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Prevalence and Morphology of C-Shaped Canals in mandibular second molar in a central Indian population: A CBCT Analysis

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ABSTRACT:

Objective: This study aimed to investigate the prevalence and morphology of C-shaped canals in mandibular second molars within the central Indian population using Cone Beam Computed Tomography (CBCT) analysis.

Methods: A retrospective analysis was conducted on CBCT scans of patients. Mandibular second molars were evaluated for the presence of C-shaped canals based on predetermined criteria. Morphological characteristics including canal configuration was assessed.

Results: Among the examined mandibular second molars (n = 110), the prevalence of C-shaped canals was determined. Morphological variations such as canal configuration types (e.g., C1, C2, C3), was recorded.

Keywords: Mandibular second molar, C-shaped root canal, CBCT, Central Indian population

INTRODUCTION

Success of root canal treatment requires a thorough understanding of variations in canal configuration[1]. The C-shaped canal is an important example of such a variation and was first described using this term in 1979 by Cooke and Cox[2]. C-shaped canals are known to appear most frequently in the mandibular second molars[3].

Manning postulated that the reason for the occurrence of C-shaped canals was the failure of Hertwig's epithelial root sheath to fuse. It is usually characterized by the presence of a fin or web connecting the individual mesial and distal canals having a C-shaped axial section.[4,5,6]Two-dimensional intraoral periapical (IOPA) radiographs do not give an accurate im- age of the presence or absence of such morphology due to superimposition of adjacent anatomic structures.[7] Staining and clearing, the dental operating microscope, and computed tomographic (CT) scans are more contemporary methods of studying the varied root canal anatomy.[8]Cone beam computed tomography (CBCT) is a three dimensional radiographic technique which is non-invasive, with low radiation exposure and analyzes the presence and configuration of such canals.[9,10]

The reported frequency of C-shaped canal ranges from 2.7% to 8%.3.[11] The incidence of C-Shaped canals has a significant ethnic variation. Although C-shaped canal can be formed in any tooth, they are mostly found in permanent mandibular second molars.[12] A mandibular second molar has two roots and three root canals but great deal of variations could be seen. Predicting and negotiating a C shaped root canal configuration is challenging, especially because the C shape orifice found on the pulp chamber floor does not always continue to the apical third of the root. Early recognitions of this configuration allows for better debridement and obturation[13].

With the advent of Cone-beam computed tomography (CBCT), 3-dimensional images of the root canal anatomy can be obtained which provides accurate details of the morphology of the root canal which is almost impossible to obtain via conventional radiographic techniques[14].

The aim of this study is to evaluate the Prevalence and Morphology of C-Shaped Canals in mandibular second molar in a central Indian population.

MATERIALS AND METHOD[15]-

Sample Size Estimation:

The sample size estimation was calculated from previous literature (Sung Eun Yang et al 2021)

Daniel formula for Sample Size:

$$n = \frac{Z^2_{\alpha/2} P (1-P)}{d^2}$$

Where,

Z is the level of significance of 5% i.e. 95% confidence interval=1.96

p= prevalence = 2.76% =0.076

d= desired error of margin =5%= 0.05

$$n = \frac{1.96^2 \times 0.076 \times (1-0.076)}{0.05^2}$$

n= 107.90

n= 110 patients needed in the study

Formula Reference: Daniel et al (1977)

Study Reference: Sung Eun Yang et al

Statistical Formulas: Chi Square Test

Software Used: SPSS 27.0 Version

Using above formula, CBCT images of mandibular second molars will be collected from 110 patients (aged 18-70) who had taken CBCT for diagnostic or other dental purposes.

