CASE REPORT

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Mandibular canine with Vertucci's type II configuration: Report of a case with literature review

Apurva Satpute,[1] Mohit Zarekar,[2] Mohini Zarekar[3]

[1]Department of Conservative Dentistry and Endodontics, Govermental Dental College & Hospital, Chhatrapati, Sambhajinagar, India
[2]Department of Pediatric Dentistry, Private Pedodontic practice, Ahilyanagar, India
[3]Institute of Tropical Medicine and International Health, Charité University of Medicine, Berlin, Germany

The mandibular canine typically possesses a single root and a single root canal. Nonetheless, there has been a significant increase in data indicating differences in its anatomy, including the existence of multiple roots & canals. The aim of this article is to discuss a case of root canal therapy in a mandibular canine exhibiting Vertucci's type II configuration and review related literature. A 50-year-old woman reported with the chief complaint of pain in a lower right front tooth. Clinical and radiographic examination revealed that tooth 43 was diagnosed with chronic irreversible pulpitis accompanied by symptomatic apical periodontitis. A meticulous radiographic examination indicated the existence of two canals. Cone-beam computed tomography was performed, which revealed the presence of two canals converging into a single channel in the apical third. Endodontic therapy was performed in two stages after using calcium hydroxide as an intracanal dressing. Literature review was conducted to identify the most pertinent studies. Moreover, the assessment of the canals needed to not only identify the existence of an additional canal but also determine its internal structure using Vertucci's classification. According to the literature review, the majority of research studies concur that type I is the most prevalent design. The predominant classification among the two canals was type II followed by type III, some research also indicated the presence of two roots. This case study highlights the importance of having an in-depth knowledge of root canals and their variations. The prevalence of extra canals in the mandibular anterior region is increased due to advancements in 3D radiographic technologies and magnification devices. Accurate comprehension and sometimes modification of the access cavity is necessary.

Keywords: Anatomic variation; mandibular canine; morphologic variation; root canal treatment.

Introduction

The mandibular canines constitute a crucial tooth inside the dental arch. The long and stable root is advantageous for prosthetic support because of its proprioceptive qualities that regulate masticatory function, along with its function in occlusal guiding during eccentric motions and posterior disocclusion (1). Consequently, much effort is devoted to its preservation, despite potential morphological obstacles. Typically, mandibular canines possess a singular root and canal. The presence of multiple roots and multiple canals is an uncommon phenomenon, occurring in 1 to 5% of cases (2). Most clinicians believe that a particular tooth possesses a certain number of roots and

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Correspondence: Mohit Zarekar. Department of Pediatric Dentistry, Private Pedodontic practice, Ahilyanagar, India
Tel: +9834140684 e-mail: zarekarmohit@gmail.com
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canals. Thorough analysis of study materials has revealed that differences in tooth structure are prevalent (3). Since the onset of the 21st century, the advent of new technologies pertaining to intraoperative vision magnification and advanced radiological imaging systems has led to a significant increase in clinical studies, in vitro/ex vivo studies, and case reports. These investigations have uncovered morphological variations, including the existence of more than one root and canal in the mandibular canine (4). The intricate nature of the root canal system requires clinicians to have a thorough understanding of the internal anatomy prior to initiating endodontic treatment. This approach helps to mitigate unforeseen treatment complications associated with atypical root canal anatomy (5). This article aims to present a case report of a mandibular canine exhibiting Vertucci's type II canal arrangement and to conduct a literature review on this anatomical variation to ascertain the prevalence of multiple canals in the mandibular canine. Practitioners must have expertise about the quantity of canals, their exact positioning, length, and connections.

