A STEREOMICROSCOPIC IN-VITRO STUDY TO INVESTIGATE THE ROOT CANAL MORPHOLOGY OF MANDIBULAR THIRD MOLARS USING CLEARING TECHNIQUE

ABSTRACT

AIM: To analyse the root canal morphology of mandibular third molars using clearing technique. **MATERIAL AND METHODS:** Ninety permanent extracted mandibular third molar teeth were collected based on inclusion and exclusion criteria. Teeth were then decalcified and were made transparent Methylene Blue Dye was injected to color the pulp space. These teeth were then observed under sterio Microscope and root canal systems were identified according to Vertucci's Classification. **RESULTS:** The most common anatomical morphology found was having two roots. Overall type I Vertucci's configuration was the most common pattern of canals. Other canal patterns that were found included type II, III, IV and V. In this study no canal of type VI, VII or VIII were found. **CONCLUSION:** The morphological variations in root patterns and canal configuration of mandibular third molar should be given consideration for successful endodontic treatment.

ZAFAR, Salwa*
TABASSUM, Sameena*
SABHARWAL, Sumit*
RAI, Vivek Kumar*
SRINIVASAN, Arun*
TANNIRU, Hema Iswarya**

KEYWORDS

Endodontic. Root canal. Stereomicroscopy. Third molar.

Department of conservative and endodontics, Saraswati Dental College and Hospital, Lucknow, Uttar Pradesh, India*
Dental practitioner, Andhra Pradesh, India**
Correspondence: sabharwal@gmail.com (SABHARWAL S)

| **Received** 02 Dec 2014 **Received in revised form** 05 Dec 2014 **Accepted** 07 Dec 2014

INTRODUCTION

Successful endodontic treatment depends on a long-unaltered paradigm: the correct biomechanical preparation of the root canal and its sealing.[1] The dentist must be familiar with dental anatomy, since one of the main reasons for failure in Endodontics is the lack of knowledge in this area.[2] Regarding third molars as teeth with countless individual variations, making anatomic classification difficult[3].

Peters et al.[4] (2001) reported that the original geometry of canal, before shaping and cleaning procedures, had more influence on the changes that occurred during preparation than the instrumentation technique itself. Thus, they emphasized on the importance of root canal anatomy. Sommer et al.[5] (1956) demonstrated a technique where by the teeth were sectioned longitudinally to give a sagittal view of the pulpal spaces from the coronal portion of the apex. The exposed canal was filled with the opaque wax and series of preparations of each tooth was assembled. This method rarely showed the presence of lateral canals or of apical ramifications.

A technique described by Rosenteil[6] (1957) suggested that the root canals be reproduced with a radiopaque material. After the pulpal residue had been removed by a papain digesting solution, the material was introduced by syringe through a previously drilled hole in the proximal surface of the tooth leading to pulpal chamber. Once this was done, radiographs were taken of the teeth and were mounted together or superimposed on one another for study. The criticism of this technique was that the three dimensional aspect of the pulp and depth was lost; the student still had only two dimensional teaching aid. Another method introduced by Barker et al.[7] (1969) suggested that the teeth be reproduced in clear polished resin and that the pulpal spaces be filled with red epoxy resin. This resin is strong and resists fracture. This method was first successful attempt to give truly three dimensional views of the pulpal spaces. It was criticized because the clear plastic specimens were mounted on Perspex pedestals in clear liquid paraffin. This method is extremely difficult to associate the pulpal spaces with the exterior of the tooth. The apical portion of tooth which is greater value to the endodontist was obstructed by the mounting.

There are different radiological methods to evaluate the canals morphologies, such as conventional radiography, tooth clearing, CT, and CBCT; however, conventional radiography, especially periapical radiography, is the most common and simple way.

Advantages of this method are availability, low dosage of required X-ray, and being inexpensive and easy to perform in clinics.

Clearing technique has been found to be the best technique for studying root canal morphology. Omer et al.[8] (2004) have reported that it is better than radiology. The lateral and accessory canals can be better detected with clearing technique.

The morphology of mandibular third molars may be of interest to the operator for many procedures including surgical removal, auto-transplantation for atraumatic procedures, and endodontic treatment as reported by Mendes et al.[9] (2004). Tooth auto-transplantation using mandibular third molars is reported be a useful surgical method to replace non-restorable teeth, with a high long-term survival rate by Yan et al.[10] (2010).

Sidow and West reported that restorative, prosthetic, and orthodontic considerations often require endodontic treatment of third molars in order for them to be retained as functional components of the dental arch.[11] Mandibular third molar is important for maintaining the alveolar arch and it is in close proximity to inferior alveolar nerve so it is essential to understand its morphology for good endodontic treatment.

There have been a large number of studies on mandibular premolars and first and second molars using clearing technique but very few studies are available on third molars especially in Indian population. Hence this study was undertaken to analyse the root canal morphology of mandibular third molars using clearing technique.

MATERIAL AND METHODS

Ninety permanent extracted mandibular first molar teeth were collected from the Out Patient Department of Saraswati Dental College, Lucknow, India. Teeth were collected irrespective of age and sex of the patients. Informed consent was taken from the patients and permission to conduct the study was obtained from the ethical committee of the institutional review board.

