SSRG International Journal of Medical Science
ISSN: 2393 – 9117 /doi:10.14445/23939117/IJMS-V7I12P103

Volume 7 Issue 12, 8-13, December 2020

Canal Configuration In Mesiobuccal Root of Permanent Maxillary First Molar Teeth Among Bangladeshi Population- An *In Vivo* Study

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Abstract
This study determined the type of canal configuration in mesiobuccal root of permanent maxillary first molar among the Bangladeshi population. Fifty permanent maxillary first molar teeth undergoing endodontic treatment were studied. Access cavities were made in all teeth for identifying the first and second mesiobuccal canals (MB1 and MB2 canals). Ultrasonic tips & magnification loupes (x2.5) were used to open the subpulpal groove from the MB1 canal towards the palatal canal to locate the MB2 canal. Dentin was carefully removed at the expense of the mesial wall. If an MB2 canal was identified, size 08 or 10 or 15 K-files were inserted into the canals. RVG was taken to confirm the presence, and canal configurations in the mesiobuccal root were determined. Chi-square test was applied to evaluate any association between the presence of a second mesiobuccal canal with other variables ($p<0.05$). The results showed that 30% were type I, 36% were type II, 20% were type III, and 14% were not defined canal configuration in the mesiobuccal root. It can be concluded that type II and type I canal configuration are more frequently encountered than type III and type IV in the mesiobuccal root.

Keywords: *Root canal configuration, mesiobuccal root, ultrasonic, loupes*

I. INTRODUCTION

Previous studies have indicated that the missed canal acts as a reservoir for colonization, growth, and microorganisms' proliferation. The persistence of microorganisms in this canal is responsible for an intra-appointment flare-up,[1] and secondary endodontic infection. This fails endodontic treatment, and re-treatment of the root canal or surgical procedure is often required.[2]

The permanent maxillary first molar is the complex permanent tooth to appear in the oral cavity exposing it to decay and endodontic treatment. A number of studies have been published on its complex anatomy regarding root canal morphology using various ethnic groups, methods, and approaches.[3]Furthermore, the second mesiobuccal (MB2) canal of the first permanent molar tooth is one of the difficult canals to locate in Endodontics. This is because, in the maxillary first molars, the second mesiobuccal canal departs the chamber at a sharp mesial inclination and then bends again distally, making its detection and negotiation challenges. Furthermore, an inability to detect and treat a second mesiobuccal (MB2) canal may be a reason for endodontic failure in maxillary first molars.

Regarding the techniques and method to evaluate the maxillary first molar root canal morphology, a number of in-vitro and in-vivo studies have been published. Frequently utilized methods to study the root canal morphology are using radiographic techniques,[4] staining solutions, decalcification, sectioning,[6,7] ultrasonics, loupes, and the dental operating microscope,[8,9] and more recently introduced cone-beam computed tomography (CBCT). The MB2 canal incidence has been reported to be as low as 18.6% in an in vivo study,[10] and as high as 95.2% in an in vitro study.[11] Weine et al.,[12] evaluated maxillary first molars and

Located four canals in 62% of the cases. Neaverth et al.[13]studied roots of maxillary first molars. During endodontic therapy, their canal configurations were categorized. Mesiobuccal roots in 77.2% of cases were judged as having two canals. These data warrant the study of the MB2 canal in our population.

Due to the high percentage of treatment failures, mainly due to the difficulty of detecting the second mesiobuccal canal's presence and location (MB2), located in the mesiobuccal root

of the first maxillary molar,[2]the canal configuration in mesio-buccal root need to be further investigated. Ultrasonics is particularly advantageous in MB2 canal location due to the cavitation effect. Few endodontists use ultrasonics for MB2 canal search, and the majority prefer the use of bur and explorer. The use of ultrasonic tips may be more conservative and aids in selective dentin removal. The combination of ultrasonic and magnification has been mentioned as a convenient, safe, non-invasive, and successful method in many literature.[14]However, the technique of a combination of ultrasonics and magnification loupes for identification of MB2 canal needed further investigation. The current study aimed to describe the variations in the root canal configuration in the mesiobuccal root of the maxillary first molar using magnification and ultrasonic.

