INTRODUCTION

Successful root canal therapy depends greatly on the quality of cleaning and shaping of the entire root canal system. To achieve this, a clinician must have good knowledge of the canal morphology and configuration. The most common reason of endodontic failure is apical percolation, which is often due to improper/incomplete canal obliteration or by leaving a canal completely unfilled. Very often, a canal may be left unfilled or underfilled because the clinician has failed to recognize its presence. Hence, it is of immense importance to identify all canals present in the tooth/teeth being endodontically treated and to prepare them accordingly.

A variation exists in the frequency of occurrence of the number of canals in every root, and the incidence of fusion and the number of roots. These variations can be seen in canal morphology of teeth and could be due to differences in ethnic background, age, and gender. The use of surgical telescopes, head lamps along with modified access preparations helped locating MB2 canals in half of our study population.

BACKGROUND: Successful root canal therapy requires extensive knowledge of root canal morphology and configuration of teeth. Various studies have reported that the frequency of missed second mesio buccal canal (MB2) canal in maxillary first molars is very high.

METHODOLOGY: The purpose of the current study was to determine the occurrence of MB2 in maxillary first molar in a Saudi sub-population that was referred to the clinics for primary endodontic treatment. After creating a rhombooidal access under magnification (Dental Loupes, Orascoptic 2.5 x) the MB2 canals was identified and verified by a radiograph. The association between age, gender and frequency of MB2 canal was determined with chi-square test (p < 0.05) using the SPSS software.

RESULTS: Second mesiobuccal canal was found in 45% of the. Further, 36% females and 55% males had a second MB canal. About 64% and 36% of the second MB canals exited from one and two foramens respectively. There was no statistical difference observed in the incidence of types of MB canals with regards to age and gender.

CONCLUSION: The use of surgical telescopes, head lamps along with modified access preparations helped locating MB2 canals in half of our study population.

KEYWORDS: Maxillary first molar tooth; root canal morphology; canal configuration; Mesiobuccal canal, Second mesio-buccal canal.


Received: 19 November 2015, Accepted: 26 December 2015

ORIGINAL ARTICLE
and has described four different configurations\textsuperscript{23,24}. Weine also mentioned that high failures of endodontic therapy of the maxillary first permanent molar is very likely due to the failure to locate and obturate the MB2 canal\textsuperscript{23}. One of the reasons for using Weine's classification in the current study was that it mentions about the exit position of the apical foramen. In a retrospective investigation of patients, it was shown that in root treated maxillary first and second molars, only 9 to 18\% of MB2 canals were located and prepared respectively\textsuperscript{17}. However, Neaverth et al\textsuperscript{9} reported the location and treatment of 77.2\% MB2 canals in maxillary first molars. The objective of this study was to evaluate the incidence of MB2 canal in maxillary first molars of a Saudi sub-population that was referred to the clinics for primary endodontic treatment.

**METHODOLOGY**

A total of 100 Saudi patients were included in this study that required primary endodontic treatment in maxillary first molars. Consent was taken and forms were signed by the patients. Patients included in this study were systematically healthy. When adequate anesthesia was achieved and isolation was done using rubber dam, the tooth was accessed for pulp chamber opening. The access cavities on the teeth were modified into rhomboidal shape so that the search for the second canal could be facilitated. A groove was made at the floor of the pulp chamber, lingual to the mesio-buccal canal orifice, followed by a sub-pulpal groove between mesiobuccal and palatal orifices. This groove was continued where the sub-pulpal groove between the mesiobuccal and palatal orifices diminished or the mesiolingual orifice was located. Canal irrigation was done profusely using 2.5\% sodium hypochloride solution and floor of the chamber was dried by the use of suction tip prior to inspection of canal orifice. Using orascopic loupes (Orascopic, 2.5 x), an explorer (starlite DG16) was engaged from the distal towards the mesial so that the localizing the MB1 opening could be done and a straight-on and distal angle radiographs were recorded for each working length of the instrument.

When the working length determining instrument appeared to be off-center in the root on a distal projection X-ray radiograph, a second canal was suspected and when two separate files or gutta-percha points were seen radiographically at working length, then it was confirmed that the mesio-buccal root had two canals with two separate apical foramina. However, a type 2 Weine configuration (two canals exiting from one foramen) were suspected, when placement of an instrument in one MB canal impeded the full length placement of an instrument in other MB canal. Clinically this can be confirmed when the instrument in one canal obstructs the placement of another endodontic file in the other canal or when a GP point placed at the working length of one canal is scored by a file placed in the other canal\textsuperscript{26}. Data were analyzed using chi-square testing. A probability level of $P = 0.05$ was considered to be statistically significant.

