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Root Canal Morphology of Maxillary First Molars Using Cone Beam Computed Tomography

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***Abstract**:*
***Aim**: To determine the incidence of variation in canal anatomy of maxillary posterior teeth in patients in Chennai using non invasive Cone Beam Computerized Tomography.*
***Background:** The success of endodontic therapy is determined largely by a good understanding, cleaning and shaping of the canal anatomy followed by effective obturation. In the past, this was achieved primarily by endodontic exploration although conventional radiography did help when multiple angles were used. The onset of CBCT provides the opportunity to assess canal anatomy 3-dimensionally in a non-invasive manner. The advances in CBCT technology that have resulted in reduced radiation have also made it practical to use CBCT for diagnostic assessment of canal morphology. The dentist can then be prepared to explore the pulp chamber at the right depth and location to identify variations in canal anatomy in order to clean them effectively.*
***Results**: In the present study, 36 numbers of patients with a total of 60 maxillary first molars were assessed. CBCT's of these patients obtained for other reasons were sourced and a software viewer was used to analyze and record variations in maxillary first molar anatomy. Multiple variations in root morphology, canal numbers and configurations were identified and statistically assessed. The results from this study indicate that 86.6 % of maxillary first molars have at least an extra canal, most commonly in the mesiobuccal root. The Type II and Type III configurations (Vertucci's classification) were observed in 3.3 and 40 % of teeth respectively. The results suggests that there is a high incidence of variation in canal anatomy and morphology in maxillary first molars and emphasize the use of CBCT in endodontic diagnosis in order to achieve better treatment outcomes.*

I. Introduction

One of the most common reasons for endodontic failure is undoubtedly missed canal anatomy or morphology. [1] The identification, cleaning, shaping and obturation of the root canal system are undoubtedly extremely challenging. In the past, dentists have depended on conventional radiography, studying the dentin map assessing tooth morphology and other relatively unpredictable techniques to achieve a clear understanding of canal anatomy and morphology. Many of these techniques have been hallmarks of endodontic treatment and have helped successful outcomes. The evolution of computerized tomography in the recent past has however made it possible for dentists to use enhanced radiology techniques for identifying canal anatomy and morphology. While computerized tomography has been available for sometime, these techniques expose the patient to a significant amount of radiation. The advent of Cone Beam Computed Tomography has meant significantly reduced radiation and affordable CT in many dental institutions and practices [2]. Cone Beam computerized Tomography obtains a cone based volume of data which can be analyzed using appropriate software 3-dimensionally in the axial, saggital and coronal planes. The images can then be assessed using a software viewer at a reasonable degree of resolution.[3] This enables pre-endodontic access assessment of canal anatomy and morphology giving the dentist accurate information to help him explore the pulp chamber and identify all canals. This kind of information reduces the risk of canal perforation, missed canal anatomy or morphology and greatly improves the chances for endodontic success [4] [5]. CBCT scanning has observed to be more accurate than digital radiographs in determining root canal morphology. CBCT scanning can also be used in vivo in diagnosis and preoperative assessments. [6-9]

II. Materials And Method

The department of Oral Radiology of Saveetha Dental College was approached to provide CBCT data obtained for a total number of 60 patients residing in Chennai. Patients included into the study had at least one maxillary first molar present. The teeth that were examined had no pathology of any sort and had intact crowns and roots. The data was viewed in a Galileo software viewer in order to identify the number of roots, the number of canals in each root and the configuration of variant canal anatomy (if any) in these teeth. The data was then tabulated and statistically analyzed to determine the incidence of variation in root number, canal number and canal configuration. [10]

III. Results

TOOTH NO

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	16	30	50.0	50.0	50.0
	26	30	50.0	50.0	100.0
	Total	60	100.0	100.0	

TABLE 1: No of teeth used in the study

NO OF ROOTS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	60	100.0	100.0	100.0

TABLE 2: Frequency of number of roots possibly found

NO OF CANALS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	8	13.3	13.3	13.3
	4	47	78.3	78.3	91.7
	5	5	8.3	8.3	100.0
	Total	60	100.0	100.0	

TABLE 3: Frequency of number of possible root canals

PALATAL ROOT CANALS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	58	96.7	96.7	96.7
	2	2	3.3	3.3	100.0
	Total	60	100.0	100.0	

