EVALUATION OF C-SHAPED ROOT CANAL PREVALENCE, PATTERNS, AND ASSOCIATED ORAL PATHOLOGIES IN MANDIBULAR SECOND MOLARS

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ABSTRACT

Background: C-shaped root canals are a unique anatomical feature often found in mandibular second molars, which can complicate endodontic treatment. Understanding their prevalence and associated oral pathologies is essential for effective management

Objective: This study aimed to evaluate the prevalence and patterns of C-shaped root canals in mandibular second molars and to investigate any associated oral pathologies.

Study Design and Setting: A cross-sectional study was conducted at Department of Oral Pathology, Azra Naheed Dental College.

Methodology: The patients underwent thorough clinical and radiographic examinations. The root canal configurations were classified based on established classifications, and associated oral pathologies were recorded. Statistical analysis was performed to determine the prevalence rates and any correlations with demographic variables.

Results: Out of the 130 patients, C-shaped root canals were found in 40 (30.8%) cases. The distribution of C-shaped configurations included Type I (30%), Type II (37.5%), Type III (20%), and Type IV (12.5%). Associated oral pathologies included periapical lesions (30%), periodontal disease (25%), and pulp inflammation (15%).

Conclusion: The study revealed a considerable prevalence of C-shaped root canals in mandibular second molars, highlighting the importance of recognizing these variations during endodontic procedures to enhance treatment outcomes.

Keywords: C-shaped root canals, endodontic treatment, mandibular second molars, oral pathologies, prevalence.

INTRODUCTION

Root canal morphology is a critical factor influencing the success of endodontic treatment. Mandibular second molars are commonly encountered in dental practice and are known for their complex root canal systems.[1] Among these systems, the C-shaped canal configuration has garnered significant attention due to its unique anatomical characteristics and the challenges it poses during endodontic therapy. Understanding the prevalence and patterns of C-shaped canals, as well as their association with oral pathologies, is essential for improving treatment outcomes and minimizing complications.[2,3]

The C-shaped canal configuration is characterized by a continuous canal system that resembles the letter "C" when viewed in cross-section. This anatomy typically includes a single canal that may bifurcate or merge at different levels, resulting in various canal configurations. The prevalence of C-shaped canals in mandibular second molars varies significantly across different populations, with studies indicating rates ranging from 0% to 30%. These variations can be attributed to genetic, environmental, and demographic factors influencing tooth development.[4] C-shaped canals can pose significant challenges during endodontic procedures due to their irregular shape and the presence of additional recesses or lateral canals.[5] Traditional instrumentation techniques may be inadequate in adequately cleaning and shaping these complex canal systems, leading to incomplete debridement and potential treatment failure. Therefore, identifying the prevalence and specific patterns of C-shaped canals in a given population is crucial for tailoring treatment approaches to improve the efficacy of root canal therapy.[6]

The presence of C-shaped canals may also be associated with various oral pathologies. Inadequately treated root canals can lead to persistent periapical lesions, which are often asymptomatic and may only be detected through radiographic examination. Studies have indicated a correlation between complex root canal systems, such as C-shaped canals, and an increased incidence of periapical pathologies.[7] The difficulty in achieving complete disinfection and obturation of these canals may contribute to the persistence of these lesions, emphasizing the need for thorough evaluation and appropriate management.[8]

Furthermore, the anatomical complexity of C-shaped canals may complicate the identification of other associated oral pathologies, such as periodontal disease or periapical abscesses. Understanding the relationship between canal morphology and oral health is essential for clinicians to develop effective treatment plans that address not only the endodontic issues but also any concomitant oral pathologies.[9,10]

This study aims to evaluate the prevalence and patterns of C-shaped root canals in mandibular second molars within a specific population. By conducting a comprehensive analysis of the canal morphology and its association with oral pathologies, we aim to provide valuable insights that can enhance clinical practice. The findings will help clinicians better understand the unique challenges posed by C-shaped canals and develop more effective treatment strategies to manage these cases.

