VARIATIONS IN ROOT ANATOMY AND CANAL CONFIGURATION OF MANDIBULAR SECOND MOLAR IN AN INDIAN POPULATION

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Abstract
Aim: To investigate variations found in the anatomy of the root(s) and root canal system using a clearing technique of second permanent mandibular molar teeth in an Indian population.
Material & Method: Hundred extracted human mandibular second permanent molars from Indian population were included. Teeth were then immersed in 5% sodium hypochlorite solution for removal of pulp tissue remnants after access cavities preparation; with the application of vacuum at the root end, Indian ink was injected into the root canal systems. Before going to make out the root anatomy and canal configuration of mandibular permanent second molar, tooth has to undergone demineralization followed by immersion into the methyl salicylate solution (oil of wintergreen) and the number and anatomy of roots and root canals configuration were determined according to Vertucci's classification.
Results: Two separate flat roots were found in 85% of the teeth followed by two fused roots and a single conical root in 10% and 5% respectively. 70% of the distal roots of second mandibular molars had one canal. 80% teeth had two canals in mesial root of which 60% were type IV and 20% were type II canal configurations (Vertucci 1984). 5% had C shaped canal configuration.
Conclusions: It is observed that in majority of Indian population, permanent second molars have two roots with two canals in the mesial having type IV canal configuration and one canal in the distal root with type I canal configuration. It is also observed that C shaped canals are found only in 5% of Indian population.
Keywords: C-shape canal, canal morphology, clearing technique, mandibular molars.

Introduction

The understandings of root anatomy and canal configuration have a foremost influence on the success rate of endodontic treatment. Root anatomy and root canal configuration may have definitive racial influences, thereby necessitating the identification of root canal morphologies of different races. Modern dentistry incorporates endodontics as an essential part of restorative and prosthetic treatment, any tooth with pulpal involvement, provided that it has ample periodontal support, can be a candidate for a root canal treatment[1, 2]. Yet, the convolution of the root canal anatomy presents clinical challenges and adversity that often imperil the prime objective of such therapy[3, 4].

Comprehensions of both standard and peculiar anatomy precept the specification of root canal treatment and can unswervingly influence the likelihood of success[5]. Thus, like for any surgical procedure, endodontic treatment should be preceded by a thorough knowledge of pulp chamber and root canal anatomy. Once the assessment of complex anatomy has been done the elimination and prevention of microbial contamination will be directly related to the outcome of disease process. [6]. The study of root and root canal anatomy has endodontic implication[7]. There is significant amount of variation in the morphology of pulpal systems between different races of different individuals and individual between the same races. Location, negotiation and management of canals is deciding factor in various races for success of root canal treatment hence it is imperative to be familiar with variations in root canal anatomy. Various studies have shown variation in the shape and number of canals amongst different races [8,9,10]. In comparison with the mandibular 1st molar the root canal anatomy of mandibular second molar is generally small; the most prevalent configurations are three, two, and four root canals respectively. The two mesial orifices lying close to each other. During shaping and cleaning procedures the concavities of distal aspect of the mesial root and mesial aspect of distal root must be considered. The access cavity is similar to that for the mandibular first molar when three canals are present, which may be more triangular and less rhomboidal. The distal convergent of the buccal and lingual walls forms a triangle in cases where distal orifice is less often ribbon shaped bucco-lingually. The second mandibular molar may have only two canals, one mesial and one distal in cases where the orifices are nearly equal in size and line up in the buccolingual center of the tooth. During root canal procedure the endodontic instrument placed in the mesio buccal canal seems to be in the distal canal with single or fused roots in some mandibular second molars, and this is because of variation of the C-shaped canal where the two canals sometimes are connected by a semicircular slit. Review of literature revealed that in mandibular permanent second molar C-shaped canals were more commonly found when compare to other permanent molars[11]. The expressive communal variation in the C-shaped canals of mandibular second molar in percentile was found

to be in range 10% and 32.7%[12, 13, 14,15,16,17] and this percentile is quite lesser in Indian population. In the past, various techniques have been used to study the canals in *in vitro* studies, such as use of a dental operating microscope, macroscopic sections, microscopic sections, transverse sections, micrometric measurements, examination of intraoral radiographs, clearing and staining, filling and clearing and scanning electron microscopy[18, 19, 20, 21]. Among all these methods, clearing technique is one of the most reliable method to provide a three dimensional analysis of the pulp chamber and root canal system which include diaphonization followed by clearing and staining[22, 23]. A comprehensive literature search showed us that there are limited studies on the root anatomy and canal configuration of Indian mandibular second molars. The aim of this study was to evaluate root anatomy and root canal morphology of permanent mandibular second molar teeth in Indian population by staining and clearing technique.

