



Anatomical Root Variation in The Permanent Mandibular Canine of Iraqi People Using CBCT: A preliminary study

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Abstract

Background: Knowledge of root canal morphology is essential for performing a successful RCT that includes proper mechanical and chemical debridement, as well as effective root canal filling. Failing to clean and shape all root canals can result in treatment failure due to persistent infection from microorganisms left in the untreated canal.

Aim of the study: To evaluate the presence of a 2nd root in the lower canine or a single root with two canals in the mandibular canine via CBCT.

Material and methods: A total of 316 patients visited our clinic in Baghdad, Iraq, for various treatment modalities. After CBCT imaging to analyse the morphology of the permanent mandibular canine on each side, data were collected and cases with any side of the canine being absent, incomplete root formation, root canal-treated teeth, teeth with periapical pathology, or any internal or external tooth resorption were excluded.

Results: Double-rooted mandibular canines were observed in 32 out of 632 cases (5%). A bilateral examination revealed 8 cases with bilateral double-rooted mandibular canines, while the others exhibited these on the left side only. Variable root canal configuration occurred in 36 cases (5.6%). Significant differences in data were observed between men and women.

Conclusions: Most people's mandibular canines have one canal in single root according to the CBCT examination. All double-rooted mandibular canines occurred in women and most of these were found on the left side. Additionally, mandibular canines with two canals in one root were more frequently observed in women than in men.

Keywords: mandibular canine with second root, two canals in single-rooted canines, CBCT, mandibular canines.

Introduction

Familiarity with root canal morphology facilitates successful RCT with proper mechanical debridement, chemical cleaning, and root canal filling (Vertucci, F. J., 2005; Peikoff & Trott, 1977). Omitting a canal from cleaning and shaping results in treatment failure due to the persistent infection caused by the remaining microorganisms and necrotic tissue within the canal (Neelakantan et al., 2010).

Due to anatomical variations in the root canal morphology, several classifications have been investigated (Weine et al., 1969; Vertucci, F. J., 1984; Gulabivala et al., 2001), Vertucci's classification is the most commonly used (Vertucci, F. J., 1984).

The permanent mandibular canine is typically reported to have the longest single root among the lower teeth with single canal (Pineda, F. & Kuttler, Y., 1972; Ouellet, R., 1995). Anatomical variations in the lower permanent canine have been associated with various genetic and racial factors (Cleghorn et al., 2008; Somalinga et al., 2014). Many studies have documented morphological variations in the permanent mandibular canine (Versiani et al., 2013; Aminsobhani et al., 2013).

Two canals within single-rooted mandibular canines have been reported in about 15 percent of patients (Green, D., 1973; Vertucci, F. J., 1984). The incidence of mandibular canines with two canals in two roots have been documented in approximately 5 percent of patients (Pécora et al., 1993; Ouellet, R., 1995).

The lower permanent canine may have up to two roots (You-Nong et al., 1995; Mirzaie et al., 2012; Zhao et al., 2014; Singh et al., 2016; Yang et al., 2016; Soleymani et al., 2017), with various root canal morphologies based on Vertucci's classification (Figure 1). Several root canal anatomies occur in the Iraqi population.

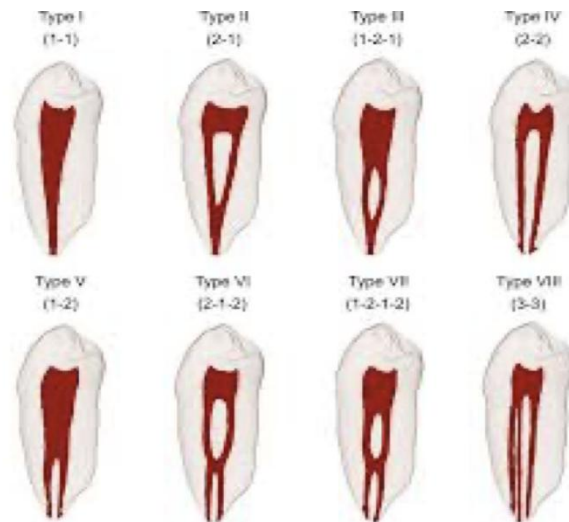


Figure 1: Root canal morphologies based on Vertucci's classification (Vertucci, F. J., 1984)

To study the variation in the root canal morphology of the permanent lower canine, we can use several methods, including clinical inspection during endodontic therapy, retrospective patient assessment, traditional radiography, digital radiography, staining the canal and cleaning the tooth, sectioning of the tooth, examination under microscope, micro-computed tomography and, recently, cone beam computed tomography (Cleghorn et al., 2006; Plotino, 2006; Grover, C., & Shetty, N., 2012).

