



PREVALENCE OF C-SHAPED CANALS & RADICULAR GROOVE IN SAUDI-ARABIAN POPULATION: A CROSS-SECTIONAL CBCT STUDY.

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Abstract

Cone-beam computed tomography was used in the current retrospective investigation to determine the prevalence of the C-shaped canal system in mandibular molars and premolars in a Saudi Arabian population (CBCT). A total of 500 mandibular teeth were examined using CBCT images which were analyzed to detect the C-shaped root canal according to Fan's criteria. Only one Mandibular 1st Molar revealed C-shaped canal, whereas 68 Mandibular 2nd Molars (13.6%) & 88 Mandibular 1st Premolars (16.4%) & 30 Mandibular 2nd Premolars (6.4%) showed C-shaped canals. The radicular groove was most classically noticed on Mandibular 2nd Molars (110 teeth-22%), Mandibular 1st Premolars (78 teeth- 15.6%) & Mandibular 2nd Premolars (23 teeth- 4.5%). These results were found to be statistically significant. ($p < 0.05$) The prevalence of C-shaped canals & radicular groove was most commonly noted in Mandibular 1st Premolars & Mandibular 2nd Molars respectively in Saudi population. This study's findings can assist practitioners prevent perforations and root fractures by highlighting how common it is for mandibular premolars and molars to have C-shaped canals and radicular grooves.

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DOI: 10.48047/ecb/2023.12.10.945

Introduction

Understanding the root canal morphology plays a pivotal role in efficacious endodontic therapy. The complexity & variation of the root canal morphology in diverse ethnicity, races, genders and in numerous anomalies of the teeth like dens invaginatus, dens evaginatus, fusion, gemination, taurodontism, supernumerary roots make the endodontic therapy challenging. One such complex anatomic disparity is the presence of C-shaped root canals mostly noted in Mandibular 2nd Molars seen as the letter 'C' in transverse section. C-shaped canals was first documented by Cooke & Cox in 1979 and is seen in Mandibular & Maxillary Molars, Mandibular premolars & sometimes in Incisors also.(1,2) The fundamental feature noted in C-shaped canals is the presence of a fin or web connecting the individual root canals. The clinician needs to be more cautious while treating C-shaped canal morphology as they are wide, oval and have a complex anatomy with potentially wide pulpal tissue. Several problems can arise due to this variation including ineffective sealing ability of the canal (45.2%), missed canals (9.5%), over-obturation (7.1%) & iatrogenic errors (7.1%). This morphology can also result in

formation of elbows during root canal shaping (42.1%) & zip formation (83.5%).(3) Improper knowledge about the C-shaped canal anatomy can lead to irregular debridement, remnants of soft tissue & infected residue or also can be source of bleeding during an endodontic treatment.(4,5)

C-shaped root canal morphology is genetically determined and is dictated by the ethnic origin of an individual. (6) It is found throughout the world, but the prevalence of C-shaped canals is higher in Asian population as compared to American, African and European population. In Malaysian population, the C-shaped root canals were found in 48.7%⁶ of mandibular 2nd molars whereas 10% incidence was found in Jordanian population. (7) Between 31.5% and 42% of extracted teeth for the Chinese population had C-shaped canal systems, according to reports.(8)

Pre-operative radiography cannot reliably detect C-shaped canal morphology, hence new technological methods for magnifying and lighting the root canal, including as dental microscopes, loupes, digital radiographic visualization systems, and CBCT, have been used

recently.(8) Digital radiographic techniques have numerous advantages over the conventional radiographic examination.

After extensive & exhaustive review of literature, it is found that there is a dearth of studies to analyses the root canal morphology & incidence of C-shaped canals in Mandibular 2nd molars in Saudi Arabian population. Likewise, it has been noted that there is a change in canal morphology when tooth is viewed along the root length as opposed to cross section of a tooth. All these problems can result in failure to recognize C-shaped canals & make the cleaning & shaping of root canal system challenging.

