

## ORIGINAL ARTICLE

# Root Canal Configuration of the Mesio-buccal Root of Maxillary First Permanent Molars in Local Population

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## ABSTRACT

**Objective:** The purpose of this in vitro study was to investigate variations in the root canal morphology of mesiobuccal root of maxillary first permanent molars in local population of Rawalpindi and Islamabad.

**Study Design:** Descriptive cross sectional study.

**Place and Duration of Study:** The study was conducted from 1<sup>st</sup> January to 30th June 2017 at Islamic International Dental Hospital (IIDH), Riphah International University, Pakistan.

**Materials and Methods:** Mesio-buccal root of eighty two maxillary first permanent molar teeth collected from Islamabad and Rawalpindi were analyzed using the Clearing Technique. Convenience sampling technique was used. Data was analyzed by using SPSS version 24. Descriptive statistics were used. Frequency and percentages were calculated for types of canal configuration.

**Results:** The frequency of a single canal orifices in the mesiobuccal root of maxillary first molar was 48.7% (type I, III, V and others), that with two canal orifices was 50% (type II, IV, VI and others), whereas with three canal orifices was 1.23%.

**Conclusion:** According to the results of this study, a second canal is common occurrence in local population of Rawalpindi and Islamabad. The distribution of canal configurations of our population differs from other populations suggesting ethnic/racial divergence.

**Key Words:** Canal Configuration, Maxillary First Molar, Second Mesio-buccal Canal.

## Introduction

The Principal aim of carrying out endodontic treatment is to shape and clean all the pulpal spaces, thoroughly.<sup>1,2,3</sup> Root canal morphology of the teeth is often very complex and extremely variable.<sup>4,5</sup> False presupposition regarding root canal morphology of tooth leads to inaccurate diagnosis, inappropriate debridement, ledge formation and instrument separation during endodontic treatment.<sup>6,7</sup> Subsequently, it results in an inadequate root canal

treatment and insufficient apical seal.<sup>1,8</sup> All these factors can decrease the prognosis of the endodontic treatment.<sup>9</sup>

Morphologically, Maxillary permanent first molar is one of the tooth with most variations.<sup>10,14</sup> Current literature highlights that the most common variation in permanent maxillary first molars is the presence of second canal in the mesio-buccal root [MB2].<sup>1,3</sup> The frequency of second mesio-buccal canal in Caucasian population was found to lie between 28-62%.<sup>15,16</sup> The frequency of the second canal is reported to be higher in the Asiatic population.<sup>17,20</sup>

Weine et al reported presence of two root canals in mesio-buccal root of maxillary first molar teeth in 54% cases of the Japanese sub-population.<sup>13</sup> Factors contributing to the variation of morphology are ethnic/racial background,<sup>20</sup> age<sup>21,23</sup> and gender<sup>24,26</sup> of the population.

There is a paucity of research in this area in Pakistani population, which is limited to one study that was carried out in Turner dental school, Manchester. The study found that the prevalence of MB2, in 33 extracted teeth collected from Punjab dental hospital Lahore, were 53%.<sup>18</sup> Considering this the objective of the study was to determine the root

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Funding Source: Nil; Conflict of Interest: NIL

Received: March 29, 2018; Revised: September 14, 2018

Accepted: October 15, 2018

canal configuration of the mesio-buccal root of permanent maxillary first molars by utilizing clearing technique<sup>10</sup> on extracted teeth collected from dental hospitals in Rawalpindi and Islamabad. This knowledge will contribute to the sparse statistics in Pakistan and will be valuable in the clinical training of Pakistani dental students.

