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ORIGINAL ARTICLE

PREVALENCE OF C-SHAPED ROOT CANALS AND ITS TYPES IN MANDIBULAR SECOND MOLARS IN KARACHI PAKISTAN: AN IN-VITRO STUDY

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ABSTRACT

Proper knowledge and insight pre-operatively about the morphology of root canal system are pre-requisites for success of endodontic treatment. C-shaped root canals present challenging anatomic complexity which can often result in complications during endodontic intervention. For the virtue of proper diagnosis and effective endodontic treatment, knowledge related to diagnosis and treatment of this aberrant morphology as well its' frequency in local population is crucial. To determine the prevalence of C-shaped root canals and its types in second mandibular molars in a sample representing Karachi population. This study was Cross-sectional descriptive type. To achieve the calculated sample size Non-probability convenient sampling technique was used. Extracted 210 second mandibular molars of patients were used as samples. Access opening was done using No. 2 round diamond bur. Pulp chamber floor was examined using Dg 16 endodontic explorer. Sodium hypochlorite was used for organic debris and pulpal remnants dissolution and then rinsed under tap running water. Afterwards samples were placed in Nitric oxide and then again rinsed. Dehydration of the samples was performed by using Ethyl Alcohol. Specimens were placed in methyl salicylates for achieving transparency. Dying of the specimens was done using India ink. Samples were observed after sectioning under Stereomicroscope at 7.5x magnification. Out of 210 teeth examined in vitro, 9.5% presented C-shaped root canal among which 45% were found to resemble Melton category I, 20% were belonging Melton category II and 35% of the observed belonged Melton category III. C-shaped root canal morphology is not uncommon in Karachi population. Possible explanation of this could be ethnic predilection and the geographical position of Karachi, Pakistan.

Key words: *C-shaped canal, Second Mandibular Molars, Endodontic treatment, Morphological variation*

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INTRODUCTION

Successful endodontic treatment relies on adequate debridement and three dimensional obturation of root canal system entirely.[1-4] Improper location, preparation or inadequate obturation of the root canal system ends up in endodontic failure.[5] It is necessary for dental clinicians to have substantial knowledge related to the morphological variations that can present in root canal system so as to minimize the procedural errors along with providing adequate endodontic treatment.[5,6]

Studying the tortuous anatomy of roots and its root canal system poses significant impact endodontically as well as anthropologically. Enormous morphological variations are recognized in the presentation of root canals from different populations .[6] Thus for achieving adequate endodontic treatment, it is utmost important to have thorough knowledge about normal as well as

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unusual morphology of the pulp so as to perform meticulous cleaning, shaping and obturation.[1-4] Genetic predisposition and environmental influences posses significant role in variable morphology of teeth, roots along with the root canal system. Knowledge regarding anatomy of root canal system in different racial population hold importance so that the clinicians have full knowledge and are well aware of morphology presenting frequently in a particular race.[7-9]

C-shaped Canal system bears morphological diversity. This term was coined due to the cross-sectional presentation of C shape of the involved root canal.[10] The main cause of this anatomical variation is linked during root development where halt in the developmental fusion of Hertwig's epithelial root sheath occurs. Basic anatomical feature of a tooth which can help to identify a root canal bearing C shape is the occurrence of a typical fin or web type connection between root canals inside tooth. This morphological variation of root canal anatomy often presents considerable challenge not only in thorough debridement but also during proper obturation.[5,11]

Second Mandibular molar is the most common tooth found to have root canals with C shape. [11, 12] Root canals having C shape are evident in maxillary premolars and molars, and in mandibular premolars. [11, 12] Different classifications were presented for efficient understanding of morphology of root canals with C shape.[11-18] Melton[19] has explained three variations of root canals with C shape according to the cross-sectional shape:

C1: C-shaped root canal which is continuous

C2: C-shaped root canal which is semicolon shaped

C3: Two separate and discrete root canals

The most applicable and non-invasive method for determining root canal system morphology is through its radiographic evaluation.[12] Errors often accompany two dimensional presentations whereas; cost and radiation concerns are associated with three dimensional radiographs.[20] Clearing technique historically is used in different researches for exploring the variations seen in morphology of different root canals.[21,22]

Rationale of our study was to rule out the possible prevalence of root canals in second mandibular molars having C shaped morphology in a sample presenting Karachi Pakistan so as to give the clinician knowledge about its occurrence in Karachi Pakistan population.

