

Determination of Number of Apical Foramina in Mesial Root of Mandibular First Molar - Ex Vivo

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ABSTRACT

Objective: This study was design to investigate the number of apical foramen in mesial root canal of mandibular first molar in local population.

Study Design: Cross Sectional Descriptive Study

Place and Duration of Study: The study was conducted to evaluate number of apical foramen in mesial root canal of mandibular first molar at Institute of Dentistry, Liaquat University of Medical and Health Sciences, Jamshoro, from March 2007 to August 2007.

Materials and Methods: One hundred specimens of extracted permanent mandibular first molar teeth were decoronated at cemento-enamel junction. Root canal orifices of mesial root were located and radiograph was taken with 15 # K files inside root canals with visible tip at root apex. The specimens were classified as: 1C/1AF (1canal\1apical foramen); 2C/2AF; 2C/1AF and 3C/ 3AF. The existence of apical foramina/foramen was additionally confirmed under dental operating microscope and classified in the same manner. Out of 100 specimens, 1C/1AF was not observed in specimen, 2C/1AF was observed in 43%, 52% had 2C/2AF and only 5% had 3C/3AF.

Results: A total of 100 specimens of permanent mandibular first molar teeth were included in this study. Periapical radiographs were analyzed to investigate the number of canals of the mandibular 1st molars and compare the number of apical foramina observed on the radiographs to that revealed by dental operating microscope.

Conclusions: Significant difference was not observed in Radiographic and dental operating microscope findings (Wilcoxon rank sum test; $p = 0.99$).

Key Words: Mandibular molar, apical foramina.

INTRODUCTION

Better prognoses in endodontic treatment can only be attained if clinicians have comprehensive understanding of the internal anatomic pattern of teeth.¹ Variations and complexities in the root canal anatomy pose some serious challenges to success rate of endodontic therapy. This complex root canal system limited the clinicians to instrument, debride and obturate usually the main canals.^{2, 3} As the ideal apical endpoint of endodontic instrumentation and root filing has been determined to be the cemento-dentinal junction. Therefore, appropriate sealing of the root canal at cement-dentine junction level at root apex makes almost impossible bacteria to invade the periapical tissues.⁴ In most of the situations the majority of operators attempt to terminate instrumentation 1 mm short of the radiographic apex.⁵ The knowledge of the morphological dimensions of this particular area therefore is imperative in determining the final shaping diameter in this area. The physiological foramen or apical constriction is considered the terminus of the root canal preparation. Hence, careful radiographical evaluation of two or more periapical radiographs is also essential to get detailed information of the area.^{6,7} The most challenging part of the root canal preparation is the apical third which may be prepared using various

endodontic techniques. Many investigations have worked on tooth morphology, topography, curvature, ramifications of the main root canal, diameters, localization and number of foramina, and apical deltas by using different methods. Since there are differences in selection of materials, methods used, and classification of canal configurations, different opinions have arisen about root canal morphology.⁸ Stressing the significance of canal anatomy, variations in canal geometry before shaping and cleaning procedures had more influence on the changes that occur during preparation than the instrumentation techniques themselves.⁹ The external surfaces of roots often masks their internal complexity. Apart from certain anatomical features in tooth type the racial differences also contributing in this regard.¹⁰ If the root-end preparation only includes the main root canal, bacteria and the other harmful irritants from an isthmus or from an accessory root canal may gain access to the periradicular tissue via the poorly filled root canal system. This would negatively affect the surgical endodontic treatment outcomes.¹¹

From the early work to the most recent studies demonstrating anatomic complexities of the root canal system, it has long been established that a root with a tapering canal and a single foremen is the exception rather than the rule. Investigators have

