Prevalence of Unclassified Root Canal Configuration in Permanent Maxillary First Molar in Indian Population.

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ABSTRACT

Background: If a canal is left untreated, it is a foci of infection. Therefore, it is critical to know the usual configuration of the root canal along with the variations in root canal anatomy, in order to keep the cause of endodontic failure to a minimum. Aim: This study investigated the canal configuration in maxillary first permanent molar mesiobuccal root radiographically followed by histological evaluation in Indian population. **Methods:** Endodontic access preparation was performed on 100 human permanent maxillary Ist molars and all the canals were explored. The mesiobuccal root was separated and radiographed in mesiodistal and buccolingual direction. India ink dye was injected actively in the root canal of each sample. The root samples were prepared for histological viewing. The slides made were observed under light microscope and canal configurations were tabulated. **Results:** The radiographic interpretations by observers were correlated with histological findings and analyzed statistically (p value). The radiographic findings revealed a good inter observer agreement (Cohen kappa). On matching histological and radiographic interpretations, it revealed 69.2% Vertucci type I predominance. New unclassified canal configurations were also observed. **Conclusion:** To divulge three dimensional architecture of the root canal, application of alone conventional radiography is not enough.

Keywords: Mesiobuccal root, Permanent maxillary first molar, Root canal configuration.

INTRODUCTION

With the increasing general awareness in our society, both the clinicians and the patient choose to preserve the teeth to maintain the integrity of the dental arch for which endodontic therapy provides a new horizon in dentistry since it is a practical solution to extraction of decayed teeth. One of the reasons of endodontic failure is the improper debridement of the canal, which in turn is due to the inability to detect any anatomical irregularity within it.[1] Thus if a canal is left undetected and untreated, it is a foci of infection.

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Therefore, it is not only critical to know the usual configuration of the root canal but also it is equally important to be familiar with variations in root canal anatomy, in order to keep the cause of endodontic failure to a minimum.[2] Permanent Maxillary first molar is the largest tooth in the arch and possibly the most treated and least understood of all the posterior teeth.[3-5] In the past years the morphology of canal systems in maxillary permanent molars has been evaluated in the various studies.[6,7] Weine and Vertucci analyzed the root canal anatomy and described a standardized classification which was widely accepted.[8,10] P Carrotte in 2004 has described the average root canal configuration for all the teeth.[11] His finding showed prevalence of single canal system in case of upper central incisors, lateral incisors and canines whereas in maxillary first premolar showed single canal(6%), two canals(95%) and three canals system(1%).[11] Maxillary second molar has incidence of single canal (75%), two canals (24%) and three canals (1%).[11] Maxillary first molar has incidence of four canals (93%) and three canals(7%).[11] Maxillary second molar has incidence of three canals (63%) and four canals (37%).[11] In mandibular central incisor, incidence of single canal (58%) and two canals (42%) was

seen.[11] Mandibular Lateral incisor exhibited two canal system (42%).[11] Mandibular canine presented two canals system (6%).[11] Mandibular first premolar showed single canal predominance (73%) while second premolar had single canal system (85%).[11] Mandibular first molar has incidence of four canals (33%) whereas second molar has four canals (8%).[11] Sometimes, two canal system(13%) was also shown by lower second molar.[11] Success of endodontic treatment can be enhanced by proper correlation of clinical, radiographic and histological interpretations. With the help of conventional radiography by taking two radiographs at different angles, it is possible to get an overview of the root canals position. A more detailed and confirmative information regarding root canal morphology can be obtained histologically by demineralization, sectioning and staining. It gives the exact canal configuration thus serves as a "gold standard" *in*-vitro.[4] Ground sections in contrast to sectioning using microtomy is useful tool for undecalcified teeth.[12] In the present study, the teeth specimen were decalcified and then microtomed using automated rotating microtome. This routine microtomy process is helpful in understanding the root canal morphology histologically without disturbing the root canal original internal anatomy. More advanced tool for exploring root canal morphology *in-vitro* is Computed Tomography. The potential for exploring root canal *in-vivo* using computed tomography technique is still a concern due to its radiation exposure, financial cost and is not universally available.