Case Presentation

A 50-year-old woman with an unremarkable medical history presented to our department with the primary complaint of pain in a lower right anterior tooth. Even after removing the thermal stimulus, the pain continued to disrupt her sleep for several minutes. The clinical examination indicated that the mandibular right canine (#43) exhibited extensive proximal caries accompanied by pain upon percussion. Electric pulp testing was conducted, revealing minimal response to the test. Radiographic evaluation revealed periapical radiolucency associated with tooth 43 (Fig. 1A), and upon meticulous examination, we determined that tooth 43 possesses two separate openings from the pulp chamber, indicating the presence of two canals. The patient was diagnosed with chronic irreversible pulpitis with symptomatic apical periodontitis. Cone-beam computed tomography (CBCT) was conducted to verify two separate root canals converging into a single channel in the apical third (Vertucci's type II) (Fig. 1B). Upon receiving informed written consent from the patient, we commenced root canal therapy by giving local anaesthesia, and the entire procedure was conducted under a rubber dam. The access opening was created with an endodontic access #1 round diamond bur and an endo-Z (Dentsply, Maileffer, USA) tapered safe-end bur. Upon accessing the pulp chamber, we discovered two canal orifices positioned labially and lingually (Fig. 1C). This observation differed from the typical singular opening situated at the center of the crown or root. Consequently, size Nos. 6, 8, & 10 K (Dentsply, Maileffer, USA) files were utilised for establishing the glide path, while a No. 15 K file was employed to ascertain the operating length using electronic apex locator (Root ZX, J. Morita, Kyoto, Japan) and also radiographically to ascertain the canal configuration (Fig. 2A). The canals were methodically prepared using manual hand k-files and RaCe NiTi (FKG Dentaire, Switzerland) rotary files upto the size of 25/04, employing a crown-down technique. The canal was regularly flushed with a solution containing 3% sodium hypochlorite (Parcan, Septodent, USA) and normal saline. A calcium hydroxide (CH) paste was administered as an intracanal dressing, considering the periapical lesion for 2 weeks. The subsequent session in-

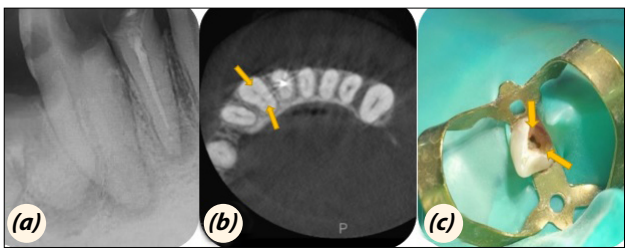

Fig. 1. **(a)** Preoperative radiograph **(b)** Preoperative Cone beam computed tomography (CBCT) coronal scan showing two separate canals **(c)** Clinical photograph after access opening showing two distinct canals opening.

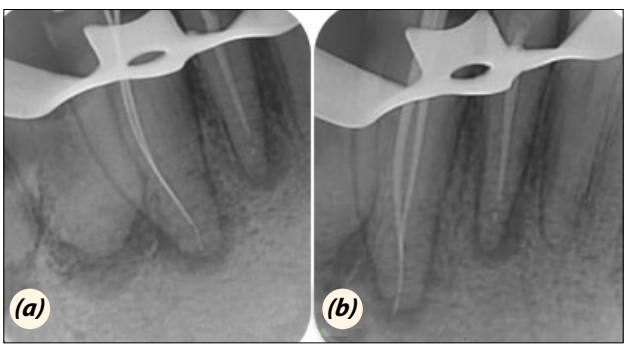

Fig. 2. **(a)** Working length determination radiograph **(b)** Mastercone radiograph.

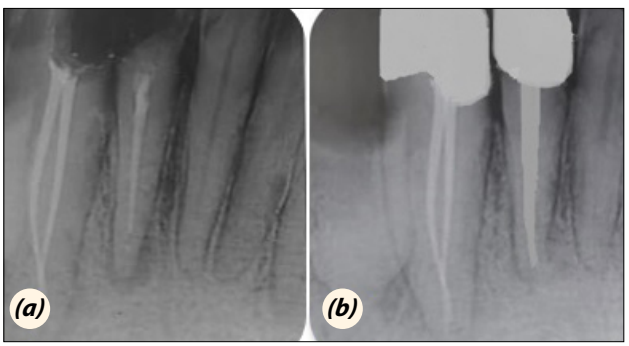

Fig. 3. **(a)** Immediate post obturation radiograph **(b)** Radiograph obtained on 6 months follow up.

volved the treatment of the root canal utilising a combination of 3% sodium hypochlorite with ultrasonic-activated irrigation and negative apical pressure, facilitated by the EndoVac device (EndoVacTM, Kerr Endodontics, USA). This method was utilised to efficiently eliminate the CH paste. The canals were dried with a sterile paper point and then sealed using suitable Gutta-percha master cones (Fig. 2B) and MTA Fillapex (Angelus, Brazil) sealer (Fig. 3A). The restoration following obturation was performed using a composite resin (Tetric-N-Ceram, Ivoclar Vivadent). A follow-up radiograph was obtained after six months (Fig. 3B), and the patient exhibited no symptoms. The tooth exhibited proper function, and there were no indications of peri-radicular pathosis.