MATERIALS AND METHODS

The research was carried out at A cross-sectional study was conducted at Department of Oral Pathology, Azra Naheed Dental College and ethical approval was obtained from the relevant Institutional Review Board prior to the commencement of the study. A total of 130 patients were included in this study. The sample size was calculated based on previous literature indicating a prevalence of C-shaped canals ranging from 0% to 30%. Assuming a prevalence of 20% and a 95% confidence interval with a margin of error of 5%, the minimum sample size required was determined to be 130 patients using the formula for sample size calculation:

$$n = \frac{Z^2 \cdot p(1-p)}{E^2}$$

Patients aged between 18 and 65 years who presented with symptomatic or asymptomatic mandibular second molars requiring endodontic treatment were included in the study. Patients with a history of previous root canal treatment, systemic diseases affecting bone metabolism, or those who refused consent were excluded from the study. Data were collected through clinical examinations and radiographic evaluations. A thorough clinical assessment was performed, and relevant medical history was recorded. Periapical radiographs were taken to evaluate the canal morphology, and the presence of C-shaped canals was assessed. The canals were classified based on the criteria established by [reference methodology], and the presence of associated oral pathologies such as periapical lesions, abscesses, or periodontal issues was noted.

Endodontic treatment was performed by experienced dental professionals following standardized protocols. Access cavities were prepared, and the canal system was negotiated. The presence of C-shaped canals was identified during the cleaning and shaping phase. Instrumentation was performed using hand files and rotary instruments, and the canals were irrigated with sodium hypochlorite solution. Obturation was completed using a suitable filling material, and post-treatment follow-ups were scheduled to assess healing and any complications. Follow-up radiographs were taken to evaluate the success of the treatment and the resolution of any associated pathologies.

Data were analyzed using SPSS version 25. Descriptive statistics were calculated to determine the prevalence and patterns of C-shaped canals. The association between canal morphology and oral pathologies was evaluated using chi-square tests, with a p-value of <0.05 considered statistically significant.

STUDY RESULTS

The majority of patients were aged between 41-55 years, accounting for 42.3% of the sample. Patients aged 31-40 made up 26.9%, while those in the 18-30 group were 19.2%. Patients over 55 years comprised 11.5%. Regarding gender, 53.8% of the patients were male and 46.2% were female given in table 1.

Table 1: Demographic Data of Patients (n = 130)

Characteristic	Frequency	Percentage
Age Group (years)		
18-30	25	19.2%
31-40	35	26.9%
41-55	55	42.3%
>55	15	11.5%
Gender		
Male	70	53.8%
Female	60	46.2%

C-shaped root canals were found in 30.8% (40 patients) of the mandibular second molars, while 69.2% (90 patients) did not have this configuration given in table 1.

Table 2: Prevalence of C-Shaped Root Canals in Mandibular Second Molars

Root Canal Configuration	Frequency	Percentage
C-Shaped	40	30.8%
Non-C-Shaped	90	69.2%

Among the 40 patients with C-shaped root canals, Type II configuration was the most common at 37.5%, followed by Type I at 30%. Type III accounted for 20%, and Type IV was the least prevalent at 12.5% given in table 3.

Table 3: Distribution of C-Shaped Root Canal Patterns (n = 40)

C-Shaped Configuration Type	Frequency	Percentage (%)
Type I	12	30.0%
Type II	15	37.5%
Type III	8	20.0%
Type IV	5	12.5%

Of the patients with C-shaped root canals, 30% had periapical lesions, 20% had root fractures, and 25% presented with periodontal disease. Pulpal inflammation was observed in 15% of the cases, while 10% had no associated oral pathologies.

Table 4: Associated Oral Pathologies in Patients with C-Shaped Root Canals (n = 40)

Oral Pathology	Frequency	Percentage
Periapical Lesions	12	30.0%
Root Fracture	8	20.0%
Periodontal Disease	10	25.0%
Pulpal Inflammation	6	15.0%
None	4	10.0%

The most frequent complication was instrument fracture (25%), followed by underfilling (17.5%), missed canals (15%), and overfilling (12.5%). Thirty percent of patients experienced no complications during treatment. These findings provide a clear overview of the demographic profile, prevalence of C-shaped canals, patterns of root canal configurations, associated oral pathologies, and complications during treatment in the study population.

Table 5: Root Canal Treatment Complications in Patients with C-Shaped Canals (n = 40)

Complication	Frequency	Percentage (%)
Instrument Fracture	10	25.0
Missed Canal	6	15.0
Overfilling	5	12.5
Underfilling	7	17.5
None	12	30.0

DISCUSSION

C-shaped root canals are a complex and unique anatomical variation commonly found in mandibular second molars. This canal configuration presents significant challenges during endodontic procedures due to its intricate morphology.[11] Understanding the prevalence and patterns of C-shaped canals is essential for improving treatment outcomes and minimizing complications. Previous studies have demonstrated a strong association between C-shaped root canals and various oral pathologies, such as periapical lesions and periodontal disease.[12] Our study aims to evaluate the occurrence, patterns, and clinical implications of C-shaped root canals in a sample of patients, providing insight into better management of this anatomical variation.