Descriptions of the root canal configuration of permanent molars are based largely relating to the Caucasian origin.[2,13,14] This has prompted the need for further studies of root canal morphology in teeth of non-Caucasian origin in order to know the normal root canal anatomy and its variations that may exist in the dentition of different racial groups. Moreover, there is limited literature available regarding the canal configuration in Indian population.

MATERIALS AND METHODS

One hundred extracted permanent maxillary molars were selected for this study. Selection criteria included teeth with fully formed roots without root fracture, root caries and root resorption. Endodontic access was done in each tooth with the help of round and tapered diamond points and all the canal orifices were located with DG 16 endodontic explorer. Additional mesiobuccal canal orifice was explored with help of Endo Z safe tip bur and gentle probing under dental operating microscope (20.5 x magnifications). Each tooth was then sectioned with diamond cutting disc in

longitudinal direction, buccally following buccal developmental groove to bifurcation point of buccal root, and mesially from lingual outline of mesiobuccal root to the centre of mesial marginal ridge area, so as to retain the whole mesiobuccal root. The root samples were then radiographed in mesiodistal (MD) and buccolingual (BL) directions and subsequently were processed and dried under warm air. The pulp was extirpated from the root canals of these samples and India ink dye (Batch number LM025606 -Loba Chemie, India) was injected actively into the canal orifice. Decalcification of the root samples was done by using 5% Nitric acid at room temperature and the decalcifying fluid was changed daily. The endpoint of decalcification was confirmed by a precipitate formation occurring after addition of 5 ml of saturated ammonium oxalate solution to the decalcifying fluid sample. Sectioning of root samples into three segments at standardized distance of 3 mm, 5 mm and 7 mm from apex was done to obtain apical, middle and coronal third segments respectively. These segments obtained were processed in automatic tissue processor and fixed in ascending grades of ethanol of 50%, 60%, 80%, 95% and 100% respectively. The samples were cleared with xylene to achieve complete transparency. Impregnation with subsequent embedding process within paraffin wax was carried out. 5 micron thickness ribboned sections of segments were obtained using automatic rotating microtome. Histologic slides were prepared, stained with hematoxylin and eosin stains and were viewed under Olympus Trinocular research microscope (x40 magnification). The data was tabulated under radiographic and histological interpretations. In the present ex-vivo study, three observers tabulated the results of the radiographic examination according to Vertucci's classification [Table 1].[10] There was sufficient agreement among Observers A, B and C in conventional radiography results at mesiodistal and buccolingual directions for Vertucci types.

RESULTS

According to Vertucci's classification, the results of mesiodistal view, showed type I canal configuration (39%) predominantly followed by type IV (21%), type V (20%), type VI (11%), type II (5%), type VII (3%) and type III (1%). In buccolingual view, agreement between Observer A, B and C was found for type I canal configuration (84%) followed by type V (10%), type II (4%), type IV (1%) and type VII (1%). Type III, type VI and type VIII canal configurations could not be found. The results of the histologic examination were tabulated according to Vertucci's classification and statistically analyzed. According