Inclusion Criteria for CBCT images will be as follows:

> 1. Well-developed mandibular second molars with complete root formation
> 2. Teeth with fused roots
> 3. A longitudinal groove on the lingual or buccal surface of the root
> 4. At least one cross-section of the canal that showed the C1, C2, or C3 configuration

RADIOGRAPHIC TECHNIQUE:

The CBCT images will be taken with an Orthophos SL (Dentsply, Sironna, Germany). The scanning parameters will be set as follows: 85Kv, 6Ma, 14.1 sec exposure, 1535 m Gy Cm^2 radiation dose and 11×11 cm FOV. All CBCT scans will be then reconstructed by the Xelis Image System

IMAGE ANALYSIS:

Endodontist will measure all the images individually with an oral radiologist's opinion as the final golden standard when inevitable disagree on the same images. Views of mandibular second molars the mandibular second molars will be evaluated from the pulpal floor to the apex on coronal, sagittal and axial sections will be observed to determine the canal prevalence, configuration type, bilateral occurrence of C-shaped canals.

| C1		The shape is an uninterrupted "C" with no separation or division
C2		The canal shape resembles a semicolon resulting from a discontinuation of the "C" outline, but either angle α or β should be no less than 60°
C3		Two or three separate canals and both angles, α or β are less than 60°
C4		Only one round or oval canal in that cross-section
C5		No canal lumen can be observed (which is usually seen near the apex only)

C-Shaped Canal Configuration (According to fan et al)
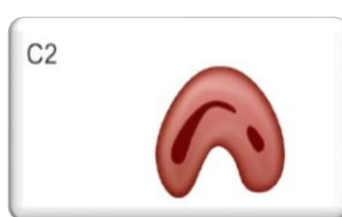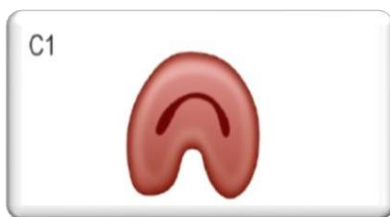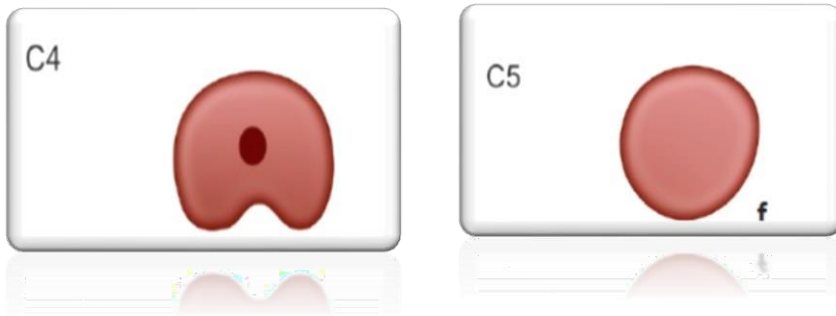
Table 1: Comparison of morphology of C-Shaped Canals at right and left side.

Morphology	Right Side	Left Side	χ2-value
C1	40(36.36%)	38(34.55%)	
C2	39(35.45%)	37(33.64%)	
C3	12(10.91%)	14(12.73%)	
C4	19(17.27%)	21(19.09%)	0.35 P=0.94,ns
Total	110(100%)	110(100%)	

Comparison of morphology of C-Shaped Canals
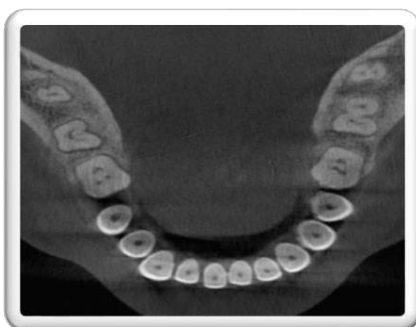
C1
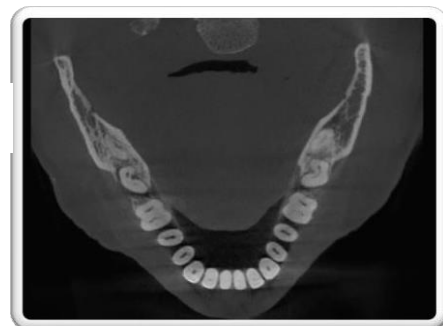
C2

C3

C4

Table 2: Comparison of laterality of C Shaped Canals.

