Original Research

PRESENCE OF ISTHMI IN MESIOBUCCAL ROOT OF MAXILLARY FIRST MOLAR: A CONE BEAM COMPUTED TOMOGRAPHY STUDY

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Abstract

Background- Various irregularities in root canal system are the norm amongst these Isthmus are one of the predominant feature that complicates the root canal treatment.

Methods- CBCT scans of 60 patients were selected on the basis of predetermined inclusion and exclusion criteria making a total of 120 right and left Maxillary permanent first Molar teeth. Both the maxillary first molars were evaluated on the basis of CBCT scan for presence or absence of isthmi. Each tooth was evaluated in the axial plane with an interval and thickness of 1mm from the orifice to apex & vice versa to detect presence of isthmus.

Results- On the basis of scan, overall prevalence of isthmi was found to be 88.3%, in the mesiobuccal root of Maxillary First Molar. Highest frequency of RCI was observed (38%) in the cervical third extending up to middle third whereas, lowest was seen in apical third region (7%).

Conclusion- On the basis of results obtained in this study it can be concluded that isthmus are found most commonly in cervical and middle third region. CBCT is an effective technique for detecting and locating the isthmus.

Key words- Cone beam computed tomography, Root canal isthmus, Maxillary first molar.

INTRODUCTION

The success of the root canal treatment is influenced by the anatomy of root canal system. Complexity of the root canal could render the treatment difficult, affecting cleaning, shaping, and obturation. Inadequately cleaned canals may lead to periapical inflammatory responses as well as destruction of bone, indicating a need for periapical surgery for the removal of lesion along with the contaminated area of the apex.[1] One such anatomical irregularity in molars is the area of isthmus, which can act as a reservoir for necrotic debris, tissue remnants, organic matter and microorganisms.[2]

According to Vertucci, an isthmus is defined as a narrow anatomical part or passage connecting two larger structures or cavities, which can be considered as a lateral connection between canals of the same root or classified as an anastomosis.[3] Isthmus can also be considered as complete and partial, former is a continuous connection between the two main canals of the same root, while later is an incomplete connection with one or more openings between two main canals.[4]

In an effort to overcome these difficulties found during endodontic therapy several invasive and non-invasive method have been applied so far to examine the morphology of the root canals. These include periapical radiography, vertical and transversal sectioning, decalcification, stereomicroscope, surgical microscope, dissecting microscope, scanning electron microscope. Among these one of the most regularly used imaging method is Periapical radiography. However because of certain limitations its application in the outcomes of RCT is limited.[7-18]It might be illusory to evaluate the three-dimensional macro configuration of the root canal system by an imaging examination that shows the anatomical structures in only two dimensions. Therefore, incorporation of new technological resources, such as cone beam computed tomography (CBCT) and micro-computed tomography (μCT) aid in the study of internal root canal anatomy. [8,10,12,17-18]

Therefore, this study was carried out to determine the presence of isthmi at different locations in mesiobuccal root of maxillary first permanent molar using cone beam computed tomography.

MATERIALS AND METHODOLOGY

The databases of patients with different diagnoses who were referred to the dental radiology service of private clinics in Delhi were searched to select CBCT scans of 60 patients making a total of 120 right and left Maxillary permanent first Molar teeth of via CARESTREAM CS 3D Imaging software (version 3.3.11.0) & HP Computer with Intel(R) Core(TM) based processor .[19]

CBCT images of permanent maxillary first Molar, free of defect, within age group of 21 to 30 years, with fully formed apex were included. Images with high-resolution were taken up to ensure that the analyses was accurate. Images with extensive coronal restorations, internal or external resorption, calcified root canals, poor quality scans, post and crowns were excluded from the study.