Patel et al., 2007 reported that CBCT has become the preferred technique to study the morphology of the root canal configuration precisely since it is non-destructive and affords a 3D view of all morphological details of the root canal.

Limited data were available for Iraqi population with regards to the presence of another root in the permanent mandibular canine, therefore, this study targeted to assess the incidence of permanent mandibular canines with morphological variations (two_rooted mandibular canine, or single root occupying multiple canals) in Iraqis using CBCT (Vertucci, F. J., 2005; Al-Dahman et al., 2019).

Materials And Methods

In total, 316 patients came to clinic in Baghdad, Iraq, for various treatment modalities (Ethical Approval No. 279 / University of Anbar). After CBCT imaging to analyse the morphology of the permanent mandibular canine on each side (632 teeth), data were collected and any case of incomplete root formation, root canal-treated teeth, teeth with periapical pathology, or any internal or external tooth resorption were excluded from analysis. Furthermore, excluded any patient who moved during the scanning process.

The NewTom Go 2D/3D (CEFLA S.C. Via Bicocca 14/C 40026 Imola (BO) Italy) was used with the field of view set to 10 mm × 10 mm was used with 150 mm. Only scans with a large FOV were used to afford a clear bilateral view of the permanent mandibular canines. A panoramic x-ray was also performed in cases with variant morphologies.

The research sample of this study involved 96 men and 220 women with 33.5 years mean age. The data were investigated by two specialists (radiologist and endodontist) with in excess of 16 years of practice, considering all views (coronal, axial and sagittal), as shown in the figures (2-6).



Figure 2: Mandibular canine with bilateral presentation of a second canal – CBCT sagittal (a), coronal (b) and axial (c) views.



Figure 3: Bilateral presence of double-canal canines – CBCT panoramic view.

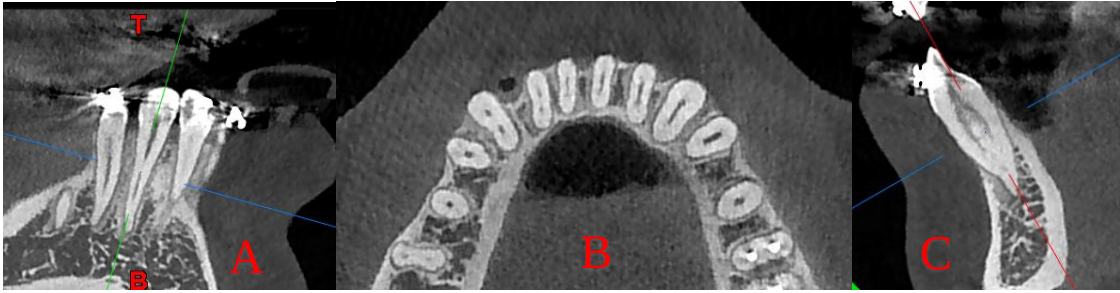


Figure 4: Mandibular canine with unilateral presentation of second canal – CBCT coronal (a), axial (b) and sagittal (c) views.

