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Original Article

Evaluation of the relationship between buccolingual width of mesiobuccal root and root canal morphology of maxillary first molars by cone-beam computed tomography

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ABSTRACT

Background: One of the main reasons for the failure of root canal treatment is the incomplete knowledge of the root canal system. With respect to the complexity of maxillary molars root canal system, and the possibility of the relationship between the buccolingual width of the mesiobuccal root and root canal morphology in maxillary molars, the aim of this study is to determine this relationship with cone-beam computed tomography (CBCT).

Materials and Methods: This *in vitro* study carried out on 311 CBCT scans. Maxillary first molars (n = 311) were evaluated in three sagittal, axial, and coronal planes. For each tooth the number of canals, presence of second mesiobuccal (MB2), buccolingual width of mesiobuccal root at the cementoenamel junction (CEJ), and mid-root level, and type of canals according to the Vertucci's classification were determined.

Results: The results showed that 49.1% of first maxillary molars had 3 and 50.8% had four root canals. The most common canal type in the mesiobuccal root was Vertucci's Type I followed by Types II, IV, and V. The prevalence of MB2 in the Iranian subpopulation was 50.1%. In maxillary first molars with MB2, the buccolingual width of mesiobuccal root at the CEJ and mid-root level ($P < 0.001$) was significantly greater than the corresponding values in other one without MB2.

Conclusion: The results showed that the buccolingual width of mesiobuccal root in maxillary first molars at the CEJ level and mid-root was correlated with the number of root canals.

Key Words: Cone-beam computed tomography, maxilla, molar, morphology, root canal

INTRODUCTION

Knowledge of clinician about the root canal system anatomy and its variations is an important factor for successful endodontic treatment.[1] Missed canals are reported to be responsible for 42% of endodontic retreatments causes.[2] Maxillary first molars are the most difficult teeth for endodontic treatment. Inability to find the second mesiobuccal root canal (MB2) is one of the most common causes of endodontic treatment failure in such teeth.[3,4]

Evidences show a correlation between the size of crown and presence of additional root canals in

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mandibular incisors, mandibular premolars, and distolingual root in mandibular molars.[5-7] Previous studies have shown that the buccolingual width of teeth significantly correlates with the number and type of canals.[5-7]

An ideal method for study the morphology of the root canal system should be accurate, simple, nondestructive, and most importantly applicable *in-vivo* for examination and diagnosis prior to root canal treatment.[8] Cone-beam computed tomography (CBCT) is much more accurate than two-dimensional radiographies.[9] Moreover, it is a nondestructive method and can be used for radiographic examination and diagnosis prior to treatment *in-vivo* and most importantly, has high accuracy comparable to that of the staining techniques.[9] With respect to the complexity of the maxillary first molar treatment and the high prevalence of MB2 canal in these teeth and also the possible correlation between mesiobuccal root anatomy and its root canal morphology, this study was designed to assess this relationship using CBCT.

MATERIALS AND METHODS

Measurement of buccolingual width of the mesiobuccal root at the CEJ level. In this *in-vitro* study, 311 CBCT scans were evaluated. These CBCTs were taken during 2015–2016 from patients between 30 and 60 years in an oral and maxillofacial radiology clinic in Tehran. All CBCT scans were taken using NewTom VG CBCT system (Image Works, Verona, Italy) with standard exposure settings (11 cm × 16 cm field of view, 0.3 mm voxel size, 110 kV, 3.6–5.4s). Milliamperage was automatically (safe-beam) adjusted based on the anatomy of each patient from 1 to 20 mA. The inclusion criteria for the maxillary first molars were: No cusp coverage that would complicate the measurements, no history of previous root canal therapy, completely formed apices with no resorption, and no metallic restorations or orthodontic brackets on the maxillary first molars or the adjacent teeth.

All measurements were made using NNT Viewer software (NNT 2.21; Image Works, Verona, Italy) [Figure 1]. First, the number of canals and presence/absence of MB2 was determined on axial sections [Figures 2 and 3]. Then, the buccolingual width of the mesiobuccal root at the cementoenamel junction (CEJ) and mid-root level was measured and recorded in the axial plane using the software ruler [Figures 4-5]. The type of canal according to the Vertucci's classification was determined on the sagittal plane and confirmed by changing the section in the axial plane from the pulp chamber to the apex. Vertucci classification system is one of the most commonly used classifications and has been beneficial when categorizing many, but not all, canal configurations. This classification described the root canal system of human permanent teeth into eight different types (4).