shown multiple foramina. The traditional classical concept of this anatomy is that usually the root canal narrowed toward the apex and expanded to form the apical foramen. Further, the narrowest part of the canal formed the apical constriction, just short of the Apical Foramen (AF). Some authors had suggested that often no apical constriction is present, particularly with apical pathosis and root resorption. The classic concept is also that the AC forms the minor foramen (or minor diameter): The most apical opening of the root canal is designated the AF or major foramen or greater diameter.¹² The mean distance between the major and minor diameters has been determined to be 0.5 mm in a young person and 0.67 mm in an older individual.⁷ During biomechanical preparation of root canals care must be taken to leave the apical foramen in its original position and to keep it at a suitable diameter for proper debridement of the root canal system.¹³ There are numerous cases in the literature concerning the unusual anatomy of the mandibular first molar especially number of canals & foramina. The presence of a third canal in the mesial root of mandibular molars has been reported to have an incidence rate of 1 to 15%. This additional canal may be independent with a separate foramen, or the additional canal may have a separate foramen and join apically with either the mesiobuccal (MB) or mesiolingual (ML) canal.¹⁴ These differences and variations may be due to different classification systems, and ethnic background of tooth sources.¹⁵ It is necessary to identify these anatomic variations and include them in the apical preparation.¹⁶ Mandibular molars can have an additional root located lingually (the radix entomolaris) or buccally (the radix paramolaris). If present, an awareness and understanding of this unusual root and its root canal morphology can contribute to the successful outcome of root canal treatment.¹⁷ The C-shaped canal configuration was first reported by Cooke and Cox. While most C-shaped canals occupy in the mandibular second molar, they have also been reported in the mandibular first molar, the maxillary first and second molars and the mandibular first pre molar. C-shaped mandibular molars are surnamed for the cross-sectional morphology of its root and root canal.¹⁸ Some classic studies on internal dental anatomy have provided important data for better understanding of endodontics, thus contributing to the success of root canal therapy.¹⁹ Therefore this study was design to investigate the number of apical foramen in mesial root canal of mandibular first molar in local population.

MATERIALS AND METHODS

In this cross sectional descriptive study the term used root canal means pulpal space which confines in root, while Apical Foramina (AF) designates portal exit of root canal that lies 0.2 mm to 2.0mm short of most apical end of root. The study was conducted at

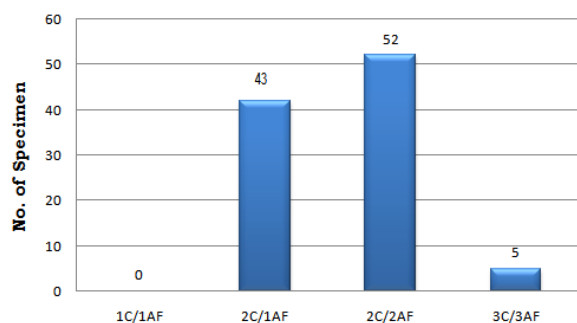
Operative Department of the Institute of Dentistry, Liaquat University of Medical and Health Sciences, Jamshoro from March 2007 to August 2007. One hundred permanent mandibular first molar teeth with patent canals well-developed root were included. While sclerosed canals, previously endodontically treated teeth, immature open apices teeth, teeth with resorbed roots and fractured teeth were not included in this study. Teeth were collected from Dental OPD of Liaquat University Hospital, Hyderabad (extracted for prosthetic or periodontal reasons), and only those teeth satisfying the inclusion criteria were included in the study. Age, sex and ethnical group of the patients from whom the teeth were extracted were not taken into consideration in this study. Dental crowns were removed close to the cemento-enamel junction by pressing the tooth against a plaster abrasion tool. The roof of the pulp chamber completely removed and access to the root canals were obtained without touching the floor of the chamber. Distinct distal root were amputated using a high-speed fissure bur with abundant water-cooling, so that only mesial root were left. Root canal orifices were located with endodontic explorer and canals explored with #06, #08, and #10 K Type endodontic files (Dentsply-Maillefer, Ballaigues, Switzerland) after being irrigated with 1% sodium hypochlorite using a Luer-Lock syringe with a 25/5 gauge dental needle. Once apical patency was obtained, the 10 # files inserted into the canals until the tip of the endodontic file was visualized exiting the apical foramen/foramina. Radiograph was taken with files inside root canals and specimens were be classified as: 1C/1AF (1canal\1apical foramen); 2C/2AF (2canal\2 apical foramen); 2C/1AF (2canal\1apical foramen) and 3C/3AF (3canal\3apical foramen), Furthermore apices were examined to conform the existence of apical foramina/foramen under dental operating microscope and classified in same manner. Collected data was entered in SPSS version 16. The result of radiographic and microscopic examination were tabulated, analyzed and compared statistically using the Wilcoxon rank sum test.

RESULTS

A total of 100 specimens of permanent mandibular first molar teeth were included in this study. Periapical radiographs were analyzed to investigate the number of canals of the mandibular 1st molars and compare the number of apical foramina observed on the radiographs to that revealed by dental operating microscope.