Material and methods

This descriptive study was conducted in Teerthanker Mahaveer dental college, Moradabad. From department of oral and maxillofacial surgery hundred extracted permanent mandibular second molar teeth were collected and by using curettes and ultrasonic scaler plaque and calculus were cleaned and removed. Diamond round bur of number 2 were used to prepare the access cavities followed by immersion of teeth in 5% sodium hypochlorite (Prime Dental Products Pvt Ltd., Mumbai, India) which dissolve organic debris and soft tissue remnants for one day. Under running tap water tooth were rinsed for two hours and dried overnight. After drying, decalcification of teeth was done for 5–14 days by immersing it in 10% nitric acid solution (Qualigens Fine Chemicals, Mumbai, India) with change in acid solution once in a day. The acid was stirred briskly three times a day with glass rod and with the help of periodic radiograph end point of decalcification was determined. After decalcification procedure was complete the traces of aqua fortis (HNO_3) were removed by washing the specimen under running tap water for 4 hours. By using ascending concentrations of ethyl alcohol (Thermo Fisher Scientific India Pvt Ltd., Mumbai, India) starting with 70% for 12 hours, followed by 90% for an hour and 3 rinses of 1 hour each of 100% ethyl alcohol were used for complete dehydration of the specimens. Immediately after dehydration the specimens were placed in methyl salicylate (Rankem Fine Chemicals Ltd., New Delhi, India) or xylene for two hours which made the extracted teeth transparent. The only reason for storing them in oil of wintergreen (methyl salicylate) as opposed to xylene was because of the highly corrosive nature of xylene. To inject Indian ink into the root canal system an endodontic irrigating syringe with gauge 27 needle was used. The examination of cleared teeth was done under stereo microscope under 7.5x magnifications. The statistical analysis of data was done using the Statistical Package for the Social Sciences (SPSS) at confidence level of 95% and significant level of 5%. P-value £0.05 was considered as significant. The configurations of canals were categorized using Vertucci's classification[7].

1. *Type I*. A single canal extends from the pulp chamber to the apex.
2. 2. *Type II*. Two separate canals leave the pulp chamber and join short of the apex to form one canal.
3. 3. *Type III*. One canal leaves the pulp chamber, divides into two within the root, and then merges to exit as one canal.
4. 4. *Type IV*. Two separate and distinct canals extend from the pulp chamber to the apex.
5. 5. *Type V*. One canal leaves the pulp chamber and divides short of the apex into two separate and distinct canals with separate apical foramina.
6. 6. *Type VI*. Two separate canals leave the pulp chamber, merge in the body of the root, and re divide short of the apex to exit as two distinct canals.
7. 7. *Type VII*. One canal leaves the pulp chamber, divides and then rejoins within the body of the root, and finally re divides into two distinct canals short of the apex.
8. 8. *Type VIII*. Three separate and distinct canals extend from the pulp chamber to the apex.

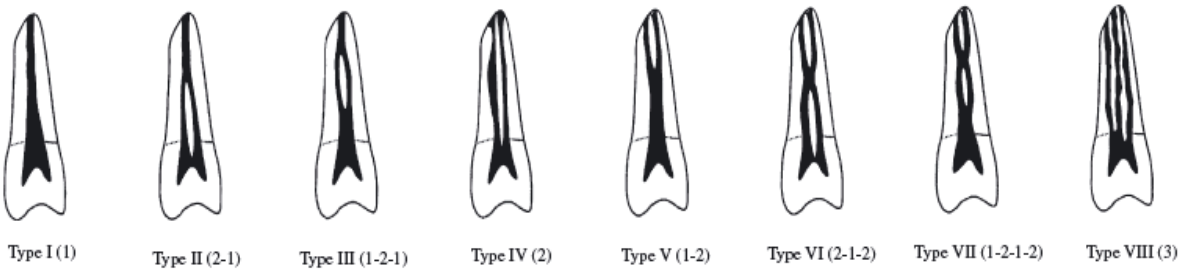

Figure 1: The Vertucci's classification.