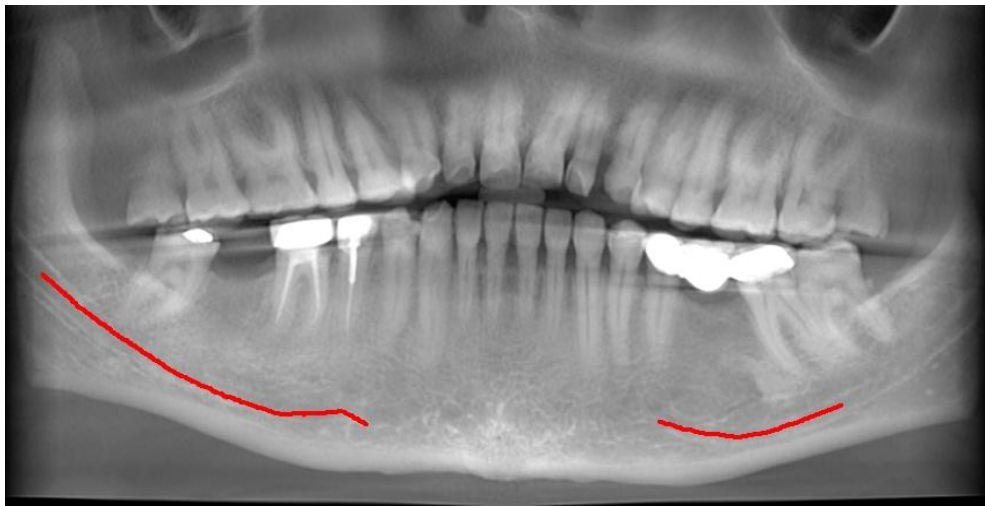


Figure 5: Unilateral presence of double-canal canines – CBCT panoramic view.



Figure 6: Mandibular canine with unilateral presentation of second root – CBCT axial (a) and sagittal (b) views.

Figure 7 presents a panoramic radiograph that shows the clarity of the presentation of a 2nd root in the lower canines compared to the presentation of two canals in single-rooted mandibular canines, which was clear in the CBCT scans.



Figure 7: Bilateral presence of double-rooted canines – Radiograph panoramic view.

Results

Double-rooted mandibular canines were found in 32 of 632 cases (5%). Bilateral examination revealed only 8 cases of bilateral double-rooted mandibular canines; the other cases occurred on the left side alone, as shown in Table 1.

Mandibular canines with two roots	Prevalence	
	Women	Men
Left	24	0
Right	8	0
Total	32	0

Table 1: the prevalence of mandibular canine with the presence of second root

All Two-rooted mandibular canines occurred in women, as Table 1 shows.

Variations in root canal system in the lower canines occurred in 36 cases (5.6%) with Type III configurations according to Vertucci's classification.³³ As Table 2 shows, all occurred bilaterally.

Mandibular canines with two canals in single root.	Prevalence	
	Women	Men
Left	20	4
Right	8	4
Total	28	8

Table 2: The incidence of mandibular canines with a single root occupying two canals

Men accounted for 22% of cases of lower canines with two canals in single root. About 33% of these cases occurred on the right side. The occurrence of lower canines with two roots by age is shown in Table 3.

Age (years)	No. of Two-rooted mandibular canines
15–20	0
21–30	0
31–40	0
41–50	4
51–60	16
61–70	8
71–80	4

Table 3: Incidence of mandibular canines with double roots by age

Table 4 shows the existence of mandibular canines with single root in two canals by age.

Age (years)	No. of One-rooted mandibular canines with two canals
15–20	0
21–30	8
31–40	4
41–50	8
51–60	8
61–70	8
71–80	0

Table 4: Occurrence of mandibular canines occupying single root in double canals by age

A z-test was performed for statistical analysis to show the proportion of each type of root and canal, with significance set at the 0.01 level. The results are presented in Table 5.

	Men		Women		Total	z-test	p-value
	No.	%	No.	%			
One root	192	32.0%	408	68.0%	600	8.29	0.001
Two roots	0	0.0%	32	100.0%	32		
One root and one canal	184	32.6%	380	67.4%	564	7.62	0.001
One root and two canals	8	22.2%	28	77.8%	36	2.93	0.001
Total	192	30.4%	440	69.6%	632	9.39	0.001