Data were coded and analyzed using SPSS version 22.0 (IBM Corp., Armonk, NY, USA) and *t*-test.

RESULTS

A total of 311 maxillary first molars were evaluated; out of which, 153 (49.1%) had three canals and 158 (50.8%) had four canals. Table 1 shows the frequency distribution of mesiobuccal, distobuccal, and palatal root canal types.

In maxillary first molars with MB2 canals, the mesiobuccal root width at the CEJ level was 1 mm ($P < 0.001$) and at mid-root level was 1.5 mm ($P < 0.001$) wider than the corresponding

Table 1: Frequency distribution of mesiobuccal, distobuccal, and palatal root canal types according to the Vertucci's classification

Canal type	Mesiobuccal, *n* (%)	Distobuccal, *n* (%)	Palatal, *n* (%)
Type I	155 (49.8)	309 (99.4)	311 (100)
Type II	87 (28)	-	-
Type III	2 (0.6)	1 (0.3)	-
Type IV	59 (19)	-	-
Type V	6 (1.9)	1 (0.3)	-
Type VI	2 (0.6)	-	-
Type VII	-	-	-
Type VIII	-	-	-
Total	311 (100)	311 (100)	311 (100)

Table 2: Mean buccolingual width of the mesiobuccal root of the maxillary first molars at the cementoenamel junction and mid-root level in the presence and absence of mesiobuccal 2

MB2	Level	Minimum (mm)	Maximum (mm)	Mean (mm)
Absence	CEJ	9.2	12.2	10.8
	Mid-root	3.9	6.5	4.9
Presence	CEJ	10.2	13.3	11.9
	Mid-root	5	7.7	6.1

CEJ: Cementoenamel junction, MB2: Mesiobuccal 2

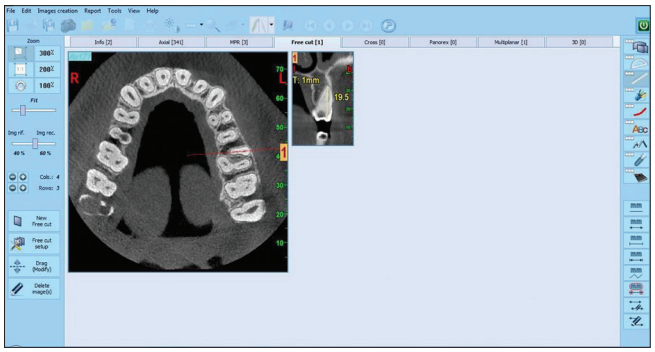

Figure 1: Software environment.

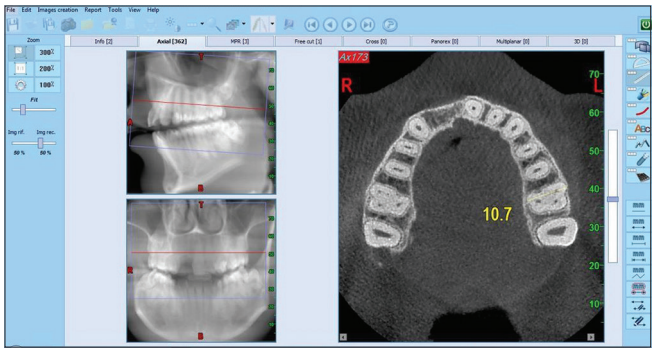

Figure 2: Measurement of buccolingual width of the mesiobuccal root at the CEJ level.

values in teeth without MB2 canal, respectively. Table 2 shows the mean buccolingual width of the mesiobuccal root of the maxillary first molars at the CEJ and mid-root level in the presence and absence of MB2.

DISCUSSION

This study evaluated 311 maxillary first molars on CBCT scans of an Iranian population. The number of canals in each root, type of each canal, the prevalence of MB2 in the maxillary first molars and its correlation with buccolingual width of mesiobuccal root were evaluated.

