtained by using conventional radiographic images both in vivo (19) and ex vivo (16). In recent clinical studies, they evaluated the incidence of additional canals by using loupes or dental operating microscope magnification as well as based on records of clinical patients and or treated teeth (20).

Nevertheless, those techniques are not able to determine in detail the root canal system irregularities due to limitations. An adequate amount of information in the everyday clinical practice can be provided by periapical radiograph. Still, few factors such as the regional anatomic landmarks or superimposition of adjacent teeth and hard tissues of the orofacial region can confound their interpretation. As possible geometric distortion of the image can occur by using this radiograph, numerous three-dimensional anatomic irregularities may be covered (21,22). Nonetheless, cone beam-computed tomography (CBCT) imaging techniques provide an effective solution to overcome these limitations. Valuable data for diagnosis and treatment planning before or during root canal treatment and surgical endodontic procedures can be provided by constructing detailed three-dimensional images of the teeth and the surrounding dentoalveolar structures (23). The aim of this study is to evaluate the root canal morphology of the first maxillary molars in the Chennai population between different genders by using CBCT imaging.

MATERIALS AND METHOD

A total number of 40 Cone Beam Computed Tomography (CBCT) images were obtained from Department of Oral Radiology of Saveetha Dental College and Hospital, Chennai, India, requiring tomographic examination as part of their dental examination, diagnosis or treatment planning. All the CBCT images of patients were examined for the root canal configurations in maxillary first molar between different genders according to Vertucci's classification. All root canal morphologies of maxillary first molars between different genders were investigated and compared.

Teeth were selected in order to fulfil the following inclusion and exclusion criteria:-

Inclusion criteria:

i. First maxillary permanent molars in both first and second quadrant
ii. With no previous root canal treatment
iii. With fully developed roots and mature apices

Exclusion criteria:

i. Open apices
ii. Root resorption
iii. Calcification or extensive coronal restorations.
iv. Grossly decayed tooth

Overall, 66 teeth fulfil the above criteria collected from CBCT of 19 male and 21 female. All teeth were analysed by using three planes which are sagittal, axial, and coronal and the following anatomic features were evaluated and recorded; the number of roots and their morphology, number of canals per root and Vertucci's classification of the root canal system.

RESULTS

Based on the radiological examination of this study, all the teeth selected were multi-rooted and containing at least three-separated roots. There was no significant difference among the means and standard deviations (SD) of the numerous measurements of the molars in terms of group and gender. The measurements were made for each tooth in terms of difference between ocllusal pit and pulp chamber, pulp floor and furcation and CEJ and pulp chamber.

Table 1 shows distribution of maxillary first molar according to the number of their roots. Almost 70% of the teeth selected in this study indicated that maxillary first molar normally has 3 canals followed by 4 canals which recorded with approximately 30%. None of the tooth recorded with neither one, two nor five canals.

Table 1: Distribution of maxillary first molar according to the number of their root canals

	1 canal	2 canals	3 canals	4 canals	5 canals
Female	0	0	22	8	0
Male	0	0	25	11	0

Table 2: Vertucci's classification of male maxillary first molar

GENDER	ROOT	TYPE							
		I	II	III	IV	V	VI	VII	VII
M	P	100%	0	0	0	0	0	0	0
	MB	23%	3.3%	1.7%	0	0	0	0	0
	DB	100%	0	0	0	0	0	0	0

Table 3: Vertucci's classification of female maxillary first molar

GENDER	ROOT	TYPE							
		I	II	III	IV	V	VI	VII	VII
F	P	100%	0	0	0	0	0	0	0
	MB	27%	13%	3.3%	0	0	0	0	0
	DB	100%	0	0	0	0	0	0	0

Table 4: Distance between occlusal pit and pulp chamber in maxillary first molar

Gender	N	Mean	Standard Deviation	Degree of freedom	Sig. (2 tailed)
Distance between occlusal pit and pulp chamber	66				
Female	35	4.57	0.89	95	0.2824
Male	31	4.47	0.69		

Table 5: Distance between pulp floor and furcation in maxillary first molar

Gender	N	Mean	Standard Deviation	Degree of freedom	Sig. (2 tailed)
Distance between pulp floor to furcation	66				
Female	35	2.49	0.43	95	0.0325
Male	31	3.00	0.63		

Table 6: Distance between CEJ and pulp chamber in maxillary first molar

Gender	N	Mean	Standard Deviation	Degree of freedom	Sig. (2 tailed)
Distance between CEJ to pulp chamber	66				
Female	35	2.76	0.38	95	0.5695
Male	31	3.09	0.42		

Table 2 and 3 shows the root canal configuration of maxillary first molars according to Vertucci's classification. In both males and females, both genders indicated with mostly type I, II, and III with none of the teeth recorded with type IV, V, VI, VII and VIII. In males, both palatal and distobuccal roots 100% found with type I root canal anatomy with none indicated with type II or III. In comparison with mesiobuccal root, 23% recorded with type I root canal morphology. Less than 5% of the teeth examined with type II (3.3%) and III (1.7%).