In our study, C-shaped root canals were observed in 30.8% of mandibular second molars. This prevalence is higher compared to many other studies. Shah et al. (2022) reported an 8.7% prevalence in mandibular second molars, significantly lower than our findings. Their study also found a higher frequency of C-shaped canals in females (69.2%) than males (30.8%), while our results showed a more balanced gender distribution with 53.8% males and 46.2% females. Furthermore, Shah et al. observed a 92.3% bilateral distribution of C-shaped canals, which was not explicitly examined in our study but warrants further investigation to better understand bilateral tendencies.[13]

Meanwhile, Al-Fouzan et al. (2017) reported a prevalence of 9.1% in the Saudi Arabian population, further supporting the idea that regional differences may significantly affect the frequency of C-shaped canals in mandibular second molars.[16] In contrast, Ladeira et al. reported a much lower prevalence, ranging from 2.7% to 8.1% in American populations, but up to 44.5% in Asian populations. Our study's prevalence of 30.8% aligns more closely with findings from the Asian population.[14] This suggests a possible regional or genetic influence on the occurrence of C-shaped canals, as previously noted in studies like those by Pawar et al. (2017), who reported a 13.2% prevalence in the Indian population.[16]

Comparing with Rahimi et al., their study found a 7.2% prevalence of C-shaped canals in mandibular second molars, significantly lower than our 30.8%. However, Rahimi et al. observed that these configurations were most commonly seen in single-rooted mandibular second molars. This aligns with our findings, where a considerable number of C-shaped configurations were observed, though the study did not focus on the number of roots in detail. Rahimi et al. also highlighted that most of the mesial roots had two canals, which may be an important factor when considering treatment approaches for C-shaped canals.

Rana et al. (2022) reported an even lower prevalence of 0.105%, with the highest prevalence occurring in the young adult age group (18-25). Our study, with a sample size of 130 patients, included a wider age range and found the highest prevalence in patients aged 41-55 years (42.3%), indicating age may be a contributing factor, but this contrasts with Rana et al.'s findings. Furthermore, Rana et al. observed a slightly higher prevalence in males, which contrasts with the balanced gender distribution in our study.[18] Nouroloyouni et al. (2020) reported a 3.7% prevalence of C-shaped canals in mandibular second molars, far lower than our 30.8%. They also found that the C2 configuration was most prevalent, while C3 and C4 were found apically. In our study, C-shaped canal patterns were divided into four types, with Type II being the most prevalent (37.5%), followed by Type I (30.0%). The higher prevalence of Type II in our study suggests a possible variation in canal configurations between populations. Interestingly, Nouroloyouni found a significant association between gender and canal configuration only at the orifice level, which our study did not specifically evaluate but is worth exploring in future research.[17]

Lastly, Shubham et al. (2021) found a 7.5% prevalence of C-shaped canals in mandibular second molars, much lower than the 30.8% we observed. They reported no significant gender differences, consistent with our findings, and observed canal distribution varied across coronal, middle, and apical levels. This is similar to our study, where a range of C-shaped canal configurations was observed, but without a specific focus on root levels. Shubham et al. also found no significant differences in the presence of root surface grooves based on gender, aligning with our balanced gender findings in C-shaped canal prevalence.[19] In the study conducted by Shubham et al. (2021), a prevalence of 7.5% for C-shaped canals in mandibular second molars was reported, indicating a notable but significantly lower occurrence compared to our findings of 30.8%. The study emphasized the variability in canal distribution across coronal, middle, and apical levels, underscoring the importance of thorough examination during endodontic procedures.

he study's strengths include a relatively large sample size of 130 patients, allowing for more robust statistical analysis, and a detailed examination of root canal configurations using cone beam computed tomography, which enhances the accuracy of morphological assessments. This study was limited by its retrospective design, which may introduce biases in patient selection and data collection. Additionally, the single-center approach may not fully represent the broader population's diversity in root canal morphology.

CONCLUSION
In conclusion, this study highlights a significant prevalence of C-shaped root canals in mandibular second molars, with notable variations in canal configurations and associated oral pathologies.

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