

Prevalence of two-rooted and one-rooted mandibular canines with two root canals in Poland, assessed using CBCT: A preliminary study

Magdalena Piskórz^{A–D}, Karolina Futyma-Gąbka^{C,D}, Ingrid Różyło-Kalinowska^{E,F}

Department of Dental and Maxillofacial Radiodiagnostics, Medical University of Lublin, Poland

A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of the article

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Address for correspondence

Karolina Futyma-Gąbka
E-mail: lek.dent.karolina.futyma@gmail.com

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Abstract

Background. The normal anatomy of mandibular canines presents with 1 root and 1 root canal. Two roots are found in approx. 2% of cases, and a bilateral configuration is even rarer. Canines with 2 root canals are found in around 15% of cases. Cone-beam computed tomography (CBCT) enables the detailed visualization of the teeth.

Objectives. The present study aimed to evaluate the prevalence of two-rooted mandibular canines and one-rooted mandibular canines with 2 root canals in a Polish population by using CBCT.

Material and methods. A total of 300 consecutive CBCT scans, taken for different clinical indications, were examined to assess permanent mandibular canine anatomy. The study group included 182 females and 118 males aged 12–86 years (mean age: 31.7 years).

Results. Among 600 cases, 27 two-rooted teeth were found (4.5%), and there were only 6 cases of one-rooted mandibular canines with 2 root canals (1.0%). Six cases of two-rooted canines had this configuration bilaterally, all in females. Five cases of canines with 2 root canals were found on the left side (83.3%). The predominance of the occurrence of two-rooted canines in females (81.5%) was strongly emphasized.

Conclusions. The prevalence of two-rooted mandibular canines in a Polish population, evaluated by means of CBCT, was higher, while the presence of 2 root canals was lower than in recent literature reports. There was no side predilection of two-rooted mandibular canines, although their occurrence was higher in females.

Keywords: CBCT, two-rooted canines, mandibular canines, one-rooted canines with two root canals

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Introduction

Cone-beam computed tomography (CBCT) has become a meaningful tool for diagnosis and treatment planning in dentistry. CBCT images give the opportunity to analyze a case in 3 dimensions – sagittal, coronal and axial. In comparison with medical computed tomography (CT), CBCT is characterized by lower radiation doses, a shorter scan time, better accessibility, and easier interpretation in daily dental practice. Therefore, many dentists use this radiological method for advanced diagnosis and treatment risk assessment.

The proper evaluation of the number of roots or root canals contributes to successful endodontic treatment.¹ The Vertucci system is useful for classifying the configuration of root canals and divides them into 8 types: Type I – a single main canal is present starting from the pulp chamber to the root apex; Type II – 2 separate canals leave the pulp chamber, but join to form 1 canal toward the apex; Type III – 1 canal leaves the pulp chamber and divides into 2 smaller canals, which merge again later to exit as 1 canal; Type IV – 2 separate and completely distinct canals run from the pulp chamber to the apex; Type V – a single canal exits the pulp chamber and divides into 2 canals with separate apical foramina; Type VI – 2 separate canals join at the middle of the root to form 1 canal, which extends to just short of the apex and divides into 2 again; Type VII – the canal starts as single until the middle third of the root, then divides into 2 separate canals that rejoin after some distance, and then divide into 2 again near the apex; and Type VIII – the pulp chamber near the coronal portion divides into 3 separate canals extending to the apex.¹ Ordinola-Zapata et al. created a modified classification system based on micro-CT scans, and identified 37 types of root canal configuration.² Further studies are needed to evaluate the use of this classification in CBCT examinations.