to Vertucci's classification, type I (51%) canal configuration was observed in predominance followed by type II (17%), type IV (16%), type V (10%) and Type III (2%) configurations. No samples showed type VI, VII and type VIII canal configuration. Various additional canal configurations were evident in histologic findings, which could not be seen radiographically. These additional types of canal configuration which do not fall under any classification were typed as 1-2-3 canal configuration [Figure 1 A,B,C,], 2-4-1 type canal configuration [Figure 1 D,E, F,] , 3-2-1 type canal configuration []Figure 1 G,H, I,] and 2-3-1 type canal configuration [Figure 1 J,K,L,].
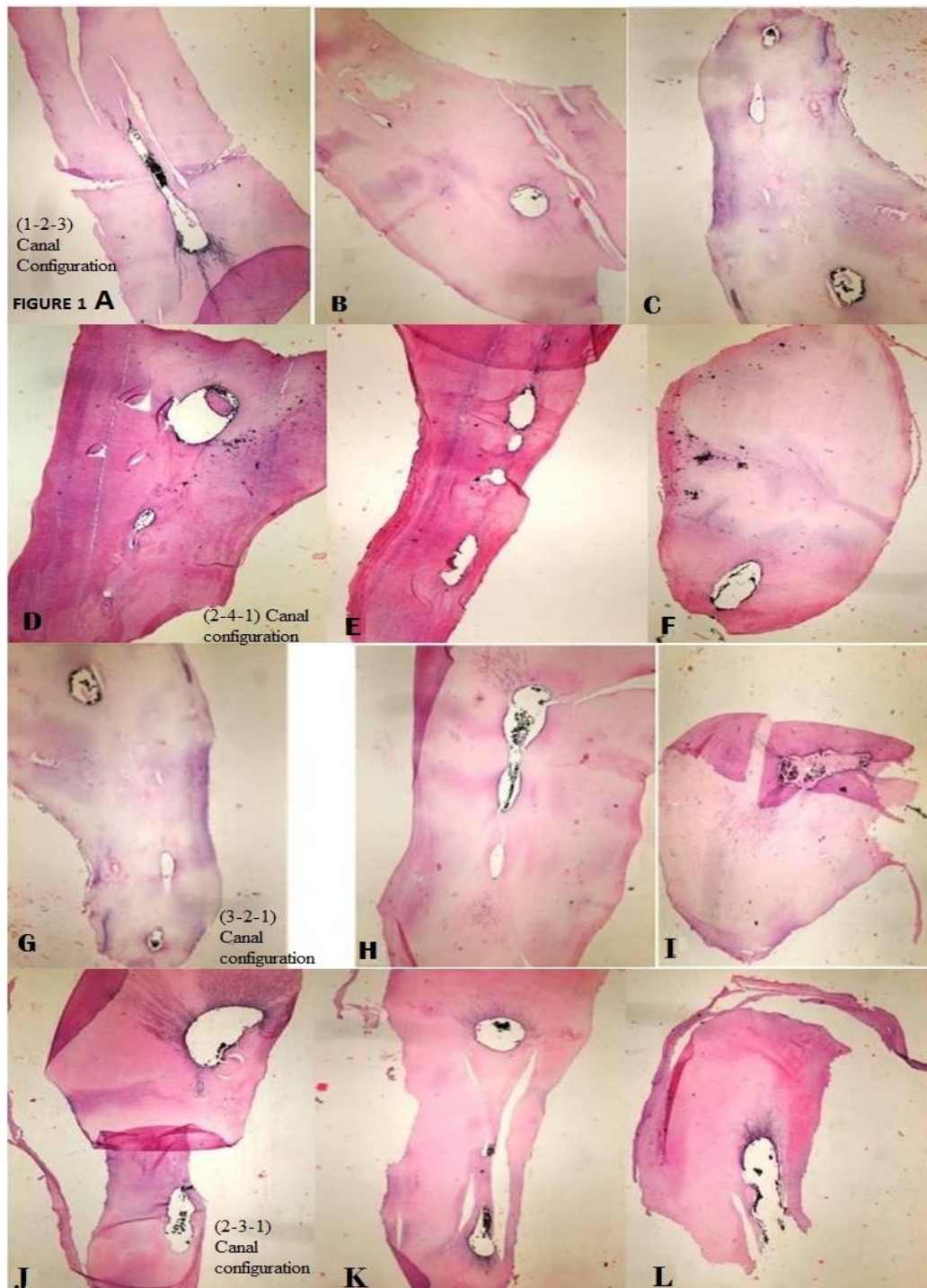

Figure 1: Canal configuration (1-2-3) **A**. coronal section. **B**. middle section. **C**. apical section.
Canal configuration (2-4-1) **D**. coronal section. **E**. middle section. **F**. apical section.
Canal configuration (3-2-1) **G**. coronal section. **H**. middle section. **I**. apical section.
Canal configuration (2-3-1) **J**. coronal section. **K**. middle section. **L**. apical section.