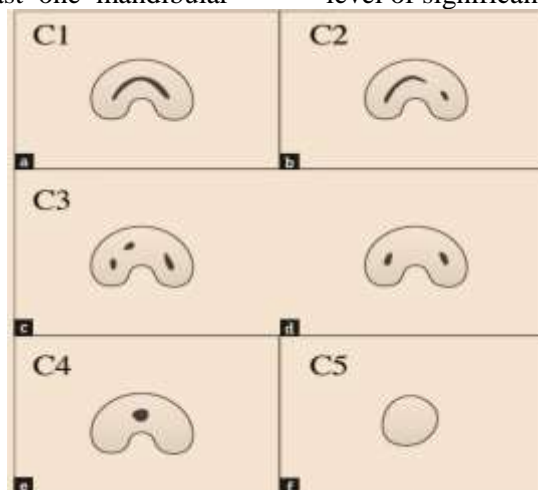
Hence, the aim of the present study is to identify the diagnostic modes including radiography & CBCT to better visualize and study the morphology of C-shaped canals in Mandibular 2nd molars in Saudi Arabian population & also make the visualization of C-shaped canals as a single unit easier.

Methodology

In the Department of Conservative Dentistry & Endodontics at University, 500 consecutive patient examinations conducted between January 2022 and November 2022 resulted in the collection of CBCT images of the mandibular molars and premolars. At least one mandibular

first, second, or mandibular premolar with a completely formed root was required for the inclusion. Clear or distorted CBCT images, root canal treatment, posts or crowns, periapical lesions, and the evidence of physiological or pathological processes such root resorption were among the exclusion criteria. Both a radiographic and clinical examination were used to assess every tooth.

A Endodontist assessed the root canal configuration using Romexis data viewer software (Romexis, Finland). According to Fan et al. (9)'s description of the three anatomical traits necessary to define the C-shaped root canal systems, they were as follows: joined roots, a longitudinal groove on the root's buccal or lingual surface, and at least one cross section of the canal exhibiting a C1, C2, or C3 form. Each tooth's axial, coronal, and sagittal plane slices were examined, and measurements were taken at three different axial levels: apical (2 mm coronal to the radiographic apex), middle (full length of the root divided by 2), and coronal (2 mm below the pulpal floor) (Fig. 1). Data analysis was achieved with the Statistical Package for Social Sciences Version 22 (SPSS Inc., Chicago, IL, USA). The Chi-square test was used to analyze differences between the prevalence of the C-shaped canal and RG, with a level of significance set at p 0.05.



(Taken from Fan et al.,(9))

FIGURE-1 a) the shape was an continuous “C” with no separation b) the canal was similar to a semi colon resulting from a termination of the “C” outline, but either angle should be no less than 60°. c & d) (C3): two or three separate canals (Figs. 1C,

D) and both angles, were less than 60°. e) (C4): only one round or oval canal in that cross-section. f) The canal lumen, which is typically only seen towards the apex, was not visible.

Results

Table 1: Prevalence of C-shaped canal and Radicular groove using CBCT

Variable	Sample size	Mandibular first Molar	Mandibular Second Molar	Mandibular First Premolar	Mandibular Second Premolar	P value
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C shaped	500	1 (0.2)	68 (13.6)	88 (16.4)	30 (6.4)	P<0.05
Radicular Groove (RG)	500	0 (0.0)	110 (22.0)	78 (15.6)	23 (4.5)	P<0.05

Table 1: The data collected depicts the presence of C-shaped canals & Radicular grooves in Mandibular teeth. Out of the 500 teeth examined, a total of 187 teeth were found to have C-shaped canals; whereas 211 teeth were noted with a presence of Radicular Groove.