Radiographs were taken with files inside the root canals and the specimens were classified as follows: 1Canal/1 Apial Foramina; 2 Canal /2 Apial Foramen; 1 Canal /2 Apial Foramen; 2 Canal /1 Apial Foramen. Apices were examined under dental operating microscope and the number of apical foramina was recorded. Out of 100

specimens, 1C/1AF was not observed in specimen, 43% (n=43) had observed 2C/1AF, 52% had 2C/2AF and only 5% had 3C/3AF as shown in chart No. 1 & 2. Similarly examinations by dental operating microscope showed that 1C/1AF was also not observed in specimen, 43% (n=43) had observed 2C/1AF, 52% had 2C/2AF and only 5% had 3C/3AF as presented in chart 3 & 4.



File excitement\ Radiograph

Chart No. 1: Number of canals and apical foramen of specimen by file excitement\ radiograph n=100

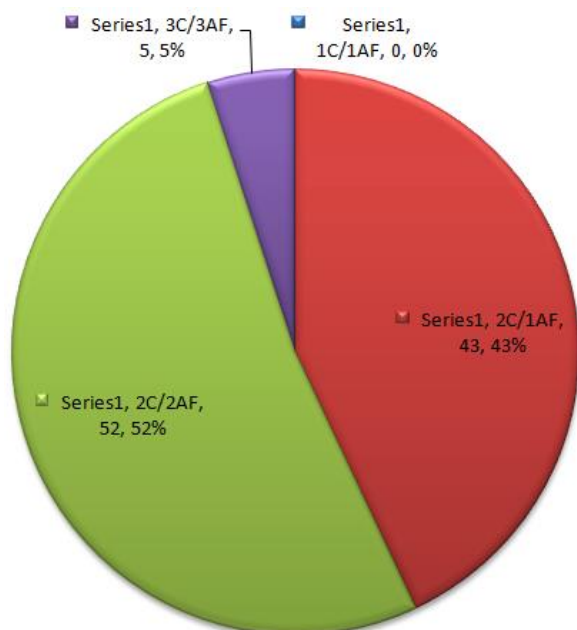
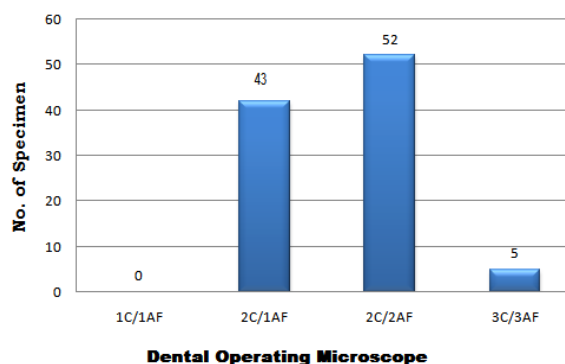


Chart No. 2: Number of canals and apical foramen of specimen By file excitement\ radiograph n=100



Dental Operating Microscope
Chart No.3 Number of canals and apical foramen of specimen under dental operating microscope n=100

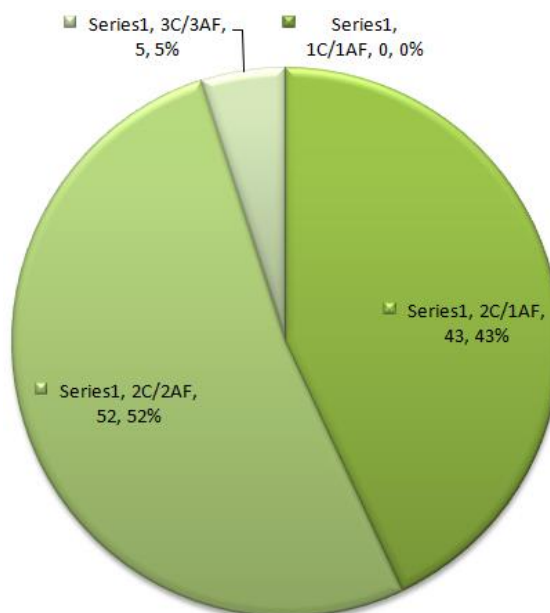


Chart No. 4: Number of canals and apical foramen of specimen. Under dental operating microscope n=100

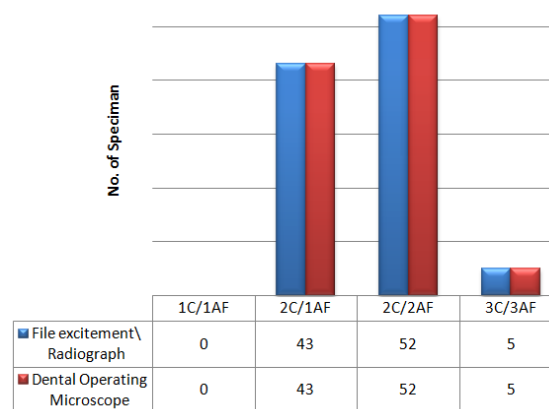


Chart No. 5: Comparison of number of apical foramen (AF) in mesial root canal of mandibular first molar visualized by Radiographs and Dental operating microscope n=100

Table No.1: Comparison of number of apical foramen (AF) in mesial root canal of mandibular first molar visualized by Radiographs and Dental operating microscope n=100

Number of canal / apical foramen by radiographs and microscope

Visualized differences were not statistically significant. (Wilcoxon rank sum test; $p=0.99$).