OBJECTIVE

- To find out the prevalence of C-shaped root canals and its types in second mandibular molars.

METHODOLOGY

This study is Cross-sectional descriptive in which sample size was calculated using non-probability convenient sampling technique. The study was conducted at Hamdard University. Ethical approval was obtained from the university ethical board. Duration of study was 6 months after approval of synopsis. At 95% confidence level using frequency of C-shaped canals 7.2% [3] sample size was calculated to be n=210 with margin of error 3.5%. Software 'Openepi.com' was used to calculate the sample size.

After confirmation through radiographs and physical appearance, extracted teeth included which were:

- Sound mandibular permanent second molars extracted due to periodontal reasons.
- Carious mandibular permanent second molars extracted due to periodontal reasons having intact canal morphology.
- After confirmation through radiographs and physical appearance, extracted teeth excluded which were:
- Grossly carious teeth having root resorption.
- Having calcified canals.
- Having any other anomaly like hypercementosis, fusion and gemination.
- Endodontically treated

Extracted second mandibular molars were collected according to the inclusion criteria from Oral and Maxillofacial Surgery Department of Hamdard University Dental Hospital Karachi. Extracted teeth were washed under tap running water and stored in 0.9% physiological saline. The attached periodontal tissues and calculus remaining after extraction were removed using a curette. Each sample was visually inspected and labeled according to the number of roots. To gain entry into the pulp chamber each tooth was accessed with the help of round diamond bur (Mani, Japan) of size No.2 in high speed hand piece (MRD, China) with water spray. Floors of the pulp chambers were explored using endodontic explorer (DG 16, HU Freiday, Chicago, IL, USA).

After locating canals samples were placed in sodium hypochlorite (5.25%) for 48 hours for dissolving pulp remnants as well as organic debris. Samples were then thoroughly rinsed under running tap water. Afterwards samples were placed in Nitric oxide (5%) at room temperature for 5 days. During immersion, the acid solution was changed each day. Traces of Nitric oxide were removed by rinsing the specimen under tap water.

Dehydration procedure for samples was then performed by keeping teeth in different concentrations of Ethyl alcohol starting from 70% Ethyl alcohol

(12 hours), followed by 90% (1 hour) and 100% ethyl alcohol (1 hour). Transparency of the samples was achieved by immersing them in Methyl salicylate. Next step was to flood the entire pulp chamber with Indian ink via 27-gauge needle. Negative pressure was generated through vacuum suction at the apices of the tooth to make the dye flow through the canals. Superfluous dye was removed by using gauze soaked in 100% concentration of ethyl alcohol. Cleared teeth were sectioned and examined using stereomicroscope with 7.5x magnification.

The data was recorded on M.S Excel 2014. Statistical package for social sciences (IBM SPSS statistics version 23) software was used to enter and analyze all the data,. Simple descriptive statistics including frequency and percentages were noted.

RESULT

Numbers of roots, root canals bearing C shape and its variations as per Melton's classification were recorded. Out of 210 extracted second mandibular molars, 46 (21.9%) were single rooted, 157 (74.8%) were double rooted and 7 (3.33%) were three-rooted (Figure.1). 11 single rooted teeth were found to contain C shaped roots morphology. 20 (9.52%, n==210) second mandibular molars teeth presented root canals having C shape. (Table.1).