It was noted that out of the teeth examined C-shaped canals were found mostly in Mandibular 1st Premolars (88 teeth-16.4%), followed by

Mandibular 2nd Molars (68 teeth- 13.6%); whereas Radicular Grooves were found mostly in Mandibular 2nd Molars (110 teeth-22%), followed by Mandibular 1st Premolars (78 teeth- 15.6%). The comparison of the prevalence of C-shaped canals & Radicular grooves between the teeth were found to be statistically significant. (P<0.05)

Table 2: Prevalence of C-shape canal in mandibular molars and premolars in axial level

Tooth	Root level	C1	C2	C3 _(c)	C3 _(d)	C4	Total
Molars	Coronal	11(15.9)	18 (26.1)	24 (34.7)	13 (18.8)	3 (4.5)	69 (100)
	Middle	10 (14.3)	13(18.7)	22 (31.6)	18(26.5)	6 (8.9)	69 (100)
	Apical	4 (6.1)	5 (7.5)	20 (29.5)	22 (31.4)	18 (25.5)	69 (100)
Premolars	Coronal	-	-	12 (10.1)	8 (6.8)	98 (83.1)	118 (100)
	Middle	27 (22.9)	63 (68.6)	6 (5.1)	4 (3.4)	-	118 (100)
	Apical	21 (17.7)	36 (30.5)	18 (15.3)	11 (9.3)	32 (27.2)	118 (100)

Table 2: Almost 69 Mandibular Molars & 118 Mandibular Premolars showed different disparities of Fan's classification laterally along the root length at various cross-sectional levels [Figure 1]. In Mandibular Molars, the C-shaped canal configurations noticed maximum were in the coronal and middle third were C3 (53.5%), whereas C3 (60.9%) and C4 (25.5%) configurations were frequently found in the apical third. In Mandibular Premolars, the most frequently found C-shaped canal configuration at coronal third were C4 type (83.1%), Middle & Apical third were noted as C2 configuration in 63 (68.6%) & 36 (30.5%) teeth respectively.

Discussion

A successful Endodontic treatment entails the step-wise completion of all the procedures which includes a wholistic approach including idyllic instrumentation, irrigation & airtight obturation. But, the very first step begins with the identifying & understanding the root canal morphology thoroughly. Only if all the canals are found, completely cleansed, and three-dimensionally obturated can the successful outcome of endodontic treatment be anticipated. (3,10) The structure of the C-shaped root canal system is intricate and endodontically difficult. It is distinguished by the fusion of the root canals, fins, and isthmus. (11) It is more difficult to identify C-shaped anatomy since it typically appears as a single oval canal in the cervical third and the C-shaped root canal system starts in the middle third. (9)

Numerous diagnostic modalities are now available to overcome the difficulties faced during a Root canal treatment. A three-dimensional imaging technology called CBCT makes it easier and better to comprehend the intricate morphological details.(12) In terms of identifying and interpreting abnormal root canal morphology, CBCT imaging has exceeded conventional radiography.(13) It benefits from a greater resolution and a much-reduced radiation dose.(14)

In the present study among the Mandibular 1st & 2nd Premolars and Mandibular 1st & 2nd Molars examined, we noted that, C-shaped canals were more commonly found in Mandibular 1st Premolars (88 teeth-16.4%), followed by Mandibular 2nd Molars (68 teeth- 13.6%). It is commonly known that Asians are more likely than other races to have C-shaped canals. In 581 extracted Chinese teeth, Yang et al.(15) found that 31.5% of them had C-shaped canals. Likewise, Seo and Park (16) noted the prevalence of C-shaped canals in Korean population in the range of 32.7% in 272 root canal treated teeth, and 31.3% in 96 extracted teeth. Jin et al.,(17) reported that 98 out of 220 mandibular second molars from Koreans had C-shaped canals (45.5%) (17). In contrast, Shemesh et al. (12) found that only 4.6% of mandibular second molars had C-shaped canal morphology, which is within the range seen in Caucasian groups.(12) In the first and second premolars of the mandible, the prevalence of a C-shaped canal was 8% and 3.5%, respectively, according to a comprehensive review by Mashyakhly et al.(18) The review found that

Venezuela had a larger prevalence of C-shaped canals in the first and second premolars of the mandible than Saudi Arabia, with 28.94% and 7.14%, respectively.(19) In a Saudi population, the C-shaped root canal morphology has only been examined in three prior investigations.(20–22) The finding of these studies noted a less number of the C-shaped canal in the Mandibular 2nd Molars (7.9%-10.6%). Using CBCT, Alnowailaty et al.,(23) conducted a study on the Saudi Arabian population and 146 mandibular first molars (24.33%) and 182 second molars (30.33%) revealed C-shaped canals.