**RESULTS**

Overall mean age of the participants in the study was 29 + 3 years and there were 53 males and 47 females. Left and right maxillary first molars were 54\% and 46\% respectively and MB2 canal was found in 45\% of the teeth (Table 1). In the maxillary first molars examined, the prevalence of second mesiobuccal canal

<table>
<thead>
<tr>
<th>Gender</th>
<th>Male n (%)</th>
<th>Female n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary molar</td>
<td>Left n (%)</td>
<td>Right n (%)</td>
</tr>
<tr>
<td>MB1</td>
<td>n (%)</td>
<td>MB2 n (%)</td>
</tr>
<tr>
<td>Number of canals</td>
<td>100 (100)</td>
<td>45 (45)</td>
</tr>
<tr>
<td>MB Canal Type</td>
<td>Exit</td>
<td></td>
</tr>
<tr>
<td>One Foramen</td>
<td>Two Foramen</td>
<td></td>
</tr>
<tr>
<td>MB1</td>
<td>n (%)</td>
<td>55 (100)</td>
</tr>
<tr>
<td>MB2</td>
<td>29 (64)</td>
<td>16 (36)</td>
</tr>
</tbody>
</table>

**Table 2. Type of MB Canal in different age groups.**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>MB Canal Type</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-24</td>
<td>MB1 n (%)</td>
<td>MB2 n (%)</td>
</tr>
<tr>
<td>25-50</td>
<td>48 (48)</td>
<td>19 (42)</td>
</tr>
<tr>
<td>&gt;50</td>
<td>7 (7)</td>
<td>2 (5)</td>
</tr>
<tr>
<td>Total no of cases</td>
<td>100</td>
<td>45</td>
</tr>
</tbody>
</table>

Column Total, * Chi-Square Test
out of all the second MB canals, 64% exited from one foramen, and 36% from two foramens respectively (Table 2). There was no statistical difference observed (P > 0.05) in the three groups with regard to age and incidence of types of MB canals (Table-3). Further, 36% females and 55% males had a second MB canal. No statistically significant difference was found for MB canal 2 between the two groups (P > 0.05) (Table 4). It was observed that 58% of the second MB canals exited from one foramen and 42% exited from two foramens in females as compared to 69% and 31% in males respectively. This association between the gender and canal configuration was found to be statistically insignificant (P > 0.05), (Table 5)

**DISCUSSION**

The purpose of the current study is to review the literature and to determine the occurrence of MB2 in maxillary first molar in a Saudi sub-population that was referred to the clinics for primary endodontic treatment. Second mesiobuccal canal was found in 45% of the teeth. Further, MB canal 1 was present in both genders while 36% females and 55% males had a second MB canal. The first MB canals exited from one foramen while 64% and 36% of the second MB canals exited from one and two foramens respectively. The teeth that most frequently require endodontic therapy in the permanent dentition are the maxillary first molars and they also have the highest rates of failure. It is believed that this is primarily due to non-identification of MB2 canals in mesio-buccal roots. These endodontic failures due to non-treatment of missed canals should be kept in mind before performing treatment. Literature clearly indicates the presence of 2nd mesio-buccal canal in the most of upper molars. It has been shown in clinical studies that up to 93% of the maxillary first molars examined have two MB canals. However, contrary data published by Sempira and Hartwell revealed that the 2nd canal in mesio-buccal were found in only 33% of maxillary first molars. Some studies have compared in vivo versus in vitro results regarding MB2 canal presence or absence. Seidberg et al had reported in an in vivo study that 33% of the teeth studied (n = 201) had MB2 canals and the percentage increased to 62% (n = 100) in their in vitro investigation. In a study conducted by Pomeranz and Fishelberg, 31% of the teeth studied in vivo had a 2nd mesio-buccal canal as compared to 69% of the teeth in vitro (n = 100 for both studies). Our clinical study also confirms the presence of additional second MB canal in mesio-buccal roots of maxillary first molars. We found out that 45% of the first molars had a second MB canal and it may be concluded

### Table 3. Comparison of MB canal type in various age groups according to Weine's Classification

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>#1 n (%)</th>
<th>#2 n (%)</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-24</td>
<td>21 (38)</td>
<td>24 (53)</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>25-50</td>
<td>29 (53)</td>
<td>19 (42)</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>&gt;50</td>
<td>5 (9)</td>
<td>2 (5)</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>Total no of cases</td>
<td>55</td>
<td>45</td>
<td></td>
</tr>
</tbody>
</table>

Column Total, *Chi-Square Test

### Table 4. Comparison of Gender with presence of MB2 Canal and exit of MB canal 2 via one or two foramen

<table>
<thead>
<tr>
<th>MB 2 Canal (n=45)</th>
<th>Present n (%)</th>
<th>Absent n (%)</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (n=47)</td>
<td>26 (55)</td>
<td>21 (45)</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>Male (n=53)</td>
<td>19 (36)</td>
<td>34 (64)</td>
<td></td>
</tr>
</tbody>
</table>