The Mesiobuccal root of maxillary permanent first molar teeth was focused to view the scans in different planes (sagittal, coronal, and axial) at 0.1-mm thickness. Axial scanning of 0.1-mm/0.1-mm slices moved from coronal to apical and from apical to coronal region. Improved visualization and valuable information was provided for identification of frequency and position of Root canal isthmi (RCI). (Fig.1 & 2)[19]The presence or absence of RCI in each tooth was analyzed; using the map reading strategy by Pecora et al in 2013, examination followed longitudinally in the axial plane from the pulp orifice to the root apex. Images were analyzed by 2 observers (one Endodontist and one Radiologist).When differences were observed, a consensus was reached, discussing the image.[8, 19] On the basis of presence and absence of complete isthmus in each tooth, the length of each root was divided into 3 equal sections and the findings were recorded into 6 categories according to the site of RCI beginning and end:

1. Both in the cervical third (CT-CT)

2. Begin in the cervical third and end

in the middle third (CT-MT)

3. Begin in the cervical third and end

in the apical third (CT-AT)

4. Both in the middle third (MT-MT)

5. Begin in the middle third and end

in the apical third (MT-AT)

6. Both in the apical third (AT-AT)

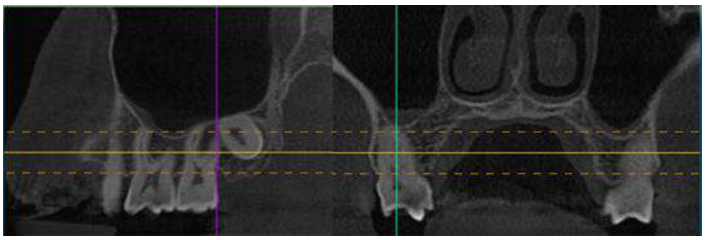

Fig. 1

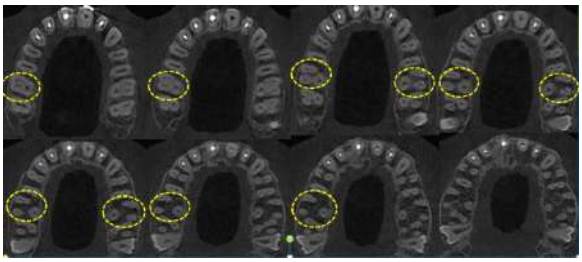

Fig. 2

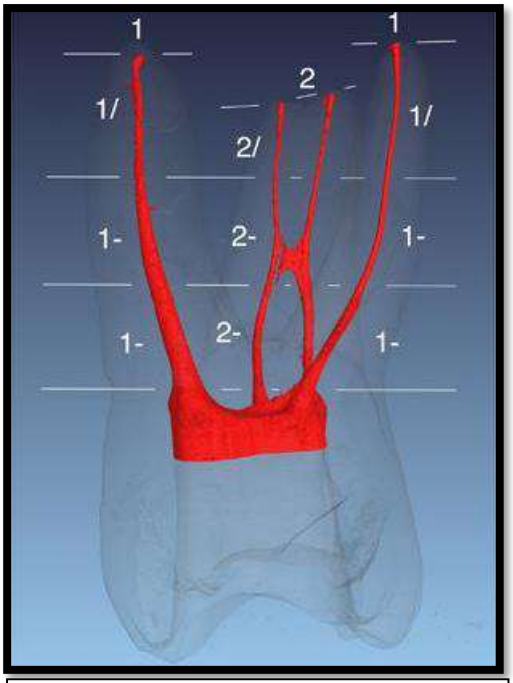

Fig. 3

The frequency distribution of the different types of isthmus was analyzed according to the level of root and evaluated by the chi-square test. Significance level was set at $\alpha=0.05$. Statistical analysis of data was performed using the Statistical Package for Social Sciences, version 20.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	30.000[a]	25	.224
Likelihood Ratio	21.501	25	.664
Linear-by-Linear Association	5.000	1	.025
N of Valid Cases	6		

Table. 1

RESULTS

Total No. of teeth	Presence of Isthmus	No Isthmus
120	93	27

Table. 2

With respect to the beginning and end points of isthmus, the frequency of RCI that begin in the cervical third up to middle third was 38%. The lowest frequency was observed in the apical third region which was 7%. (Table 2)

	FREQUENCY	**PERCENTAGE**
CT-CT	14	11.7
CT-MT	38	31.7
CT-AT	9	7.5
MT-MT	17	14.2
MT-AT	18	15
AT-AT	7	5.8

Table. 3

Out of 120 teeth, isthmi was found in 93 teeth, in 27 teeth no isthmus was present. Thus, the overall prevalence of isthmi was 88.3% in the mesiobuccal root of Maxillary First Molar.