TABLE 4: Frequency of number of possible palatal root canals

MESIOBUCCAL ROOT CANALS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	8	13.3	13.3	13.3
	2	52	86.7	86.7	100.0
	Total	60	100.0	100.0	

TABLE 5: Frequency of number of possible mesiobuccal root canals

DISTOBUCCAL ROOT CANALS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	57	95.0	95.0	95.0
	2	3	5.0	5.0	100.0
	Total	60	100.0	100.0	

TABLE 6: Frequency of number of possible distobuccal root canals

ROOT CANAL CONFIGURATION (1)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	14	23.3	23.3	23.3
	12	20	33.3	33.3	56.7
	21	2	3.3	3.3	60.0
	121	24	40.0	40.0	100.0
	Total	60	100.0	100.0	

TABLE 7: Frequency of possible root canal configurations

A total of 60 upper first molars were studied in Cone beam computerized tomography scans although unlikely to have a bearing on this study, 50% of these teeth were right upper first molars and balance were left upper first molars [Table 1]. All of the teeth in the study had 3 roots with no aberrant number of roots noted on any of the teeth studied [Table 2].There was however significant variation in the number of canals, with 78.3% showing four canals, with the most common fourth canal being the mesiobuccal second canal [Table 3].13.3% of the teeth studied had only one canal in each root while 8.3% of the teeth study had 5 canals. The most common root to have a second canal was the mesiobuccal root with 86.7% mesiobuccal roots having a second canal [Table 3]. The second most common root to have a second canal is the distobuccal root with a 5% [Table 6]. The palatal root was the root with the least number of second canals with only 3.3% of root study showing a second canal [Table 4].

Multiple variations were also observed in root canal configuration with 40% of teeth that had a root with a second canal, showing a 1-2-1 configuration, meaning a common entry from the pulp chamber followed by a bifurcation that eventually united to make a single exit through the apex of the root. 33.3% of roots with a second canal showed a 1-2 configuration which means that they started as a single exit from the pulp chamber but eventually bifurcated into two canals that had 2 portals of exit through the apex. A very small percentage (3.3%) of roots had a 2-1 canal configuration that suggest separate portals of exit from the pulp chamber followed by unification to exit the root apex with a single portal of exit [Table 7].

IV. Discussion

The evaluation of maxillary molar teeth and variations in their root number, number of canals per root and root canal configuration are a very important part of endodontic treatment of these teeth. The maxillary molar presents considerable variation in the number of canals per root as well as the canal configuration in the case of multiple canals in a root. In the past this evaluation was primarily based on the understanding of the occlusal anatomy, coronal shape or tooth size.

Radiographic images either included digital or X-rays taken at multiple angles to show variations in the number of roots or the number of canal in each root. Occasionally, root morphology could be studied on a radiograph to provide more information. Once the tooth was endodontically accessed, it was also possible to study the dentin map of the pulp chamber as an indication of the number of canals. The most difficult aspect to evaluate was usually canal configuration as most radiographic aids tended to be 2- dimensional. With the advent of Cone Beam Computerized tomography however, it has become possible to evaluate these teeth with relatively non-invasive means and yet obtain a 3-dimensional view of the tooth. Unlike CT scans, CBCT has reduced acquisition time and uses lower irradiation doses. Their field of view is limited, but the spatial resolution is good in all planes. [11-13]These devices give the dental surgeon high-quality 3-D diagnostic images of the maxillofacial region and from the acquired data as well. An advantage of the CBCT is that the images can be studied by using different representations (multi- planar reformation, 3-D surface rendering). They can be rotated in any spatial plane without superposition of the anatomic structures. [14-20]

As a result, CBCT offers extensive ability to analyze a tooth resulting in very accurate assessment of all aspects of root and root canal morphology. The present study indicates the wide variation that exists in Chennai population attending the department of Oral Radiology in a reputed Dental college and hospital. The study makes a case for routine assessment of teeth such as maxillary first molars by CBCT techniques given the advantages offered by these techniques in the treatment of these teeth. Being prepared for the root canal anatomy and morphology that a treating dentist is about to encounter offers extensive advantages for treatment outcomes. The dentist is able to be prepared in terms of instrumentation and a technique plan resulting in minimal treatment complications such as perforations, ledging or transportation of root canals. This can directly affect success rates of endodontics as any endodontist can only be better prepared to treat what he can see in advance.

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