* Chi-Square Test

### Table 5. Comparison of Gender and exit of MB canal 2 via one or two foramen

<table>
<thead>
<tr>
<th>Gender</th>
<th>Foramen</th>
<th>One Foramen N (%)</th>
<th>Two Foramen N (%)</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>11 (58)</td>
<td>8 (42)</td>
<td></td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>Male</td>
<td>18 (69)</td>
<td>8 (31)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Row Total, *Chi-square Test
from our data that all maxillary first molars observed had the first MB canal and approximately half (45%) had the second MB canal as well. As majority of these 2nd canals can only be effectively identified by means of an operating microscope\textsuperscript{31}, this probably explains the results of our study. The numbers observed would be expected to increase if the identification of the MB2 canal was being performed using a microscope.

It has been reported that between 24% and 55% of MB2 canals are completely separate with separate foramina in the apical region of the root. Also, 24% to 54% of MB roots have two separate canals but have a single apical foramen\textsuperscript{28,30,33}. In our study, we observed that all of the MB1 canals exited from one foramen. Conversely, 64% of the MB2 canals exited via one foramen and 36% from two foramina. Our finding that maxillary first molars (36%) having two separate apical foramina in the mesiobuccal root is similar to the average of 30.6% which has been reported in previous clinical investigations\textsuperscript{24,29,34}. Neaverth et al\textsuperscript{9} reported that there were 61.8% of maxillary first molars which had two canals and two apical foramina.

It is a known fact that there is a great variation in morphology or the roots and the canals. However, there is no information regarding ethnic background, age and gender in published literature and conflicting reports with respect to gender and the number of canals are available\textsuperscript{13,22,35}. Our results show no statistically significant difference to report between males and females. A study by Weine et al\textsuperscript{24} concluded that incidence of MB2 canals in a Japanese population was not different from incidence of MB2 canals reported in another ethnic background. As far as age is concerned, it has been reported that the number of MB2 canals decreases with age most likely because of calcification\textsuperscript{9,22,29}. Interestingly, in our study we also observed a decrease in MB2 incidence with regards to increasing age of the patients but this was not statistically significant. It has been observed that those patients who are older have one treatable canal in the mesio-buccal root as compared to patients who are younger\textsuperscript{9,29}. Although it is very likely that that canals become smaller with increased age, it is also quite unlikely that they would completely disappear\textsuperscript{29}.

The use of loupes and/or surgical operating microscopes in recent clinical investigations has resulted in increased detection rates of the MB2 canals\textsuperscript{18,28,31,36}. The result of the use of magnification on the incidence of MB2 canal has been evaluated in a study by Buhrley et al.\textsuperscript{36}. The 2nd MB canal was reported in 71% of the maxillary molar teeth when an operating microscope was utilized for detection. Using loupes, MB2 canals were found in 62% of the teeth\textsuperscript{36}. As one would expected, the lowest numbers of MB2 canals were found in the group which was performing root canal therapy without the use of any magnification device.

In two in vitro studies conducted\textsuperscript{18,29}, a light measuring microscope and a scanning electron microscope (SEM) were used to inspect extracted teeth. Access and visibility were unhindered by the removal of teeth crowns and an incidence of 90% and 95%, for the MB2 canals was reported respectively for the two studies. Clinical search and identification of MB2 canals may be assisted and improved by high-quality illumination, magnification and an access cavity preparation that would allow maximum visibility and access ultimately.

This current study has limitations due to its small sample size as well and the use of conventional diagnostic aids i.e. periapical radiographs. Although the radiographs play an important role in assessing the root canal morphologies but do not provide complete details of the complexity specially the bucco-lingual dimentions. Newer diagnostic tools like CBCT gives accurate details of the morphology and offer promising results. Another limitation is that in the current study only dental loupes were used as means of locating the canals and authors believe that the use of dental microscope would have provided superior magnification and illumination and hence more chances of locating MB2 canals in maxillary first molars.

**CONCLUSION**

In this study, maxillary first molars were focused upon from Saudi patients referred for primary endodontic treatment. In addition to all maxillary first molars having the first MB canal, 45% of the teeth had the MB2 canal present. Furthermore, 64% of the MB canals exited from one foramen, whereas, 36% of the MB canals exited via two foramens. There were no statistically significant differences observed on the basis of gender or age variation. Identification and treating the MB2 canals in maxillary first molars may pose a challenge. However, the inability to identify, locate and treat it properly may lead to endodontic failure. The increase in use of headlamps, surgical telescopes and modified access preparations is likely to increase the incidence of treatable MB2 canals with improved treatment outcomes.

**Authors’ contributions:** ASA wrote and designed
manuscript, ZS did the statistics and wrote conclusion, HR reviewed and corrected grammatical mistakes and design of the manuscript.

Disclosure: None disclosed

REFERENCES

29. Gilles J, Reader A. An SEM investigation of the