For females, both palatal and distobuccal roots indicated with type I root canal anatomy with canal various canal morphology found in mesiobuccal root. As mentioned in Table 3, canal morphology of mesiobuccal root shows higher incidence of type II as well as type III, with approximately 13% and 3.3% respectively. This has proven that maxillary first molar has higher variation in canal morphology of mesiobuccal root compared to male.

The data in Table 4 shows the distance between occlusal pit and pulp chamber in both genders. The mean of both genders were almost similar, with female shows slightly higher than male with 4.57 and 4.47 respectively.

As shown in Table 5, the distance between pulp floor and furcation of maxillary first molar in both genders were 2.49 in female and 3.00 in male. The mean for the distance were recorded with the distance in males were greater in comparison to female. The standard variation as shown also no significant difference between both genders.

There was no significant difference among the means and standard deviations (SD) of the distance between CEJ and pulp chamber. Males were recorded with slightly higher mean which was about 3.09 in comparison with female, 2.76. Based on the data displayed, male had higher standard deviation, about 0.42 while female recorded with 0.38.

DISCUSSION

The number of canals inside each root is very important in endodontic treatment. In comparison to study done by (24), both palatal and distobuccal roots contain single canal in 100% of cases. Two palatal canals incidence is very rare (25). Based on Cleghorn et al. (6) on his review on the anatomy of the permanent maxillary 1st molar, he reported with very rare incidence of two palatal roots or canal. In the current study, similar findings have been recorded as well as in many other studies (1).

The incidence of more than one canal is significantly high and numerous variations have been reported (27). Based on study conducted by (PAKISTAN J), it was reported the mesiobuccal root discovered with a single canal in 29.4% and two canals in 70.6% of cases. As been reported by Woelfel et al. (28), highest incidence of one canal (75%) were recorded. In the current study, it was found that in 100% cases all the mesiobuccal root reported with one canal.

In the study reported by (29), type I root canal morphology was identified about 35.1% in the mesiobuccal root of maxillary permanent molar, whilst type IV morphology was identified in 33.3% and only 1.2% was identified with type VI canal configuration according to Vertucci's classification. In comparison with this study, all the mesiobuccal roots of maxillary first molar were identified with type I, II and III approximately 27%, 13% and 3.3% in female and 23%, 3.3% and 1.7% respectively. The incidence rate of the Type I canal configuration, in the palatal root in the present study was 100% similar to study done by Saudi. This result is similar to those reported for Saudi (30), Turkish (31) and Korean (32). The frequency of Type I morphology in the distobuccal root was 99.4%. Similar frequencies were found in Turkish (33), Irish (34) and Korean populations (32) of 98.5%, 97.5%, 97.7%, and 98.7%, respectively. In comparison to the present study, 100% of the selected were identified with type I canal morphology.

In the study reported by Majzoub and Kon (35), the average distance from the pulp chamber floor to the most coronal aspect of furcation on the distal aspect was equal to or less than 3mm recorded in 86% of teeth examined. In comparison to this study, it was recorded with similar measurement to male population as the average was recorded with 3mm with SD of 0.63. Whereas in the study conducted by (36), they reported the measurements in maxillary molars in relation to distance between pulp floors to furcation was 3.05mm, with SD of 0.79.

In other studies, they have measured the relation between external landmarks and pulp chamber locations. One study has reported mean distances for maxillary first molars in relation to the distance from each cusp tip to the corresponding height of the pulp chamber ceiling was 5.77mm (37). In this study, it was recorded the distance between ocllusal pit and pulp chamber in male and female were 4.47 and 4.57 respectively.

In 97% to 98% of the maxillary and mandibular molars, it was found that the pulp chamber ceiling at the cement-enamel junction, CEJ (36). In this study, it was recorded the mean of distance between CEJ and pulp chamber in male and female were 2.76 and 3.09. The knowledge of pulp chamber morphology should be done included with preoperative radiographs in order to assess other potential factors.

CONCLUSION

The present study showed that the Chennai population has a higher prevalence of type I canal configuration, followed by type II and III according to Vertucci's classification in the mesiobuccal roots of maxillary first molars. The variation of root canal morphology found in mesiobuccal roots may occur in a wide range of populations and should be taken into consideration by endodontist during surgical or non-surgical procedures of the permanent maxillary first molars.

In a nut shell, the usage of CBCT seems to be a non-invasive and effective clinically as a tool in understanding the root canal morphology as well as the root canal anatomy.

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