Mandibular canines are mostly one-rooted, and according to Vertucci, the most common type is Type I.¹ However, although it seems easy to treat such a tooth, it can cause

problems, and an unnoticed additional root canal may lead to treatment failure. In orthodontics, impacted two-rooted canines may also cause some difficulties during therapy.³ Nowadays, there is a noticeable tendency to develop three-dimensional (3D) examinations to carry out the entire diagnosis and treatment planning without applying additional radiological methods. Moreover, CBCT also allows the analysis of the soft-tissue profile.^{4,5} Canines are vital teeth, and their role is to provide structural and functional balance, tearing during mastication, and esthetic harmony. Thus, canines should be carefully analyzed to deliver the best treatment plan and keep them in the oral cavity as long as possible.

To the best of our knowledge, no study has evaluated the prevalence of an additional root or root canal in mandibular canines in Poland based on a CBCT examination. Therefore, the present study aimed to assess the prevalence of inferior two-rooted canines and one-rooted canines with 2 canals in a Polish population by using CBCT.

Material and methods

A total of 300 consecutive CBCT scans retrieved from the database of the Department of Dental and Maxillofacial Radiodiagnostics of the Medical University of Lublin, Poland, were analyzed to assess the anatomy of mandibular canines. The study group included only mature teeth, those at stage H according to Demirjian's tooth formation classification, and only the scans with the bilateral presence of canines. Endodontically treated teeth were excluded from the study, as were those with any signs of inflammation, resorption or apical cysts. Other exclusion criteria were the visible movement of the patient and the capping artifacts. The included canines had to be positioned correctly in the dental arch, without significant inclination. The examinations used the VistaVox S CBCT (Dürr Dental, Bietigheim-Bissingen, Germany), with a field of view (FOV) size of 130 mm × 85 mm and a slice thickness of 120 µm. Since some of the patients also

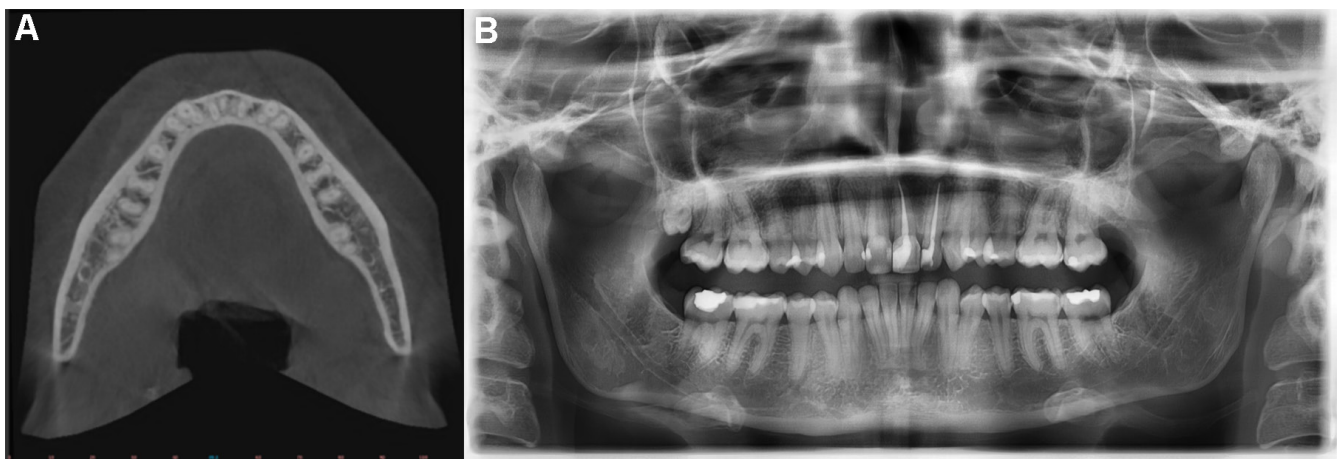


Fig. 1. Bilateral presence of two-rooted canines – cone-beam computed tomography (CBCT) axial view (A). The panoramic image does not provide the full visibility of two-rooted canines (B)