The inclusion criteria were intact teeth extracted for (1) Orthodontic treatment, (2) Periodontal diseases, (3) Periapical diseases, (4) Extreme mobility. The exclusion criteria were (1) Grossly decayed or carious teeth, (2) Fractured teeth, (3) Teeth with crazy shapes, (4) Root canal treated teeth, (5) Teeth with full coverage restoration.

Teeth were cleaned of all debris, attached tissue and calculus using an Ultrasonic Scaler and were preserved in 10% of formalin solution. Teeth were measured for length, using Electronic Vernier Caliper (MEKA Electronic Vernier Caliper 150 mm, Model no. 06912, Hangzhou Meka Tools Co. Ltd., Zhejiang, China), from the tip of the crown to the apex of the root. For curved roots, tangents were drawn to the curved portion of the tooth and end length was measured by connecting the points of tangency.

Access cavities were prepared using No. 2 Round diamond point (Mani, Japan) in a High Speed Air Rotor Handpiece (NSK Standard, NSK Company, Japan) with air-water spray. Oval shaped access cavity was prepared which extended bucally up to the tip of buccal cusp, lingually up to lingual cusp inclination; walls were diverged occlusally with No. 2 Endo Access bur (Maillefer, Dentsply, Switzerland) for better visualization of the orifices.

Shape and number of the canal orifices were observed under a Sterio Microscope. Then teeth were placed in 5.2% of sodium hypochlorite solution (Merck Limited, Mumbai, India) for 24 hours. Teeth were then decalcified and were made transparent by technique reported by Robertson et al.[12] (1978).

Following the placement in Sodium hypochlorite solution, teeth were washed with running water for 2 hours, and then placed in 5% of Nitric Acid solution (SDFCL, Mumbai, India) for 72 hours. Nitric Acid solution was renewed every 24 hours.

Teeth were then washed with running water and placed in ascending grades of Isopropyl alcohol (SDFCL, Mumbai, India) i.e. 70%, 80%, 90% and 100% successively for 12 hours each, for a total duration of 48 hours for dehydration.

Teeth were rendered transparent by placing in Methyl Salicylate (SDFCL, Mumbai, Maharashtra, India). Methylene Blue Dye (SDFCL, Mumbai, India) was injected into these decalcified and transparent teeth through the access opening till the dye exited through the apical foramen; thus the entire pulp space were colored. These teeth were then observed under sterio Microscope and root canal systems were identified according to Vertucci's Classification.[13]

RESULTS

In the studied mandibular third molars the number of roots ranged from one to four. Of the total 90 teeth studied 18.9% had 1 root. The majority of teeth had two roots (63.3%) while three roots were found in 13.3%. Only three (0.3%) teeth had four roots.

As far as numbers of canals were concerned it was observed that they ranged from one to four. maximum number of mandibular third molars had two canals (38.9%) followed by four canals in 23.3% and three canals in 20.2% single canal was present. only in 13.3% whereas C shaped canals were found in 2.2% of mandibular third molars (Table 1 and 2).

Most of the teeth with single root had type I Vertucci’s root canal (47.1%). Type II root canal was found in 3 teeth (17.6%). Type III and IV root canals were observed in 2 teeth each (11.7%) while Type V and VI were found in one tooth each (5.9%). C shaped canal was seen in one of the teeth with single root .

Table 1. Number of canals and roots in mandibular third molars of the studied population.

		Number of Canals					
		1	2	3	4	C shaped	Total
Number of roots	1	11	5	0	0	1	17
	2	0	29	11	16	1	57
	3	0	1	8	4	0	13
	4	0	0	0	3	0	3
	Total	12	35	20	21	2	90

Table 2. Classification of root canals according to Vertucci classification in the studied single-rooted mandibular third molars.

Vertucci's classification	Number of teeth	Percentage of teeth
I	7	41.2%
II	3	17.6%
III	2	11.7%
IV	2	11.7%
V	1	5.9%
VI	1	5.9%
VII	0	0
VIII	0	0
C Shaped	1	5.9%

Among the two rooted mandibular third molars mesial roots were of type I Vertucci's configuration in majority of the cases (66.7%).

Type II configuration was seen in 21% of mesial roots. 3.5% of mesial roots were of type III whereas type V was seen in 5.3%. In 1.8% cases the mesial root was found to be calcified. None of the teeth had mesial roots with Type VI,VII and VIII Vertucci's configuration.

The distal roots were of type I configuration in majority of cases (96.4%). In only 3.6% cases they were of type II. None of the other Vertucci's configuration was found in distal roots (Table 3 and 4).

13 out of 90 teeth studied had three roots. Out of these 69.2% had type I configuration in mesio buccal roots. 30.1% had type II configuration and none of the mesiobuccal roots showed type III, IV, V, VI, VII or VIII configuration.

In the mesiobuccal roots type I was again found to be the most common pattern being present in 84.6% of the teeth. Type II pattern was only seen in one tooth whereas one tooth had a calcified mesio lingual root.