In this study, among second mandibular molars which were found to have C-shaped root canals, 9 teeth (45%, n=20) had continuous C-shaped canal which is C1 configuration, 4 teeth (20%, n=20) had semi-colon shaped C-shaped canal which is C2 configuration and 7 teeth (35%, n=20) had two or more separate canals which is C3 configuration (Figure.2). Table.2 illustrate root canals bearing different types of C- shape as per Melton's classification present in different number of roots.

DISCUSSION

Mandibular second molar presents with greater variations in internal and external morphology. [12] In literature, it has been constantly reported that ethnic predilection holds significant worth in the occurrence of C-shaped root canals.[12,13] Also C-shaped root canals have been most documented commonly in second mandibular molars.[13] Knowledge of prevalence in local population along with understanding the morphological presentation can help the clinician in effective management of these cases. Failure to identify the correct morphology of the root canals leads to inadequate disinfection and obturation compromising the endodontic treatment which may results in treatment failure bringing frustration to the patient and clinician.[1,2] Recommendation for the success of endodontic treatment includes proper knowledge or insight pre-operatively about the root

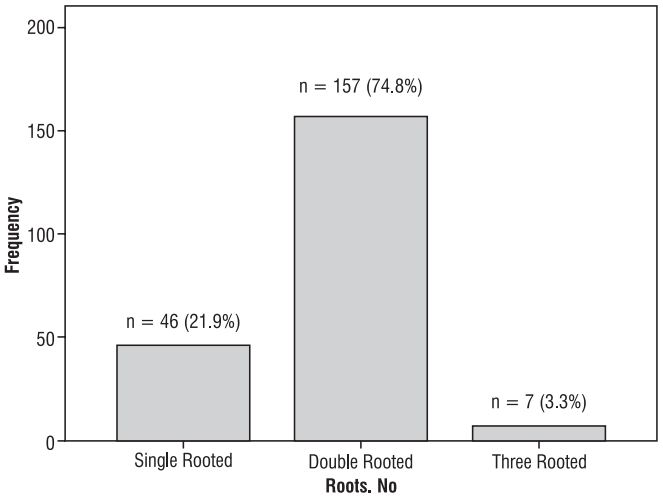

Fig 1: Number of Roots in Mandibular Second Molars

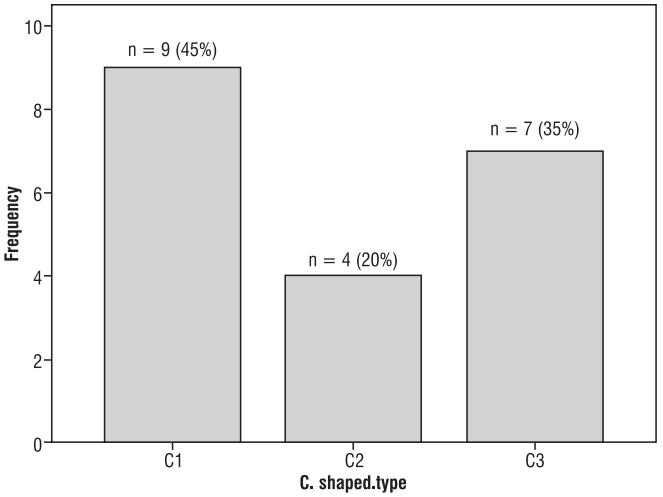

Fig 2: Types of C-Shaped Canals in Mandibular Second Molars

TABLE 1: FREQUENCY OF C-SHAPED CANALS IN MANDIBULAR SECOND MOLARS

Canal Morphology	n (%)
C-SHAPED Root Canals	20 (9.5%)
Non C-Shaped Root Canals	190 (90.5%)
Total	210

TABLE 2: TYPES OF C-SHAPED CANALS PRESENT IN DIFFERENT NUMBER OF ROOTS

No. of Roots	Types of C-Shaped			C-shaped
	C 1 n=5	C 2 n=8	C 3 n=7	n=20
Single rooted	5	4	2	11
Double rooted	-	4	5	9
Three rooted	-	-	-	0

canal morphology.[14] It has documented that root canal system presents great morphological variations in races of different origin and in distinct individuals of same ethnic groups.[23]