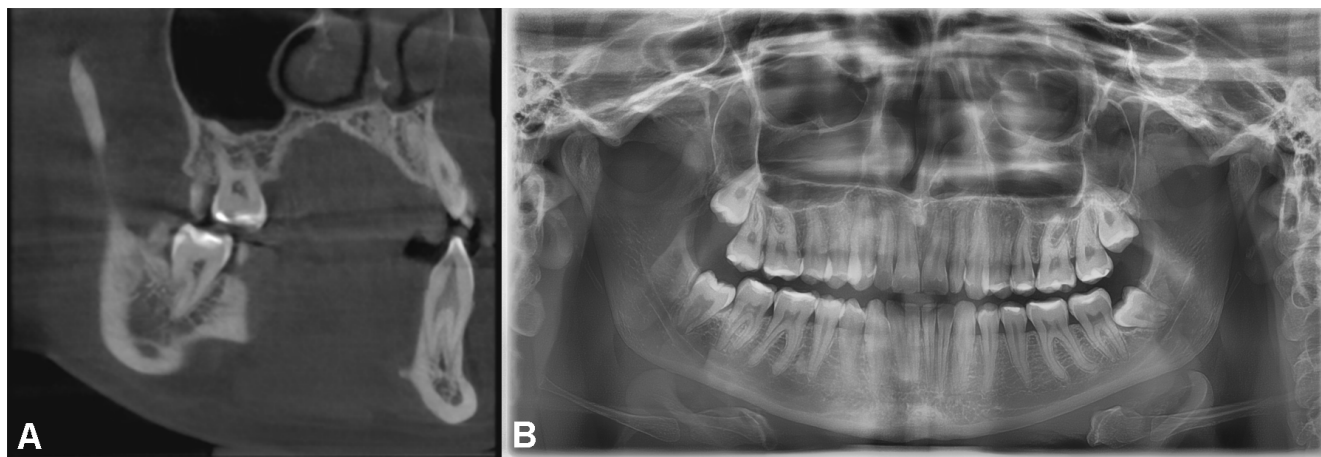


Fig. 2. Left mandibular two-rooted canine – cone-beam computed tomography (CBCT) cross-sectional view (A). The panoramic image does not provide the full visibility of a two-rooted canine (B)

had a panoramic X-ray performed, in the next step of our research, we will compare the visibility of two-rooted canines in both types of examination. Only the scans with a large FOV were included, as not all CBCT images with a FOV of 50 mm × 50 mm provided a clear bilateral view of canines. In such cases, we were unable to evaluate pre-dilection in relation to the side.

The research group included 182 females and 118 males aged 12–86 years (mean age: 31.7 years). The CBCT scans were analyzed by 2 dentists (with 3 and 10 years of experience in the field of dental and maxillofacial radiodiagnostics) in multiplanar reconstructions (sagittal, coronal and axial) and oblique planes, using dedicated image processing software VistaSoft (Dürr Dental) and the Coronis Fusion 4MP radiological diagnostic display system (MDCC-4430; Barco, Kortrijk, Belgium). The examples of the scans are shown in Fig. 1A, 2A and 3.

Two examples of panoramic radiographs are presented in Fig. 1B and 2B to emphasize the validity of the study. The panoramic X-rays showed no clear radiological signs of two-rooted mandibular canines or one-rooted canines with two root canals, which were confirmed when using CBCT.

Results

Among 600 cases, we found 27 two-rooted teeth (4.5%) (Table 1). Six cases of two-rooted canines had a bilateral configuration, all in females (22.2%). The predominance of the occurrence of two-rooted canines in females (81.5%) was strongly emphasized (22/5). They were found on the right side more often.