High-resolution CBCT scans were evaluated in this study. First, the axial section was evaluated since it shows the cross-section of all roots and canals in one view and is also, suitable for determining the number of canals in each root. Furthermore, the buccolingual width of the root at the CEJ and mid-root level can be well measured in the axial plane.[10]

CBCT is a relatively new technique with excellent accuracy, which is noninvasive and can be used *in vivo* and *ex vivo*.[11] Our results showed that the

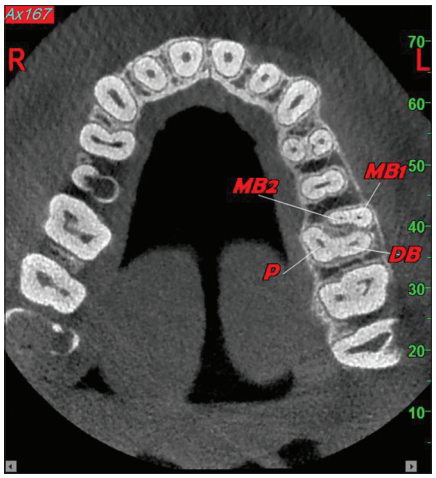

Figure 3: Evaluation of the number of canals and presence/absence of second mesiobuccal canal (left side).

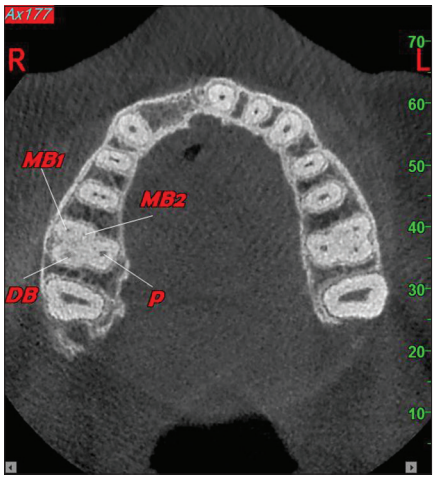

Figure 4: Evaluation of the number of canals and presence/absence of second mesiobuccal canal (right side).

prevalence of MB2 in the mesiobuccal root of the maxillary first molars in subjected population was 50.1%, and most of them were Vertucci's Type II followed by Types IV, V, III, and VI.

Rouhani *et al.*, in 2014 evaluated the root canal system of 125 maxillary first molars of an Iranian population collected from five geographical locations in Iran using CBCT. They reported that 53% of teeth had MB2.[12] Another study conducted by Zhang *et al.*, in 2011 in China on 299 maxillary first molars using CBCT revealed that 52% of teeth had MB2 and they were mostly Type IV.[13] Ghonche *et al.*, study in 2017 on the Iranian population using CBCT, showed the prevalence of MB2 46%, which was in line with our results.[14]

A systematic review by Naseri *et al.*, in 2016 on maxillary first molars of an Iranian population

Figure 5: Measurement of buccolingual width of the mesiobuccal root at the mid-root level.

reported the prevalence of MB2 to be 55%. They also assessed the mesiobuccal root canal types and reported that Types II, IV, III, and V had the highest prevalence. Our findings were in agreement with theirs regarding the prevalence of MB2 and canal types.[15]

Regarding the correlation of buccolingual width of the mesiobuccal root of maxillary first molars with the presence of MB2, it was evaluated in 311 maxillary first molars; out of which, 50.1% had MB2. The results showed that the buccolingual width of mesiobuccal root with MB2 at the CEJ and mid-root level was significantly greater than that of teeth without MB2.

Salarpour *et al*., in 2013 measured the buccolingual width (distance between the buccal and lingual cusps) of 83 mandibular premolars using CBCT and found no significant association between the presence of an additional canal and size of the crown.[6] Ghamari *et al*., in 2017 evaluated 202 extracted mandibular incisors in terms of their buccolingual and mesiodistal widths. Measurements revealed that teeth with two canals and Vertucci's Type III were significantly larger in both buccolingual and mesiodistal dimensions compared to single-canal teeth.[5]

In another study conducted in 2012 on a Korean population, mandibular first and second molars were evaluated in 86 CBCT scans. The results showed that molars with distolingual roots had a significantly wider buccolingual width than molars without a distolingual root.[7] Comparison of our results with previous studies reveals that the root canal morphology and root anatomy can be correlated. However, further studies are required to achieve a final conclusion in this issue.

CONCLUSION

The results showed that the width of the mesiobuccal root in maxillary first molars at the CEJ and mid-root level was correlated with the number of root canals.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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