The majority of C-shaped molar instances, according to the literature, have a lingual longitudinal radicular groove, and the possibility of a strip perforation in the C-shaped canal was generally discussed.(12,17) Additionally, the dentin surrounding the canal is frequently uneven, with a thin area in the mesiolingual direction known as a "danger zone."(24) In respect to Radicular Groove in Mandibular Premolars & Molars, it was noted in the current study that they were found mostly in Mandibular 2nd Molars (110 teeth-22%), trailed by Mandibular 1st Premolars (78 teeth- 15.6%). In contrast to the mandibular second premolars (4.3%), which tended to have Radicular Grooves (RG) predominantly on the mesiolingual surface of the root, Srivastava et al., (14) discovered that the prevalence of RG in the mandibular first premolars (13%) was substantially greater (p 0.05).

In this retrospective study, the prevalence of the C-shaped canal & radicular grooves were assessed in the Mandibular Molars and Premolars using CBCT scans in Saudi Arabia. Our research was based on CBCT imaging, which prevents a thorough evaluation of the root's apical 2 mm. Therefore, Fan's classification was improved, and type 5 was omitted from the present study. In the present study, the most frequent C shaped canal configurations in the coronal and middle third of mandibular molars were C3 (53.5%), whereas C3 (60.9%) and C4 (25.5%) configurations were frequently seen in the apical third. The most frequent coronal canal configuration in the Iranian population(25) was C1 (50%), followed by C3d in the centre (32.9%), and C3d at the apex (36.6%). While in Saudi Arabia, C3c was more prevalent in the coronal third (37.1%), middle third (32.3%), and apical third (30.6%), which was consistent with our study. (20) The most frequent canal configuration in C-shaped mandibular molars at the coronal,

middle, and apical levels was C1 (41.75%), followed by C3c (51.7%) and C3d (65.9%) in the study by Khawaja et al. (26)

The most frequent C-shaped canal configuration in mandibular premolars was C4 type (83.1%) at coronal third, while C2 configuration was discovered in 63 (68.6%) and 36 (30.5%) teeth, respectively, at the middle and apical thirds. In agreement with our findings, Srivastava et al.,(14) reported that 88% of canals in mandibular premolars were C4 type in the cervical third and that a high frequency of C2 type was discovered in the middle and apical thirds (68.6% and 31.3%, respectively). Our results are in line with earlier studies by Fan et al. (9) and Ordinola-Zapata et al.(27), who used microcomputed tomography and magnifying tools to discover that the coronal third mostly included cross-sections with a single round or oval root canal.(28)

Conclusion

Our study evaluated CBCT images of Mandibular teeth & aimed to analyze the prevalence of C-shaped canals & Radicular Grooves in Saudi-Arabian population. We found significant differences in the prevalence as the C-shaped canals were more commonly found in Mandibular 1st Premolars and Mandibular 2nd Molars. The attempt to examine the C-shaped canals and radicular grooves in a small number of communities around the dental facility was one of the study's limitations. Although the patients came from different places, they weren't necessarily representative of all Saudis. The findings of this study highlight the value of understanding root canal anatomy in addition to utilizing cutting-edge technologies to create updated clinical procedures to successfully treat these instances. According to the results of the current retrospective investigation, CBCT examination is being used more frequently to determine the prevalence of C-shaped canals in mandibular molars in the Saudi population. Future clinical and imaging research is necessary to confirm our findings and offer a thorough assessment and diagnosis of the C-shaped canal and significance of the radicular groove in mandibular molars and premolars.

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