Among all the evaluated teeth, only 6 cases of one-rooted mandibular canines with 2 root canals were found (1.0%), with 83.3% of them situated on the left side and 16.7% on the right side. Teeth with two root canals were found more often in females (66.7%) (Table 2). All cases (100%) were Type III according to Vertucci's classification.¹

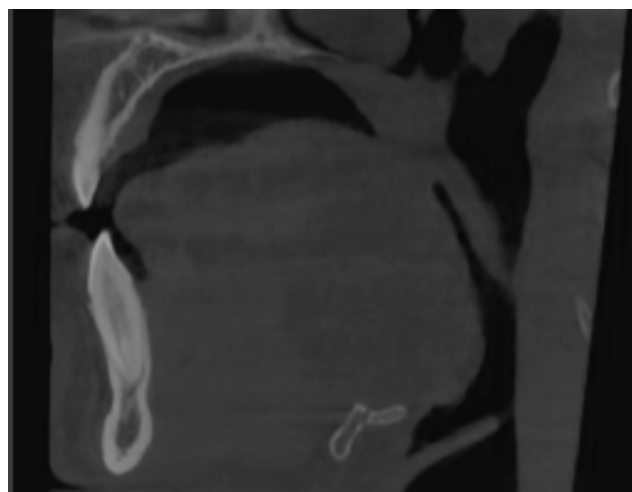


Fig. 3. Left mandibular canine with two root canals – cone-beam computed tomography (CBCT) cross-sectional view

Table 1. Prevalence of two-rooted mandibular canines

Two-rooted mandibular canines	Prevalence	
	F	M
Left (33)	4	2
Right (43)	6	3
Bilaterally (33 and 43)	6	0
Total	22	5

F – females; M – males.

Table 2. Prevalence of one-rooted mandibular canines with 2 root canals

One-rooted mandibular canines with 2 root canals	Prevalence	
	F	M
Left (33)	4	1
Right (43)	0	1
Bilaterally (33 and 43)	0	0
Total	4	2

When age was taken into consideration, the results showed that two-rooted canines and one-rooted canines with 2 root canals were most common in the patients aged 21–30 years. The age-related outcomes are presented in Tables 3 and 4.

Table 3. Presence of two-rooted mandibular canines in different age groups

Age group [years]	Number of two-rooted canines
12–20	0
21–30	18
31–40	4
41–50	2
51–60	3
61–70	0
71–80	0
81–86	0

Table 4. Presence of one-rooted mandibular canines with 2 root canals in different age groups

Age group [years]	Number of one-rooted canines with 2 root canals
12–20	0
21–30	5
31–40	1
41–50	0
51–60	0
61–70	0
71–80	0
81–86	0

Discussion

The detection of an additional root or root canal in mandibular canines influences the success of root canal treatment (RCT), but is also crucial in periapical surgery, periodontal treatment and the management of impacted teeth in orthodontics. Dentists must be aware of the anatomical alterations to the tooth to avoid iatrogenic failure. Researchers have applied different techniques and methods to evaluate external and internal tooth morphology, including staining and clearing,^{6,7} periapical radiographs,⁸ sectioning,⁹ and micro-CT.^{10,11} Recently, CBCT has been widely used in many studies investigating root and canal configuration because of its advantages.^{12–16}

It is generally very rare for mandibular canines to have 2 roots and more than 1 root canal. Indeed, Type I is the most common type of lower canine, based on Vertucci's system.^{1,17,18} Aminsobhani et al. found that 4.7% of mandibular canines were two-rooted,¹³ which is similar to the results of our study (4.5%). Rahimi et al. presented a higher occurrence of 2 roots in lower canines in the

examined population as compared to our study (12.08%).¹⁹ Others, including Mashyakhy et al.,¹⁶ Zhengyan et al.,¹⁵ Kayaoglu et al.,¹⁴ Karataşlioğlu et al.,²⁰ and Han et al.²¹ found two-rooted canines in 2.7%, 0.8%, 3.1%, 3.4%, and 1.32% of patients, respectively. Pécora et al. performed a study based on extracted mandibular canines and found that only 1.7% of the examined sample were bifid teeth.²² This variety of results can be caused by ethnic differences or smaller sample sizes. Interestingly, anthropological research revealed that the bi-rooted mandibular canine was a common feature in the European population between the 11th and 19th centuries, while no case was confirmed in the Asiatic population.²³