Literature review

Search Method

A thorough search was conducted in the PubMed Central, Scopus, and Google Scholar electronic databases to identify the most relevant studies. The aim was to identify significant in vivo studies that examined the canal structure of permanent mandibular canines. The search terms used were “permanent mandibular canines”, “root canal morphology” and “Morphologic variation”. The keywords were utilised either separately or in conjunction. The final review included English-published research that evaluated the anatomy of the root canal of permanent mandibular canines. Furthermore, the evaluation of the canals must not only recognize the presence of an additional canal but also ascertain its internal architecture by utilizing Vertucci’s classification.

Analysis of studies included

We primarily considered studies that assessed the root canal morphology of mandibular canines from the past 20 years, spanning from 2003 to 2024 (last access was on October 06, 2024). Traditionally, research on the structure of the root canal system of anteriors has primarily been conducted in laboratory settings, employing methods such dental x-rays, cleaning procedure, and more recently, CBCT and µCBCT. The usage of CBCT in clinical settings has shown encouraging outcomes in the detection of morphological connections among the many teeth within a single patient. Most research indicates that type I is the most prevalent configuration (Table 1) more than 90% (8,12,13,14,15,16 ,17,18,21,22,23,24,26,29).

We categorised Vertucci’s remaining configurations as canines with two canals, irrespective of their canal system trajectory or the presence of multiple roots. Regarding the frequency of the remaining configurations, studies shown that the next most common configurations were type II (7,8,10,11,19,25,17,30). Next most common configurations were type III (7,9,20,24,27,28,29) followed by type IV & V (6,11,13,23,25,28,30). The remaining categories VI, VII, VIII were typically found in minimal or negligible proportions (20,24,25,27).

Discussion

This study was to present an example of a mandibular canine exhibiting a single root with two root canals and to examine the existing literature regarding this anatomical variance. The mandibular canine is often recognised for the high incidence of Vertucci’s type I arrangement, consistent with our findings from the literature review (4,5,8). Nonetheless, numerous studies indicate that mandibular canines with multiple canals exhibit a high incidence of two roots (31). In fact, anthropological results indicate that the mandibular canine with two roots was prevalent among Europeans from the 11th to the 19th century, although it was not observed in the Asian population (32). Laurichesse et al. (33) reported that 2% of mandibular canines possess one root with two canals, while only 1% exhibit two roots with two canals. The recent global multicentre cross-sectional study by Martins et al. (34) revealed that the frequency of a second root canal in mandibular canine is lower in the Americas and Africa, while Europe, South Asia, and the Middle East demonstrate higher proportions. The early identification of a mandibular canine with multiple canals or multiple roots positively impacts the success rate of endodontic therapy by facilitating the use of specialized diagnostic instruments and the formulation of tailored strategies based on the tooth’s anatomical characteristics. Consequently, it is imperative to meticulously examine the diagnostic radiographs; recognising the significance of identifying a sudden discontinuity in the root canal the centre or radiolucent grooves in the lateral aspect of the root is essential, as these findings suggest the existence of multiple canals (35). Obtaining angled x-rays (20°–25° or Clark method) aids in the identification of additional canals when a suspected morphological change occurs (36). It might be necessary to use limited field-of-view CBCT to confirm internal differences that are hard to see with other methods (37). Type II canal arrangement, in which two canals converge into one canal before reaching the apex, necessitates rigorous attention to detail. Displacement of pulp tissue or organic matter from one canal into an adjacent canal can lead to canal obstruction (38). To prevent procedural errors, conduct meticulous manual exploration of these canals using radiographs before employing larger or rotary devices. Coronal pulpal tissue excision with manual tools should be maxi-

Table 1. Prevalence of mandibular canine with multiple canals according to vertucci's arrangement in various in vitro and clinical studies