The distal root had the most varied pattern. Type I configuration was seen in 77% cases, while Type II, Type III and Type V were found in 7.7% of cases.

DISCUSSION

The technique of clearing teeth has considerable value in studying the anatomy of the root canal system because unlike radiographic images, it provides a three-dimensional view of the pulp cavity in relation to the exterior of the teeth and allows a

comprehensive examination of the pulp chamber and root canal system[13].

Table 3. Classification of root canals according to Vertucci's classification in the studied two-rooted mandibular third molars.

Number of teeth (57)	Mesial Root	Distal Root
38 (66.7%)	Type I	Type I
12 (21.0%)	Type II	Type I
2 (3.5%)	Type III	Type I
1(1.8%)	Type IV	Type I
1(1.8%)	Calcified	Type II
2 (3.5%)	Type V	Type I
1(1.8%)	Type V	Type II

Table 4. Classification of Root canals according to Vertucci's Classification in studied three rooted mandibular teeth.

Number of Teeth (13)	Mesio buccal	Mesio lingual	Distal
7	Type I	Type I	Type I
3	Type II	Type I	Type I
1	Type I	Calcified	Type II
1	Type I	Type I	Type V
1	Type II	Type II	Type III

Although various techniques have been used in studies evaluating canal morphology, it has been reported that the most detailed information can be obtained by demineralization and staining[14] It was anticipated that examination of the fine details (inter-canal communications, lateral canals) would require adequate ink penetration; Methylene Blue is partly able to penetrate fine semi-calcified canals or at least stain their orifices, helping to detect them.

In the present study, number of roots ranged from 1 to 4 and the number of canals also ranged from 1 to 4. None of the teeth had 5 or 6 roots. The above findings are similar to the findings of Sidow et al.[11] (2000) and also Kuzekanani et al.[15] (2012). The most common anatomical pattern of mandibular 3rd Molars found was two roots (56% teeth). This is in conformity with findings of Sidow et al.[11] (2000) (76%) and Kuzekanani et al.[16] (2005) (73%). Also Ng et al.[17] (2001) has also reported that in Burmese population mandibular third molars having two roots was the most common pattern. However Alavi et al. [18] (2002) reported 68% Mandibular 3rd molars have 2 roots in Thai population. The difference between the two studies can be due to different ethnicity. Two canals were present in 46% of teeth which is similar to Gulabivala et al.[19] (2002). Findings with 55% of teeth with 1 root of Vertucci's type I pattern followed by 18.2% with type II pattern. Kuzekanani et al.[16] (2005) has reported type I pattern in 33% and type II in 23%. In teeth with 2 roots the mesial and distal roots both having type I Vertucci's

pattern was most common (64.2%) followed by mesial with type II and distal with Type I combination (11%) which is similar to findings of Kuzekanani's study.[15]

In teeth with 3 roots most common pattern was type I Vertucci's[20] in all 3 roots(55%) i.e. mesiobuccal, mesiolateral and distal followed by combination of type II in mesiobuccal and type I in mesiolateral and distal roots.

A study done on mandibular molars of the Sudanese population (using clearing technique) by Ahmad et al.[21] (2007) it was found that overall 59% of mandibular first molars had four canals with 3% having a third distolingual root. Seventy-eight per cent of second mandibular molars had two separate flat roots, whilst 10% were C-shaped. The most common canal system configurations were type IV (73%) and type II (14%). Inter-canal communications were more common in the mesial roots. The prevalence of inter-canal communications was 65% in first molars and 49% in second molars.

In a study on mandibular third molars in a Korean population Park et al.[1] (2013) reported that most of the mandibular third molars either had two roots (56.5%) or one root (37.9%). There was no significant difference regarding the incidence of the different types of roots according to gender (female versus male) or topology (right versus left side). A higher percentage (80.5%) of the patients had similar root morphology on both sides. Incidence of three roots was found to be rare.

Kuzekanani et al.[15] (2012) carried out a study in extracted mandibular third molars from an Iranian population. Using clearing technique and stereomicroscope they reported that out of 150 teeth studied, 21% had one root. The majority of teeth (73%) had two roots. 5.5% of the teeth had three roots. The incidence of C-shaped canal was 3.5% in this study and 8% of the teeth had at least one dilacerated root.

Sidow et al.[11] (2000) conducted a study on maxillary and mandibular molars. They observed that seventeen percent of mandibular molars had one root (40% of which contained two canals), 77% had two roots, 5% had three roots, and 1% had four roots. Teeth with two roots exhibited highly variable canal morphology, containing from one to six canals, including 2.2% that were "C-shaped." Fifteen percent of maxillary molars had one root, 32% had two roots, 45% had three roots, and 7% had four roots. Teeth with one root demonstrated the most unusual morphology, with the number of canals varying from one to six.

CONCLUSION

On the basis the steriomicroscpoic study of mandibular third molars using clearing technique the most common

anatomical morphology found was having two roots. Overall type I Vertucci's configuration was the most common pattern of canals. Other canal patterns that were found included type II, III, IV and V. In this study no canal of type VI, VII or VIII were found. A larger study is needed to arrive at a definite conclusion and for generalization of the results.

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