### Materials and Methods

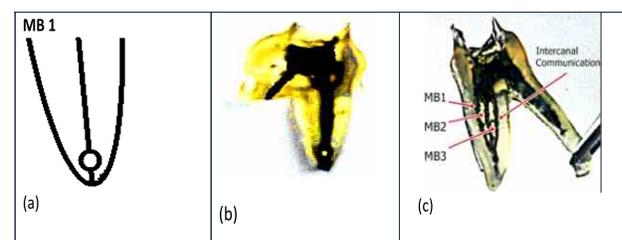
Current descriptive cross-sectional study was carried out at Islamic International Dental Hospital, Riphah International University from 1<sup>st</sup> January to 30<sup>th</sup> June 2017. Convenience sampling technique was used. 150 Extracted permanent maxillary first molars from residents of Rawalpindi and Islamabad, Pakistan were collected. The study was approved by the ethical review board of IIDH. Teeth with fully formed roots, closed apex, intact floor of pulp chamber and intact external morphology apical to the cemento-enamel junction were included in the study. On the other hand, teeth exhibiting root resorption, root fracture, calcified canals, root caries apical to cemento-enamel junction, or root canal treated were excluded. Extracted permanent maxillary first molar teeth were collected from four dental hospitals based in Rawalpindi and Islamabad by the investigators over a period of the six months and examined with naked eye. Out of 150 teeth, adherent soft tissue along with the fragments of bone and calculus were removed from the 82 teeth<sup>27</sup> that were included in the study, by manual scaling before storage in 10% formalin prior to transport to the study site.

On completion of specimen collection, the laboratory process was initiated where each tooth was prepared by creating an endodontic access cavity with diamond fissure burs (Mani, Tochigi, Japan) by holding tooth in hand. After locating orifice using an endodontic explorer, teeth were put in 5.25% sodium hypochlorite (PD, Switzerland) for two days to dissolve the remnants and debris of pulp. Thorough rinsing of all the teeth was performed with running water for four hours with the aim of cleaning the debris from the root canals. Subsequently, demineralization of teeth was done by using 5% nitric acid for 3 days (Merck, Darmstadt, Germany) at room temperature (25-30 °C). The solution of nitric acid solution was changed daily. At the end of the demineralization stage, the specimens were again

rinsed for 4 hours in running water. Before the next step of dehydration of the tooth, the root canals were injected with India ink (BDH, UK), for canal elaboration. The dehydration procedure was comprised of sequential rinses of ethyl alcohol (Merck, Darmstadt, Germany), beginning with eighty percent solution for the duration of night, succeeded by ninety percent solution for sixty minutes and then hundred percent solutions for sixty minutes. Methyl salicylate (Merck, Darmstadt, Germany) was utilized for making the teeth transparent. The teeth were dehydrated for two hours in methyl salicylate. Examination was carried out using a magnifying glass at 5 x magnifications by holding teeth in forceps. A standardized data collection proforma was used for recording the details of canal configuration. Three of the authors first identify canal configurations individually. For 20% of the canal configurations difference of observation was noted, upon initial examination by individual operators. Then these disputed teeth were configured by mutual consensus of the three operators. All the collected data was analyzed using Statistical Package for Social Sciences (SPSS version 24). Descriptive statistics were used. Frequency and percentages were calculated for types of canal configuration.

### Results

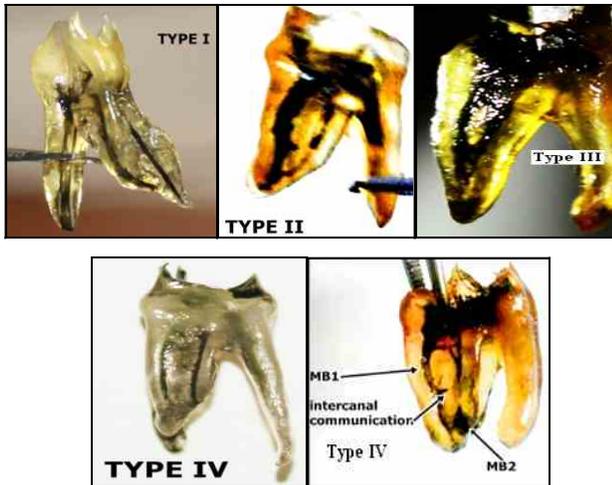
On the basis of inclusion criteria, 82 first maxillary permanent molar teeth were included in the study. Isthmuses (complete or partial) were observed in 37 (45.1%) of Mesio-buccal roots in the present study. 78 (95.1%) of teeth fell into Vertucci classification (Table-I and Figure-2), whereas, 4 teeth (4.9%) either fell into other classification or remain unclassified (Figure-1). Among them one tooth had 3 canals in mesio-buccal root all joining at apical third (Gulabivala type I (3-1)) (Figure- 1c). The remaining three teeth (3.69%) had one mesio-buccal canal with a pinhole at apical third (Figure-1a and 1b).