Author/ Year	Country used	Methodology	Sample size (n)	Type I	Type II	Type III	Type IV	Type V	Type VI	Type VII	Type VIII
Sikri and Kumar / 2003 (6)	India	Periapical radiographs and clearing	100	70%			10%	2%			
Sert et al. / 2004 (7)	Türkiye	Clearing and staining with China ink	200	76%	16%	6.5%	1.5%				
Rahimi et al. / 2013 (8)	Iran	Clearing and staining with China ink	149	91.60%	6.11%	2.29%					
Amardeep et al. / 2014 (9)	India	CBCT		79.6%	3.2%	13.6%		2%			
Bakianian Vaziri P et al. / 2008 (10)	Iran	Stereo-microscope	100	88%	5%	7%					
Aminsobhani M et al. / 2013 (11)	Iran	CBCT	608	71.8%	10.3%	2.8%	12.8%	2.3%			
Altunsoy M et al. / 2014 (12)	Türkiye	CBCT	1604	92.7%	2.1%	1.05%	1.30%	2.61%			
Han et al. / 2014 (13)China	CBCT	1291	93.73%	0.62%	3.25%		0.54%			
da Silva et al. / 2016 (14)	Brazil	CBCT	200	90.5%	1%	4%	2.5%	2%			
Soleymani et al. / 2017 (15)	Iran	CBCT	300	89.7%	3.7%	5.7%		1%			
Mashyakhy et al. / 2019 (16)	Saudi A.	CBCT	410	90.7%		6.1%		3.2%			
Doumani et al. / 2020 (17)	Syria	CBCT	409	95.87%	0.73%	3.18%		0.24%			
Karobari et al. / 2021 (18)	Malaysia	CBCT	1708	90.7%		8.2%					
Mahmood et al. / 2021 (19)	Iraq	CBCT	598	88.4%	4.8%	4%		2.6%			
Candeiro et al. / 2021 (20)	Brazil	CBCT	4805	89.12%	1.58%	6.66%	0.10%	2.41%	0.13%		
Mirza / 2022 (21)	Saudi A.	CBCT	952	98.74%	0.20%	0.62%		0.41%			
Buchanan et al. / 2022 (22)	South Africa	CBCT	386	93.8%	0.3%	5.4%		0.5%			
Iqbal et al. / 2022 (23)	Saudi A.	CBCT	570	90.35%		7.01%	2.45%				
Chen Y et al. / 2023 (24)	China	CBCT	747	93.97%	1.33%	4.28%			0.26%	0.53%	0.13%
Shaiban et al. / 2023 (25)	Saudi A.	CBCT	540	69%	7.2%	0.2%	13.7%	8.7%	0.5%	0.2%	0.3%
Siddique et al. / 2024 (26)	Pakistan	CBCT	222	93.24%	0.90%	4.95%		0.45%		0.45%	
Magat et al. / 2024 (27)	Türkiye	CBCT	1000	88.2%	1.6%	4.5%	0.2%	3.3%			0.5% 1.7%-non-classifiable
Taha et al. / 2024 (28)	Jordan	CBCT	1114	87.3%	2%	6.9%	3.1%	0.4%			
Nepal at al. / 2024 (29)	Nepal	CBCT	970	91.34%		5.15%		0.20%			
Shrestha et al. / 2024 (30)	Nepal	CBCT	741	85.6%	4.6%	3.5%	2.5%	3.8%			

mised before accessing the canal. The application of rotary instruments in this canal configuration necessitates caution to prevent instrument separation, as the instrument may penetrate the junction at a very acute or right angle upon reaching the canal confluence (37). In our case, upon accessing the root canal system, cleaning and shaping were performed with rotary instruments in a crown-down technique to reduce debris extrusion. The preparation was carried out up to a 25/04% size to preserve the tooth's structural integrity while ensuring comprehensive debridement, thereby minimising the risk of instrument separation and canal transportation. Employing such approaches alongside proficient operator skills may facilitate direct access to root canals while minimising procedural errors. This study highlights that, despite the traditional view of mandibular canine possessing a single root and one canal, advancements in radiographic technologies and magnification devices have dispelled this notion, revealing common anatomical variations in mandibular anteriors that necessitate efficient and appropriate treatment protocols.

Conclusion

Despite the literature suggesting that mandibular canines with multiple root canals are uncommon, understanding this morphological diversity is crucial for clinicians in identifying and managing such complex situations. Radiographs and magnification instruments are considered essential tools for the detection and management of additional canals. A prompt diagnosis and thorough examination of the internal structure of a mandibular canine with multiple canals facilitate the development of a customized treatment regimen that is specifically designed to accommodate its unique shape and prevent procedural errors.

We particularly included studies that analysed the root canal morphology of mandibular canines and assessed their structures according to Vertucci's classification. However, additional variations in mandibular anteriors may exist, published in various languages or employing different classification systems, which should be addressed whenever feasible. We strongly advise clinicians to use appropriate equipment and techniques when treating teeth with anatomical variations. We recommend conducting endodontic procedures on such teeth using a dental operating microscope, ultrasonic tips for conservative access openings, and an electronic apex locator for precise working length assessment.

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Informed consent: Written informed consent was obtained from patients who participated in this study.

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