II. METHODS

This Cross-sectional descriptive study was performed in the Department of Conservative Dentistry and Endodontics, Faculty of Dentistry, Bangabandhu Sheikh Mujib Medical University (BSMMU), Shahbag Dhaka and Bangladesh during September 2018-August 2019. The inclusion criteria are as follows: Permanent Maxillary first molar with following criteria; the age of the patient: 12-55 years of age, irreversible pulpitis (symptomatic/asymptomatic), pulpal necrosis, apical periodontitis (symptomatic/asymptomatic), acute or chronic periapical abscess, and failed previous root canal treatment.

Access cavity preparation:

After tooth preparation, the access cavity (local anesthesia was used whenever needed) was prepared in a triangular shape with a #2 or #4 size round bur in a high-speed contra-angle handpiece. Then, the access cavity outline was modified with the help of endo-z bur from a triangular to a rhomboidal shape to improve the extra canal orifice's visibility. Upon the straight-line access, the pulp chamber's content was flushed with 2.5% sodium hypochlorite and normal saline, and the pulp chamber floor was explored for canal orifices.

Identification of canal orifices:

First mesiobuccal (MB1), distobuccal and palatal orifices were identified using endodontic explorer and scouted with small hand files (6 or 8 or 10 K-files). The identified canals were coronally flared, and the access cavity was further refined with an ultrasonic tip (E3D) when needed. The orifices were located at the chamber's peripheries, and the triangular dentin lying on the top of each orifice was eliminated.

Troughing for MB2 canal and confirmation by RVG:

If the second mesiobuccal canal (MB2 canal) could not be readily located, gentle troughing with ultrasonic tip (SB1) was performed on the sub-pulpal groove expense the mesial wall, and 3mm long trough was prepared from MB1 canal towards the palatal canal. This developmental groove forms a line that connects the palatal and mesiobuccal canals. The second mesiobuccal canal's orifice is usually present on this groove or 1-2 mm mesial to it. The ultrasonic tip was applied at medium speed with light force under visualization of magnifying loupes. After at least 2 mm deep troughing of the pulpal chamber floor, if the second mesiobuccal could still not be identified with DG16, no further effort was made. This was done to prevent any inadvertent perforation. If an MB2 orifice was identified, an attempt was made to negotiate the canal with size 6, 8, or 10 K-files or C+ files in restricted canals. The presence and absence of the MB2 canal were judged based on Stropko's rule. Stropko considered a second mesiobuccal canal if he could instrument the canal to a depth of 3 to 4 mm after troughing. Occlusal photographs were taken with an intra-oral mirror in some cases to demonstrate the canal orifices.

Three RVG were taken from the horizontal buccal, lateral mesial, and lateral distal aspects to demonstrate the pathway of the MB2 canal with files inserted into the MB1 and the MB2 canal. Based on these radiographs, canal configuration was determined and classified according to Wiene's classification.

Completion of RCT:

Routine root canal treatment was then performed, which involved thorough shaping, cleaning, and obturation of the root canal system followed by a definitive restoration. After determining the working length by the apex locator and confirmation by RVG, biomechanical preparations of all canals were done according to the crown down technique. Canals were thoroughly irrigated with sodium hypochlorite (2.5%) & liquid EDTA (17%) along with normal saline between each irrigant. Root canal medicaments, i.e., calcium hydroxide or eugenol, were placed & the access cavity was closed with a temporary restoration, i.e., zinc oxide eugenol cement, for 1 week. After the 1-week patient was recalled, and temporary restoration was removed along with medicaments. Canals were irrigated with liquid EDTA for 1 minute, sodium hypochlorite for 5 minutes, followed by 2% chlorhexidine for 1 minute. Normal saline was used in between each irrigant. Canals were dried with paper points. After selecting master gutta-percha (G.P), canals were obturated by a single cone technique using G.P & Sealapex (Kerr dental). A radiograph was taken to confirm complete obturation & tooth were restored with light cure composite materials. Patients were referred to the department of prosthodontics for full veneer crown (FVC) if needed.

Data collection, processing, and analysis

Data were analyzed using SPSS (Statistical Package for Social Sciences, v. 22). The frequency distribution of variables was determined. Chi-square test was applied to determine any association between the presence of a second

mesiobuccal canal with other variables. The level of significance was kept at 0.05.