Laterality	No of patients	Percentage
Unilateral	83	85.45
Bilateral	27	24.55
Total	110	100

Images of Comparison of laterality of C Shaped Canals
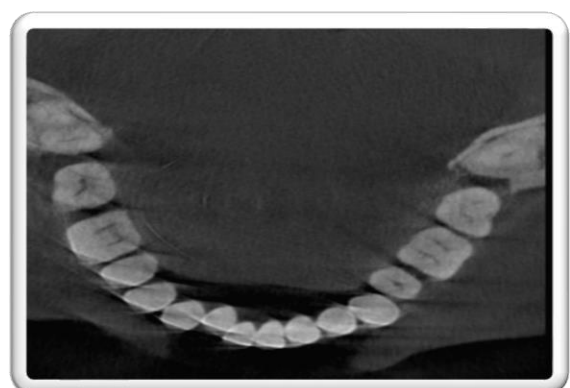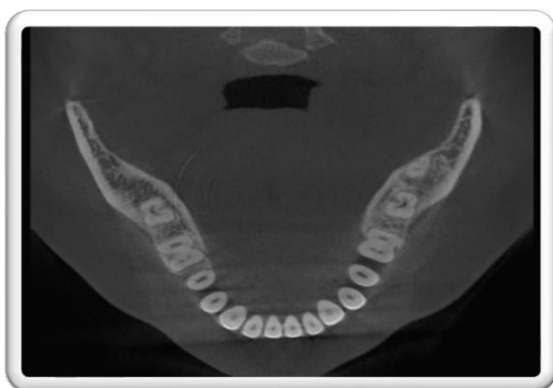
STATISTICAL ANALYSIS:

- Statistical analysis was done by using descriptive and inferential statistics using chi-square test.
- Software used in the analysis were SPSS 27.0 version and GraphPad Prism 7.0 version.
- $p < 0.05$ is considered as level of significance.

DISCUSSION :
- C-shaped root canals are an important variation seen in routine endodontic practice.
- Morphologically, these canal systems may present a conical or square root anatomy on a two-dimensional periapical radiograph with a greater occluso-apical height and a lower level of bifurcation.
- According to study conducted by M. Tassoker *et al* (2018), most of canal orifices demonstrated C1 canal configuration followed by C2 and C3 respectively.
- In this study the type C1 was found to be most prevalent on both side, right (36.36%) and left side (34.55%) And type C3 was found to be least prevalent on both sides, right (10.91%) and left side (12.73%).
- One of the studies done by Singh RD *et al* (2015) in North Indian population showed the overall incidence of C-shaped root canals to be 6.72%.
- According to the studies conducted by Avi Shemesh *et al* (2017) and Hussam Alfawaz *et al* (2019) patients with unilateral presence of the C-shaped canal configuration in mandibular second molar were more common than those with bilateral presence.
- In this study, more number of unilateral (85.45%) C-shaped canal configuration found in mandibular second molar teeth.
- According to study conducted by Kiran kumar N *et al* (2020) 6 out of 30 samples with bilateral second molars had C shaped canals on either side.
- Bilateral presence of the C-shaped canal configuration found to be 24.55%.
- Out of 220 teeth, 78 teeth shows type C1 followed by 76 teeth shows type C2, 40 teeth shows type C4 , 26 teeth shows type C3.
- Most commonly type C1 canal configuration was observed and Type C3 found to be less common.
- A high prevalence of C-shaped canals were observed in the mandibular second molars of the North Indian population studied by Rajan Dhawan *et al* (2021).
- There are some limitation to this study is the distortion of CBCT images. Artifacts related to misalignment are well known issues.

CONCLUSION
- The results of the present study showed that there is a high prevalence of Type C1 was observed unilaterally in the central Indian population in mandibular second molars.
- Further more studies will be required with greater sample size to find out the higher prevalence and morphology of C-shaped canal configuration in central Indian population.

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