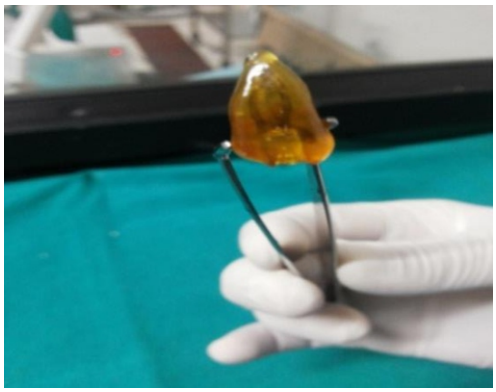

Figure 2: Mesial root having two canals

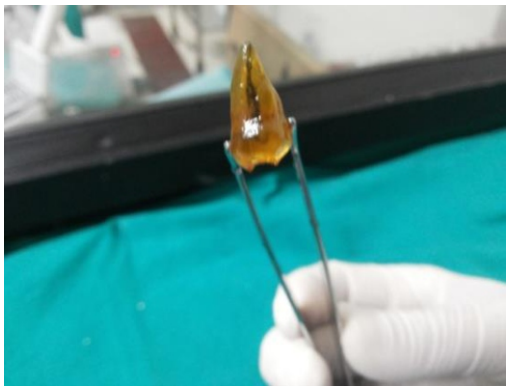

Figure 3: Distal root showing single canal

Table 1: Classification of permanent mandibular 2nd molar by root number and canal morphology:

Two separate Flat root	85%
Two fused root	10%
Single conical root	5%
C shaped canal morphology	5%

Table 2: Curvature in mesial and distal root of mandibular 2nd molar

Mandibular 2nd molar	Mesial	Distal
Straight	64%	76%
Curved	3%	2%
C shaped	5%	3%
Mesially	2%	4%
Distally	20%	10%

Figure 4.Vertucci Type II

Figure 5. Under stereo microscope Curvature in mesial and distal root

Results

Number of roots and canal morphology

Two separate flat roots were found in eighty five per cent of (85%) permanent mandibular second molar. Two fused root in 10% of cases and a single conical root in 5% of total samples studied. While 5% were C shaped canal morphology and remaining have either triangular or rhomboidal canal morphology.

Number of root canals per root and tooth

Mesial roots of mandibular second molar had two canals in 80% of cases, of which according to Vertucci classification, type IV (60%) and type II (20%) canal configurations were most common (fig.2). out of hundred extracted permanent second

mandibular molar 70% of the distal roots had one canal(fig.3).

Discussion

Clearing and staining technique has been the gold standard in determination of roots and root canals complexities as it provides more detailed information and three dimensional evaluation of root canal system.[7,24,25,].In the present study, we used an economical clearing technique that allowed three dimensional surveillance of the teeth. Despite of economical method of studying the root anatomy and canal configuration of the teeth the major drawback of clearing technique is that during decalcification the enamel is completely destroyed and hence the tooth structure cannot be preserved. A higher number of mandibular second molars with single roots and C shaped canal is commonly found in Mongoloid populations[12],[13] as compared to Indian population. In this study it was found that out of the 100 teeth, 5% had single roots and it was 9.3% in Iranian population[26] and 22% in Caucasian[27] and Asian patients[28] followed by 5.45% in other study conducted on Indian population[30]. In this study, 5% of the teeth were C-shaped but in study done by Subha N et al[30]& Neelakantan et al[29] in Indian population, this percentage was 4.55% & 7.5% respectively, in Burmese population[31] this percent was 22.4%, in Iranian population[26] study it was 7.2%. In Jordanian population, Ashraf H et al[32] found 13.8% and Al-Qudah AA & Awawdeh LA et al[33] found 10% of C shaped canals. In this study there was a high prevalence of two-rooted mandibular second molars and a total of 80% of the mandibular second molar teeth were found to have two roots which are closer to the study done by Subha N et al[30] in Indian population that is 91.91%. On comparing the root anatomy of Caucasian[7,10] ,[27]and mongoloid[12] population the permanent mandibular second molar have higher number of two rooted and single rooted teeth respectively.

Conclusion

A precise knowledge of the root anatomy and canal configuration is rationally crucial before any endodontic procedure. Exposure of radiograph at two different horizontal angles and their careful interpretation would help in finding the additional root canals. Simple canal systems have conical roots, whilst complex canal systems have wider roots. In the mesial root of the two-rooted teeth, two canals and in distal root one canal were most frequent. Round canals were most common in two rooted teeth and C-shaped canals in single-rooted teeth. The observations made in this study show that Indian mandibular second molars exhibit both Mongoloid and Caucasian traits.

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