The results of the present study showed a higher prevalence of two-rooted lower canines in females than in males (81.5%). This finding is in agreement with the results of studies performed by Karataşlioğlu et al.,²⁰ Doumani et al.,¹² Kayaoglu et al.,¹⁴ and Mashyakhy et al.,¹⁶ but it is not in agreement with a study by Soleymani et al., in which males presented with a higher prevalence of two-rooted canines than females.²⁴ A systematic review published in 2017 showed that the accessory root in lower canines is most common in females,²⁵ which is in agreement with our study.

The present study also aimed to evaluate bilateral symmetry in lower canine morphology. Our results showed a high level of symmetry for the number of roots (98.3%), which is similar to the outcomes of other research studies. Mashyakhy et al.¹⁶ and Kayaoglu et al.¹⁴ found that 95.5% of lower canines had a bilateral symmetry for the number of roots, which is also consistent with the result of 97.7% in a study performed by Al-Dahman et al.²⁶ Our study additionally assessed bilateral symmetry in two-rooted mandibular canines. Six cases revealed the presence of this configuration (22.2%), and all bilateral findings were found in females.

The assessment of the number of roots has been performed in various populations globally, but studies from Europe are scarce. It was concluded that the occurrence of bi-rooted mandibular canines was higher in a Turkish population^{14,20} and lower in a Chinese population.^{15,21} Studies performed on an Iranian population differ significantly in their results. Aminsobhani et al. found bifid roots only in 4.7% of their sample,¹³ while Soleymani et al. found two-rooted canines only in 1.33%.²⁴

The evaluation of tooth anatomy is also valuable in orthodontics. However, there is still a lack of research on bi-rooted canines in orthodontic management. In 2020, Raina and Goje presented a case report of impacted mandibular canines with 2 roots.³ The authors emphasized that the number of roots influenced the anchor value of the tooth.³ This can be significant in extraction space closure cases, such as bimaxillary protrusion treatment, in which 4 premolars are extracted and the anterior teeth are retracted into the obtained space. When a canine has 2 roots, it increases the overall root

surface area of the anterior segment and can cause some treatment difficulties.

The number of one-rooted lower canines with 2 canals in our study was low and equaled only 1.0%. This value is lower as compared to the data obtained by Zhengyan et al.¹⁵ In that study, the prevalence of a second root canal in a mandibular canine was 2.4%.¹⁵ In a study by Almohaimede et al., double canals were found in 9.94% of the examined canines.²⁷

In the present study, most teeth had a Type I configuration, according to Vertucci.¹ This finding is similar to studies performed by Karataşlioğlu et al.,²⁰ Zhengyan et al.¹⁵ and Soleymani et al.²⁴ In the current study, all 6 cases (100%) of one-rooted mandibular canines with 2 canals were Type III.

Limitations

The main limitation of this study was the small sample examined. Further research is required with an increased number of CBCT scans and the comparison of the visibility of canine anatomy with panoramic radiographs. Increased awareness of dentists about the possibility of the anatomical variability of the teeth can reduce the occurrence of treatment failure.

Conclusions

In our study, based on a CBCT examination, the majority of lower canines in a Polish population were single-rooted with a single canal. There was a higher prevalence of two-rooted canines in females than in males. Also, one-rooted canines with a double root canal were more common in females. CBCT proved to be a valuable tool for evaluating the number of roots and root canals in mandibular canines.

Ethics approval and consent to participate

Not applicable.

Data availability


The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.


Consent for publication

Not applicable.

ORCID iDs

Magdalena Piskórz  <https://orcid.org/0000-0003-4092-1122>

Karolina Futyma-Gąbka  <https://orcid.org/0000-0003-3415-8669>

Ingrid Różyło-Kalinowska  <https://orcid.org/0000-0001-5162-1382>

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