**Fig 1: Configuration of Canals other than Vertucci's Classification**

**Table I: Configuration of The Mesio Buccal Root of Permanent Maxillary First Molars According to Vertucci Classification<sup>2</sup>**

	TYPE ACCORDING TO VERTUCCI'S CLASSIFICATION					
	I	II	III	IV	V	VI
Number (n)	32	18	1	18	6	3
Percentage (%)	39	21.95	1.23	21.95	7.3	3.6



**Fig 2: Canal Morphology of Transparent Teeth According to Vertucci's Classification<sup>2</sup>**

**Discussion**

Procedural errors that occur during the course of endodontic treatment of permanent molars teeth highlight the importance of better understanding of morphology of root canal systems. Failure of endodontic treatment of first maxillary permanent molar is most likely because of missed second mesio-buccal canal.<sup>8,28</sup> Weine and colleagues<sup>13</sup> has emphasized the importance of a MB2 in the mesio-buccal root of maxillary first molars. Therefore, the purpose of current study was to investigate the variations in the root canal morphology of mesio-buccal root of Maxillary first molar teeth. The findings of the current research differ from those noted in other populations. The difference is particularly noted in relation to the presence of Type III, V and VI root canal configurations as noted in Table II. The results of the present study are in line with the results of research by Shahriaretal<sup>29</sup> on Iranian population. Shahriaretal<sup>29</sup> reported two canals in the mesioobuccal roots in 58.4% and one canal in 37.96% of cases. This correlation between

the results of two studies may be attributed to the geographic region and ethnicity as suggested by Sert and Bayirli<sup>24</sup> Sert and Bayirli argued that gender and ethnic origin must be given due consideration while carrying out the preoperative evaluation for root canal therapy.<sup>24</sup>

In Caucasians, Type I canal configuration was reported to be as high as 72%<sup>15</sup> which is much higher than the frequency in Iranian<sup>29</sup> and Pakistani<sup>18</sup> population. The two populations in which Type III canal configuration were present other than this study were Australian<sup>30</sup> and Turkish.<sup>31</sup> In most of the studies Type V and Type VI canal configuration were not present except Wastietal,<sup>18</sup> Pienda,<sup>21</sup> PT Robyn<sup>30</sup> and Shahriaretal.<sup>29</sup>

**Table II: Root canal configuration of the mesial root of maxillary first permanent molar teeth based on Vertucci's classification. (\*Studies carried out in USA)**

Investigators	Teeth (N)	Percentages (%) for types I-VI based on Vertucci's classification(%)						Other than Vertucci's
		I	II	III	IV	V	VI	
*Pomeranz&Fishelberg <sup>15</sup>	71	72	17	0	11.0	0	0	0
*Pineda & Kuttler <sup>16</sup>	262	39.3	12.2	0	35.7	12.7	0	0
*Vertucci <sup>2</sup>	100	45.0	37.0	0	18.0	0	0	0
PT Robyn <sup>30</sup> (Australia)	216	26.4	19.9	27.3	1.9	12.0	0	0
Shahriar et al <sup>29</sup> (Iran)	137	37.96	24.08	0	24.08	9.5	4.38	0
Wasti et al <sup>18</sup> (Pakistani)	30	33.3	23.3	0	23.3	13.3	6.8	0
Alavi et al <sup>19</sup> (Thai)	52	32.7	17.3	1.9	44.2	1.9	0	1.9
This study( Pakistani)	82	39.0	21.95	1.23	21.95	7.3	3.6	4.9