File excitement/ Radiograph	Dental Operating Microscope			
	1C/1AF	2C/1AF	2C/2AF	3C/3AF
1C/1AF	0	0	0	0
2C/1AF	0	43	0	0
2C/2AF	0	0	52	0
3C/3AF	0	0	0	0
Total	0	43	52	5

The number of AF visualized by radiographs and dental operating microscope of the 100 specimens analyzed is shown in Table 1 & Chart 5. Significant difference was not observed in Radiographic and dental operating microscope findings (Wilcoxon rank sum test; $p=0.99$). Radiographic and dental operating microscope findings for the number of root canal and AF coincided in 100% of the cases.

DISCUSSION

In the current study the mesial root of the lower first molar we have found that two canals with one apical foramen 43%, two canals with two apical foramen 52%, three canals with two apical foramen 5% but we did not find one canals with one apical foramen in any sample. Our results approximately comparable with results of Ponce et al, in their observations only 3% had 3 roots, third root was additional to lingual side to distal tooth root (Table 1). Characteristically the mesial roots of lower first molar existing having two root canals and two apical opening with type IV (44%), V (10%), or VI (6%) canal patterns (Table 2). Moreover, other canal forms were detected in 8% of first molars.⁴ Marroquin detected more than one main apical foramen in all teeth excluding the distal root of mandibular molars and palatal root of maxillary molars. The presences of various root apex openings maximum in proportion were mesial root lower molars (50%), and upper premolars (48.3%).⁶ In another research by Morfis et al.²⁰ with computer aided stereomicroscope observed the apices of 213 anatomies of 523 maxillary and 574 mandibular molars from an Egyptian inhabitants in contrast to our findings they have establish the high ratio of two physiological foramina in mesial (87%) roots of mandibular and mesiobuccal root (71%) of maxillary first molars, respectively; they observed high incidence of accessory foramina in mesiobuccal root (33%) of maxillary molars and mesial (26%) roots mandibular molars. The proportions of root canal patterns of permanent teeth in the people of Sri Lankan and Japanese in mesial root of lower first molar,

characteristically existing with two canals and same number of apical foramina of type IV and two canals and single apical foramen of type II canal configuration in both populations i.e. in Srilankan population mesial root shows 1 apical foramen 33.9%, 2 apical foramina 62.0% and 3% apical foramen. In mesial root of mandibular molars of Japanese population one apical foramen 39.5%, two apical foramina 52.6% and three apical foramina 7.1% were detected. Besides, additional canal varieties were found in 4.1% of mandibular first molar studied in Sri Lankans and 5.3% in Japanese. But in Japanese race, there was a comparatively low incidence of type I and a high occurrence of type IV and additional canal types.^{4,16} The results of these studies match with our findings. In comparable research by Gulabivala et al.⁷ on Burmese natives, found existence of type IV canal system was 18.7% and the occurrence of two openings at root apex was 25.9%. Walker²¹ also observed frequency of two opening at root apex in the distal root of mandibular first molars to be 28.0% in a southern Chinese race. Existence of the two apical exits in above studies is relatively low as compare to our observations.

Several researchers have confirmed three canals in mesial root however one canal was described as individual canal in one incident, the presence of three apical openings in mesial root was confirmed by several authors. Many authors agree on presence of three foramina in the mesial root but a small number of studies show three individual canals that are its own structural variation. Walker quoted three canals in mesial root of lower jaw is a rare incidence. Goel²² states the presence of two apical openings in mesial root in first molar lower jaw 60% sample they studied, 6.7% three and 3.3% were having 4 apical exits. As for as percentage of 3 apical openings Goel's observation do match our results.

CONCLUSION

This study states a mesial root of mandibular first molar with an infrequent numeral and occurrence of root canals and root canal apical exit. It is described by the existence of two or three canals in the mesial root with all canals having distinct openings in the pulpal space cavity. All canals have its individual distinct path however ends in a two root canal apical exit. Therefore; we conclude that internal root canal morphology among all races including our population has almost same pattern.

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