III. Figures

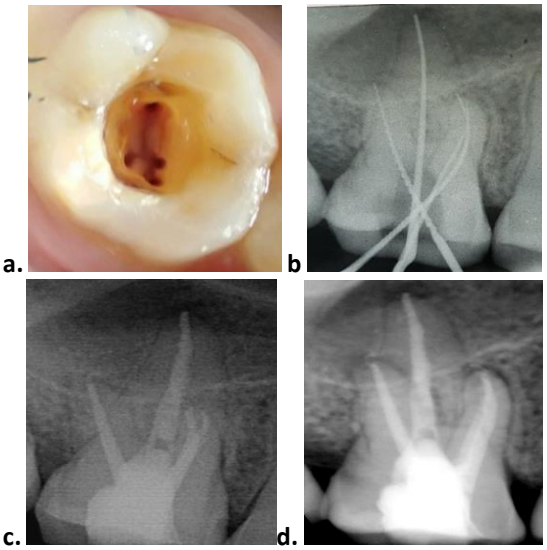

Fig. 1. Representing type III canal configuration in the mesiobuccal root. a.Photograph of access cavity, b.Working length determination x-ray, c, and d.Post-obturation x-ray

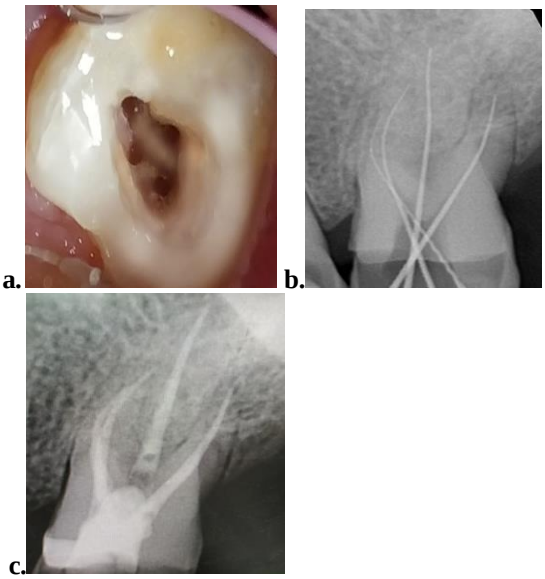

Fig. 2. Representing canal configuration in the mesiobuccal root, type not defined a.Photograph of access cavity, b. Working length determination x-ray, c.Post-obturation x-ray

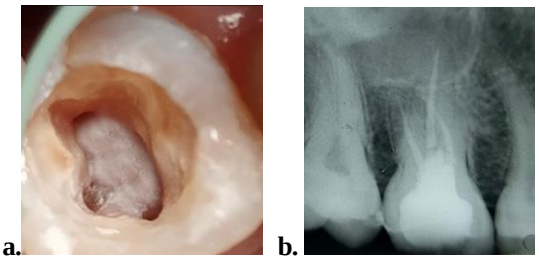

Fig. 3. Representing type, I canal configuration in the mesiobuccal root. a.Photograph of access cavity, b.Post-obturation x-ray

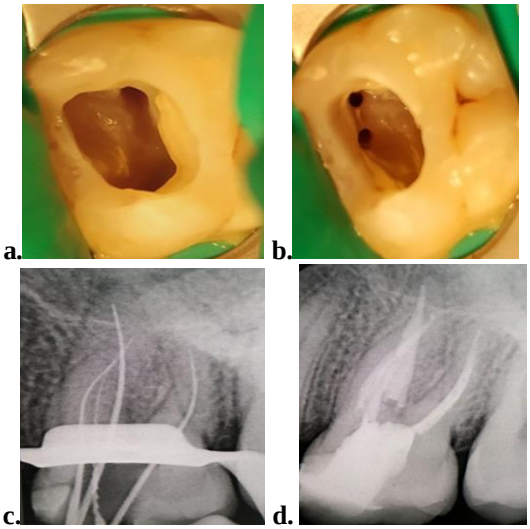

Fig. 4. Representing Type II canal configuration in the mesiobuccal root. A and b.Photograph of access cavity, c.Working length determination x-ray, d.Post-obturation x-ray