The highest incidence of Type I canal configuration was 72%<sup>15</sup> in American population. It ranged between 5.9-72%, whereas in current study it was 39% which is very close to study carried out on Iranian population by Shahriaretal<sup>29</sup> and previous study on Pakistani population by Wastietal,<sup>18</sup> 37.9% and 33.3%, respectively. Highest incidence of Type II canal configuration was also in American population 37% as reported by Seidbergetal.<sup>11</sup> In the present study, it was 21.95% which was again consistent with the results of Iranian study<sup>29</sup> and previous study done on Pakistani population<sup>18</sup> that was 24.08% and 23.3%, respectively. Type III canal configuration was found in few populations.<sup>19,30,31,32</sup> Its highest incidence was in Australian population<sup>30</sup> at 27.3% whereas in Pakistani population it was 1.23%. Highest incidence of Type IV was 59.9%,<sup>33</sup> in the current study it was found in 21.95% that is close to results of shahriaretal<sup>29</sup> and wastietal<sup>18</sup> which are 24.08% and 23.3% respectively. Type VI canal configuration in the

mesiobuccal root of permanent maxillary first molars, beside this study (7.3%), was only present in two studies Shahriar et al<sup>29</sup> 4.38% and Wastietal<sup>18</sup> 6.8% which are again very consistent with our results as close proximity of the ethnic/ racial origin and same geographical location. In the current study, Type I (3-1) Gulabivala canal configuration and was found to be in 1.23% of teeth that was previously reported only in Thai population<sup>19</sup> in 1.9% of the samples, Moreover, loops/pinholes were found in 3.67% of teeth at the apical end whereas the their incidence was reported as high as 66.7% in the Italian population<sup>34</sup>. Isthmuses (complete or partial) were frequently observed 37 of teeth (45.1% of the MB roots) in our study, which are reported to be as high as 100% in some previous studies.<sup>35,37</sup> The frequency of MB2 found in the current study is 50% which is in agreement with the previous study conducted by Wastietal<sup>18</sup> at 53%. In American population frequency of MB2 is in the range of 28-33%<sup>11,15</sup> while in European population it is 78-80%<sup>33,34,38</sup> Low incidence of MB2 in American studies may be due to their racial variation from our population. Thus, it is important to be aware of such variations to achieve a successful endodontic treatment.<sup>39</sup> In spite of the morphological knowledge of MB root of Maxillary first molars, in clinics, location of MB2 canal is almost always challenging.<sup>40,41</sup> Sometimes MB2 can be difficult to locate and treat, because it may share an orifice with MB1 canal.<sup>25,34</sup> So proper protocol must be followed while carrying out the endodontic treatment. Moreover, clinician should have adequate knowledge of canal morphology, schedule adequate clinical time and look for the MB2 by removing mesial dentinal protuberance overlying canal orifice under optimum magnification.<sup>25,42</sup> Additionally, the variation and inconsistency of incidence of MB2 among different studies can be result of insufficient sample size in most of the studies, methods used for the study (in vivo/in vitro), method of canal localization (roentgenographic examination, root sectioning, root clearing or computed tomography), age of the patient when tooth got extracted, ethnicity, geographic location and operators variability.

The limitations of the current research include convenient sampling technique and the lack of demographic information particularly regarding the

age, gender and the ethnicity of the individuals from which specimens were collected. Additionally, the sample was collected from Rawalpindi and Islamabad; hence, cautious approach should be taken while generalizing the results of the study. Thus, future multicenter studies are recommended across Pakistan. This will provide the better understanding of the correlation between the race/ethnicity and morphological variations in the maxillary first permanent molar teeth.

## Conclusion

In the light of the findings of the current study, the frequency of MB2 in the mesio buccal root of first maxillary permanent molar teeth in the local residents of Rawalpindi and Islamabad is high. Moreover, the frequency of pattern of root canal system, in the maxillary first permanent molars in local population of Rawalpindi and Islamabad, differs from other populations but is very close to north-west Iranian population. The multi-ethnic nature of today's urban populations means that dentists treat an increasing number of patients of different and mixed racial/ethnic origin.

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