Discussion

One of the common anatomic irregularities found in root canal space of permanent teeth is the presence of root canal isthmi, exception for this finding is maxillary anterior teeth. Numerous methods have been used to evaluate RCIs which include periapical radiography, vertical and transversal sectioning, clearing and staining, stereomicroscopy, surgical microscopy, dissecting microscopy, plastic casting, scanning electronic microscopy, CBCT, and MCT. Satisfactory visualization of RCIs has been achieved by CBCT images, and their use in association with a longitudinal map-reading strategy to identify isthmi. [8,14,19]

Isthmus formation occurs when an individual root projection is incapable to close itself, forming a constriction. Normally during formation of distobuccal root of maxillary molar, there is complete fusion of approximated root projections to form single root with one root canal. Isthmus is formed when an individual root projection is unable to close itself, forming a constriction. Isthmus can be present along the entire length of the root when there is no fusion, leading to a large ribbon shaped canal. It is a most common finding in the distal root of mandibular first molars and maxillary second premolars.

In our study, scans were obtained and examined from pulp orifice to root apex & vice versa. Incidence of canal isthmus in mesiobuccal (MB) root of the maxillary first permanent molar was 88.3%, whereas incidence for the same has been reported to 33.1% by Weller et al (1995), 93% by Sin H. et al (2017) & Estrela et al (2015), 52% by vertucci,[3,4,2,19] he also reported that 75% of the anastomoses were located in the middle and 15% were in the apical third of the root. A higher incidence of isthmus in the MB of upper first molar & mesial root of lower first molar was reported to be at 3-5 mm from apex by Tiexeria et al (2003).[6]

The reported incidence rate in the current study was lower than their studies, which could be due to the examination of only continuous connection between two canals in the same root; in other words,only complete isthmi were studied.Teixeira et al. (2005), found that the prevalence of isthmi was examined via cross sectional slicing at specific distances from the apex. Highest prevalence was found by the isthmi extending from cervical third to middle third i.e. 31.7% with the lowest at apical third i.e. 5.7%. Weller et al. (1995) observed that the prevalence of complete isthmus in the mesiobuccal roots of the maxillary first molars was 5.0% to 14.8% (1-6 mm of level from apex), and partial isthmus was 23.1 to 88%.[4]

Jung et al. (2005) found a lower prevalence of partial isthmus (2.6-15.8%), while in contrast to our study where prevalence of isthmi in apical third was 5.8%, Mannocci et al. (2005) found a higher frequency of isthmus at 3 mm (50.25%) of level from apex than 1 mm (17.24%).[7,12]

Several factors may be responsible for the justification of variations in the frequency of RCI found in our study. These could be because of different method of estimation, sample size, definition of isthmus, differences between RCI definitions, and tooth age.[19] While determining the frequency of isthmi in an ex-vivo study the factors that cannot be controlled are patient's age, sex and ethnicity, though age & gender of the patient can still be controlled in vivo studies. The frequency of Root canal isthmi reported in most of literature studies has been found in serial static and cross-sectional slices. Therefore, a consideration in variability of human tooth anatomy described in the literature should be taken into account before initiation of any root canal treatment. The frequency of number of roots, canals, apical foramina, isthmi, ramifications and canal shapes may not match any perfect standard.

In our study, the isthmuses were detected in all thirds of the root canals. The frequency of isthmus was found higher in the cervical and middle third. Similarly, Estrela et al & Pecora et al detected highest frequency of isthmus in these locations, whereas in contrast Haghanifar (2017) found highest incidence of isthmus in middle third region. The reason for these findings can be attributed to the fact that prevalence and site of isthmi vary among human populations dependent on race, geographical region, age, gender, research methodology, sample size and the type of isthmus.[2,8,19]

CONCLUSION

On the basis of results obtained in this study it can be concluded that isthmus are found most commonly in cervical third and middle region with a percentage of 38%. CBCT is an effective technique for detecting and locating the isthmus.

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