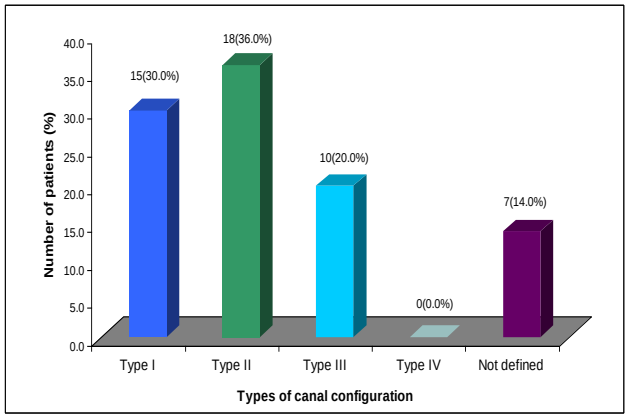

Figure. 5. Bar diagram showing the different types of canal configuration in the mesiobuccal root (N=50)

IV. RESULTS

The present study was conducted to determine the types of canal configuration in M.B. root of the maxillary first molar. A combination of ultrasonic, magnification, and RVG were used for this purpose. Patients were divided into different groups depending upon their age and location of the teeth in the maxillary arch. Chi-square test was applied to observe the association of MB2 with age and location of teeth in the arch. The prevalence of the second mesiobuccal canal (MB2) was found at 70%. 35 teeth were found to have an MB2 canal out of 50 teeth. The patients' age was grouped into two groups as 12–35 years and 36–55 years, and the frequency of MB2 canals were 24 out of 29 (82.8%) and 11 out of 21 (52.4%) in two groups, respectively. Statistical evaluation revealed a significant difference between the two age groups (p-value 0.022).

MB2 canals were detected in 22 out of 32 (68.6%) and 13 out of 18 (72.2%) in the maxillary right and left quadrant. Results were not statistically significant (p-value, 0.797). According to Weine's classification, the distribution of canals configuration in mesiobuccal root was as follows: 15 (30%) typed I, 18 (36%) were type II, 10 (20%) were type III, and 7 (14%) were not defined type (Fig 5).

V. DISCUSSION

In the present study, the second mesiobuccal canal (MB2 canal) prevalence was 70% in permanent maxillary first molar teeth. The results found in the present study have similarities and dissimilarities with those of several previous studies. Harry et al.[15] used a microscope and ultrasonic tips for study and found 68.5% MB2 canal in the Indonesian population, Alrahabi et al.[16,] in their study with CBCT, found 70.6% MB2 canal in the Saudi population, and Touzi et al.[17]used sectioning method for the detection of MB2 canal and found 75.67% in Tunisian population, which are similar with the result of the present study in Bangladeshi population. Similarly, in clinical studies, many researchers used DOM and ultrasonic to identify the MB2 canal and found 72% and 70%, respectively.[18,19]

The second mesiobuccal canals in permanent maxillary molars come under the category of hidden canals. In this study, additional techniques were employed to explore these hidden canals. An ultrasonic device was used for troughing dentin and uncovering MB2 and magnification loupe to improve the illumination and depth of visibility. A clear increase in prevalence has been observed in many clinical studies and clinical simulation studies in which MB2 canals were found in more than 71% of the teeth. This considerable increase has been attributed mainly to modification in access cavity preparation, magnification, and ultrasonic device. However, the frequency of the MB2 canal in the Bangladeshi population was 36%, as reported by Farhana et al.[20]The difference between the present study. That of Farhana et al. 20 May is due to the evaluation techniques. Farhana et al. [20]used the laboratory's clearing technique for their study and found a lower frequency of the MB2 canal than the present study. However, it is known that the laboratory studies show a higher frequency of MB2 canal when compared to *in vivo*. The clearing technique, along with stereomicroscope, showed a higher frequency of MB2 canal in different populations. Naik et al.[21,] in a study using clearing technique and stereomicroscope, found over 84% of maxillary first molars had MB2 canals in the south Indian population. Farahani et al.[20] used magnifying glass instead of stereomicroscope, which seems to be one reason for the lower frequency of MB2. Although the clearing technique helps in a detailed investigation of the delicate root canal systems, it has few drawbacks. There can be distortion in the morphology of the tooth as a result of the demineralization process. Moreover, the dyeing solution may not fully infiltrate into narrow canals and ramifications if the dimension is below the grain size of the injected dye.[5]This might also explain the reason for the lower frequency of MB2 in the study of Chowdhury et al.[20]