As compare to first mandibular molar, greater morphological variations are present in second mandibular molars.[5] Comparing with the first mandibular molar, it is observed that second mandibular molars present with smaller pulp chambers and the root canal orifices. Presentations of one to six root canals have been documented in literature with two, three and four canals being the frequent ones.[5]

In literature morphology of second mandibular molars has been studied in European, Australian and North American populations. C-shaped canals however are reported to greater extent in the Asian populations such as Chinese,[11,24-27] Japanese,[12,15] Korean,[28] Kuwaiti,[29] Lebanese,[16] Saudi Arabian,[17] Emirati,[9] Iranian,[3,14] Indian,[30] and Turkish[31,32] populations. Korean population has the highest reported C shaped canal anatomy i.e. 31% to 45%.[28]

In our study, we used the clearing technique and canal staining, which reportedly can better represent the anatomic configuration three dimensionally than clinical examination and radiographs. This technique is commonly performed in studies due to its accuracy. The morphology of root canal system using canal staining and clearing technique has been studied in Pakistani population by Faraz *et al.*[7] in mandibular first molars and Kalhoro[4] in mandibular second molars.

Historically, Caucasian population has mostly presented with double roots in second mandibular molars.[33-35] Also, researchers reported lower prevalence of second mandibular molars with single roots when studied in Asian or Mongoloid population.[24,27,35]

In our study, 74.76% of the second mandibular molars comprised of double roots which is greater than the reported prevalence by Yang et al in Chinese population i.e. documented as 61%,[24] 58.2% in Burmese population reported by Gulabivala[36] and the reported 54% in Thai population.[37] In second mandibular molars reported prevalence of double roots seems to be quite lower in our study as compared to the prevalence reported by Kalhoro which was 80%[4] in local population from Hyderabad, 86.3% in Iranian population reported by Rahimi[3] and 89.6% in Yemeni population reported by Senan.[30]

In our study prevalence of single rooted second mandibular molars was found to be 21.9% which is greater than 18% reported by Kalhoro[4] in local population and 9.3% in Iranian population by Rahimi[3]. In our study, out of 46 single rooted second mandibular molars 23.9% were found to contain C-shaped root morphology which is quite higher than 9% documented by Senan in Yemeni population.[30]

Significant diversity was witnessed in our study in the root canals number found in the mandibular second molars. Out of 210 selected teeth, 20 teeth were found to contain C-shaped root canal morphology which is 9.52%. Whereas the prevalence noted by Kalhoro [4] was 13% in the local population. Using CBCT evaluation, Hamza et al[38] reported, frequency of presentation of C-shaped root canals in second mandibular molar teeth in a Pakistani subpopulation as 10% which is closer to our study. The prevalence noted in our study is close to the documented 7.2% by Rahimi[3] in Iranian population, 9% by Senan[30] in Yemeni population and 9.1% by Alfawaz[17] in Saudi Arabian population. The prevalence reported is also very close to that reported by Ahmed[23] as 10% in Sudanese population.

In our study, C1 configuration was found to be the most frequent presentation of the C shaped root canals i.e. 45% of the total. Haddad[16] also documented that continuous C-shaped canal belonging to C1 configuration occurs most frequently which is in agreement with our results. Whereas, Kalhoro[4] reported C3 configuration to be most common.

CONCLUSION

Knowledge about canal configuration helps the clinician to utilize better treatment technique for favorable outcome and reduce the procedural errors. Our study shows the prevalence of root canals bearing C shape to be 9.52%. Clinicians need to pay attention towards the possibility of occurrence of C-shaped root canals while treating second mandibular molars so as to prevent endodontic mishaps and facilitate effective cleaning, shaping and obturation.

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5 Hira Akhtar:	Analyzed and interpreted the survey data
6 Muhammad Zohaib Younus:	Data Collection Critically reviewed the manuscript