Table 1: Various Root canal morphology classification

Vertucci classification (1984)							
Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7	Type 8
1-1	2-1	1-2-1	2-2	1-2	2-1-2	1-2-1-2	3-3
Gulabivala et al. (2001)							
Type 9	Type 10	Type 11	Type 12	Type 13	Type 14	Type 15	
3-2	2-1-2-1	4-2	3-2	2-3	4-4	5-4	
Sert et al. (2004)							
Type 16	Type 17						
2-3	1-2-3-2						

DISCUSSION

In the present study, the permanent maxillary first molars were considered as they have been described as "possibly the most treated, least understood posterior teeth" by Burns in 1987.[5] Moreover, these teeth also hold a special place in maintaining the occlusal harmony. A major cause of endodontic failure while treating maxillary molars is the inability to locate, debride and obturate the frequently present second mesiobuccal canal (MB-2). Keeping this complexity of root canal system in view, the present *ex-vivo* study was undertaken.

Moreover, many studies carried in past on root canal morphology of Caucasians have indicated variations in root canal configuration.[2,13] This suggested a need for further studies on the anatomy of root canal systems of teeth of non-Caucasian origin to establish the occurrence of root canal variations that may exist in the dentition.[14] As the information on the canal configuration of permanent maxillary first molars of Indian population is scarce, the present study was undertaken.

The present study design is based on the studies conducted by A Eder et al, F S Weine et al, Frank J Vertucci, F Wasti et al and A. M. Alavi et al. [4,9,10,14,15] To undertake a study to evaluate the canal configuration in Indian population, it was decided to take one hundred samples as they showed statistical significance and reliability in results. During endodontic access cavity preparation and exploration of canals, the use of dental operating microscope was employed to increase the possibility of detecting a second mesiobuccal canal.[16] The mesiobuccal root was chosen as it shows complexity and variations in its anatomy, thereby leading to endodontic failure. [5] As radiography in mesiodistal and buccolingual directions is difficult to be carried out in three rooted maxillary molars, it was decided to separate the mesiobuccal root along with the crown portion from the distobuccal and palatal root. In the present study, the classification given by Vertucci in 1984 has been used because it contains more number of variations in canal configuration and is widely accepted.

In the present ex-vivo study, the results of the radiographic examination were tabulated according to Vertucci's classification by three different observers, namely Observer A (Endodontist- I), Observer B (Endodontist- II) and Observer C (Oral Radiologist) to remove bias and to increase reliability in results. There was sufficient agreement among Observers A, B and C in conventional radiography results at mesiodistal and buccolingual directions for Vertucci types. Therefore, it may be assumed that there is no inter-observer difference for radiological images. The findings of Observer A are more congruent with Observer C hence, for further evaluation, only the observations by Observer A have been taken into account for matching with the histological results. In the present study, according to the Vertucci's classification, the results in mesiodistal view and buccolingual view, showed type I canal configuration predominance. Type III, type VI and type VIII canal configurations could not be found. Similar results were also observed by Frank J Vertucci and F Wasti et al.[10,12] The differences between the canal configurations in the present study and that of the other studies can be attributed to the racial difference.[9,13]

CONCLUSION

The present study which evaluated the root canal configuration of the mesiobuccal root of the permanent first maxillary molar in Indian population has revealed that all the types of canal configurations described by Vertucci only type I, II, III, IV and V were detected and type VI, VII and VIII were not observed.

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