Conversely, 87% of teeth were reported to have an MB2 canal in a clinical study done using DOM and ultrasonic.22It is obvious that DOM provides standard gold magnification for detecting the MB2 canal. DOM has higher magnification, illumination, greater depth, and area of visibility as compared to loupes. The use of DOM and the age of the study group (20-45 years) could be the reasons for higher frequency in the study of Mulay et al.[22] (2016). Furthermore, variation in skill levels and experience can influence the outcomes of studies.[23]

The age factor is also related to the prevalence of the MB2 canal. The patients in the age group of 36–55 years showed fewer MB2 canals (52.4%) than patients of age groups 12–35 years (82.8%). As age advances, there are less chances of locating the second MB2 canals. It can be presumed that with age, the tooth is exposed to various insults like caries, attrition, erosion, etc., leading to calcification of the orifice or canal itself, and deposition of secondary dentin and cementum causes further narrowing of the root canal system. This is in accordance with other studies that a significant inverse relationship between age and the occurrence of two canals.[24,25] So, the results in the present study were statistically significant (p-value 0.022).

Calcification of the root canal begins from coronal portion while the apical portion of the canal remains patent in most cases. In 2D radiograph, it is not possible to get the impression of the canal's narrow apical portion. 3D radiography like CBCT is needed to demonstrate such canals. Furthermore, DOM has a greater depth of visibility than loupes, so it provides more control in the deeper troughing of coronal dentin, which obstructs the patency of the canal. In our study, we used a 2D radiograph, i.e., RVG and magnification loupes. We might be reasons for failure to locate some of the MB2 canals in elderly patients though they were apically patent.

Various studies have been done to evaluate the differences in internal morphology between right and left maxillary first molars, but none have reported any considerable results. In the present study, no significant difference in the prevalence of the MB2 canal was found with the occurrence side (p-value 0.797). In our study, 30% of canals were graded as type I, similar to most of the available studies,[16,17,19. Still,] our result differs from the result of Chowdhury et al.[20] that reported type I canal configuration most frequent with 54%, and the probable reasons have been discussed earlier. Type II canal is most frequently found in the mesiobuccal root of the maxillary first molar tooth. In this study, 36% were type II, which is similar to other findings.[6,11,13] Accordingly, Touzi et al. [17] in Tunisian and Naik et al.[21] in south Indian population found type II canal 47.29%, 32.2%, and 37% respectively. Type III canal configurations have shown variable results in different studies. Our result was similar to the finding of Naik et al.[21,] which was 20%.

On the other hand, Alrahabi et al.[16] in the Saudi population and Touziet al.[17] in the Tunisian population have reported 11.8% and 12.16%. Type IV canal configuration has been is demonstrated in only a few clinical studies. None of the teeth were found to have type IV canal in the present study, and it is in accordance to the finding of Alrahabi et al.[16] But, Touzi et al.[17] by using sectioning technique and Toure et al.[26] by using clearing technique found type IV canal 2.7% and 2.9% respectively. Laboratory studies like clearing technique and histological sectioning are needed to demonstrate type IV canals. Furthermore, DOM, CBCT, and a larger sample size could have helped identify the type IV canal. RVG was used in our study, which has certain limitations since it is a two-dimensional image of a three-dimensional object. CBCT is a relatively recent innovation that overcomes many of the limitations of RVG and can help the clinician to determine the number of root canals and their location relative to one another.[27]According to Stropko[28] in approximately 9% of cases type of canal in the mesiobuccal root of maxillary first molar couldn't be classified and termed them as rudimentary canal as they neither join MB1 canal nor they exist in the apical third of the root. In the present study, we couldn't classify in 14% cases, which is according to the finding of Touzi et. al.17 in the Tunisian population.

VI. CONCLUSION

Based on this study, it can be concluded that the prevalence of the MB2 canal in the mesiobuccal root of the permanent maxillary first molar among the Bangladeshi population is high. Furthermore, type II and type I canal configuration are more frequently encountered when compared to type III and type IV.

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