Table 5: The proportion of each result with significance set at the 0.01 level

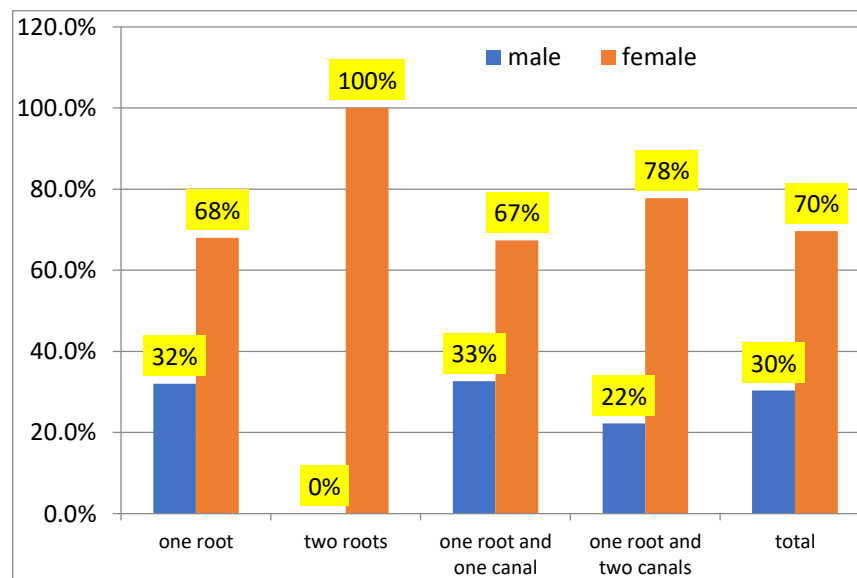


Figure 8: The proportion of each root and canal type by sex

Discussion

The presence of additional roots or canals in permanent lower canines significantly impacts the success rate of root canal treatments. It also influences the treatment plan for periapical surgery, impacted teeth, and orthodontic and periodontal procedures (Piskórz et al., 2023).

To study the variation in the root canal system of permanent lower canine, we can

use several methods like clinical inspection during endodontic therapy, records the retrospective assessment of patient, traditional radiograph, digital radiograph, staining the canal and tooth clearing, sectioning of the tooth, examination under microscope, micro-computed tomograph and recently CBCT (cone-beam computed radiography) (Grover, C., & Shetty, N., 2012; Cleghorn et al, 2006; Plotino, 2006).

According to Vertucci's canal configuration of root canal system, the incidence of two canals in one rooted lower canine or two rooted mandibular canines (Piskórz et al, 2023). Based on Aminsobhani et al. study that found 4.7% of lower permanent canines have two roots, which is approximately near to the percentage of this study (5%). While Rahimi et al. showed higher incidence of two roots in permanent mandibular canines in the examined people in compared with this study (12.08%). According to, Zhengyan et al., Karataşlioğlu et al., Mashyakhly et al., Kayaoglu et al., Han et al. found 0.8%, 3.4%, 2.7%, 3.1%, 1.32% of patients have two-rooted mandibular canines respectively. The difference in the result of studies caused by the ethnic difference and the number of sample size.

Anthropological research indicates that double-rooted lower canines were commonly present in European populations from the 11th to the 19th centuries, while no confirmed cases were found in Asian populations.

We found double-rooted mandibular canines exclusively in women, and a systematic review from 2017 indicated that second roots in lower canines are more common in women more often than in men. Conversely, Soleymani et al. found lower canines with two roots occur more frequently in men than in women.

In this study, 5% of the sample population had double-rooted mandibular canines. This is similar to the rate found in the Pakistani population (5.2%) and the Serbian population (5.8%), although it diverges from

the results of the study performed on an Iranian sample, which found two roots in 12.08% of 149 teeth (Khan, N. et al., 2021).

This study aimed to examine the bilateral symmetry of the number of roots and found approximately 89.85% bilateral root symmetry, which is somewhat lower than Al-Dahman et al.'s finding of 97.7% bilateral symmetry in terms of root number. Eight of 24 (33%) patients had bilaterally symmetrical double-rooted mandibular canines. In comparison, Magdalena et al. reported a 22.2% bilateral symmetry of double-rooted lower canines.

Single-rooted mandibular canines with two canals were found in 5.6% of the patients in our study. This differs from Magdalena et al.'s finding of a 1% incidence rate for lower canines with a single root occupying two canals. All cases involved one root with double canals, classified as Type III canal configuration as said by Vertucci's classification, as in Magdalena et al.

Limitations

In this study, a major limitation was the sample size. Increasing the sample size in future research would enhance the reliability of these results. Additionally, more women participated in this study than men, so the number of men included in future research samples should be increased. That will decrease the failure rate of root canal treatments for mandibular canines.

Conclusions

Consistent with the CBCT examination conducted in this study, most individuals' mandibular canines have one root with a single canal. All double-rooted mandibular canines were found in women, and most of these occurred on the left side. Additionally, the presence of one root occupying two canals in the lower canine also were detected in women rather than men.

Conflict of interest

The authors reported that they have no conflicts of interest.

Acknowledgments

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