

Root canal morphology of maxillary second premolars among the Kurdish population in Iraqi Kurdistan: a retrospective CBCT assessment

Morfologia kanału korzeniowego drugiego przedtrzonowca szczęki wśród populacji kurdyjskiej w irackim Kurdystanie: retrospektywna ocena CBCT

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Słowa kluczowe: drugi przedtrzonowiec szczęki, kanały korzeniowe, morfologia, CBCT, iracki Kurdystan.

Abstract

Aim of the research: To explore the morphology of the root canal systems of permanent maxillary second premolars among the Iraqi Kurdistan population.

Material and methods: Cone-beam computed tomography (CBCT) scan images were accessed from a documented database of 300 patients (165 male, 135 female) from Iraqi Kurdistan regions, who had had oral and maxillofacial examinations. The age of the patients ranged from 18 to 50 years, and scanned images were evaluated by 2 independent dental radiologists who assessed the axial, sagittal, and coronal sections to check the number of orifices, roots, root canals, and foramina. Canal configuration was classified using the Vertucci classification to evaluate and analyse the root canal morphology.

Results: One orifice was the most prevalent number of orifices in 3 governorates in Iraqi Kurdistan (86.33%). The teeth with one canal (67.0%) and one root (89.33%) were the most prevalent. One foramen was the most prevalent number of a foramen in 3 governorates and Iraqi Kurdistan (86.7%) followed by 2 foramina (13.3%). The first canal type was the most prevalent in the Kurdish population with permanent maximally second premolars (69.0%) followed by class V (12.3%) and class II (11%). Classes VI (0.7%) and III (2%) were rare canal types in this region. Class VII canal type was not found in the population in the Iraqi Kurdistan region.

Conclusions: One orifice, one foramen, one canal, and one root with type I were the most prevalent morphology of the maxillary second premolar in Iraqi Kurdish populations

Streszczenie

Cel pracy: Zbadanie morfologii systemów kanałów korzeniowych stałego drugiego przedtrzonowca szczęki wśród populacji irackiego Kurdystanu.

Materiał i metody: Dostęp do obrazów tomografii komputerowej wiązki stożkowej (CBCT) uzyskano z udokumentowanej bazy danych 300 pacjentów (165 mężczyzn, 135 kobiet) z regionów irackiego Kurdystanu, którzy przeszli badanie jamy ustnej i twarzoczaszki. Wiek pacjentów wahał się od 18 do 50 lat, zeskanowane obrazy badali dwaj niezależni radiolodzy stomatologiczni, którzy oceniali przekroje osiowe, strzałkowe i koronowe pod kątem liczby otworów, korzeni, liczby kanałów korzeniowych i otworów. Konfiguracja kanałów została sklasyfikowana przy użyciu klasyfikacji Vertucciego do oceny i analizy morfologii kanału korzeniowego.

Wyniki: Jeden otwór był najbardziej rozpowszechnioną liczbą otworów w trzech guberniach irackiego Kurdystanu (86,33%). Najliczniejszą liczbą korzeni były zęby z jednym kanałem (67,0%) i jednym korzeniem (89,33%). Jeden otwór był najczęstszą liczbą otworów w trzech guberniach i irackim Kurdystanie (86,7%), a następnie dwa otwory (13,3%). W populacji kurdyjskiej dominował pierwszy typ kanału ze stałymi maksymalnie drugimi przedtrzonowcami (69,0%), następnie klasa V (12,3%), klasa II (11%). Klasy VI (0,7%) i III (2%) były rzadkimi typami kanałów w tym rejonie. Typ kanału klasy VII nie został znaleziony w populacji w regionie irackiego Kurdystanu.

Wnioski: Jeden otwór, jeden otwór, jeden kanał i jeden korzeń z typem I były najczęstszą morfologią drugiego przedtrzonowca szczęki w populacji irackich Kurdów.

Introduction

Root canal morphology plays a highly significant role in the success of endodontic treatment to locate all existing canals and properly clean, shape, and obturate the root canal space three-dimensionally [1]. Based on the published findings, the inability to recognize the presence of, and adequately treat, all the root canals may lead to high percentages of treatment failure [2]. Studies on the internal and external anatomy of teeth have shown that anatomic variations can occur in all groups of teeth and can be extremely complex. Numerous factors contribute to the variations found in root canal studies, including ethnicity, age, and gender [3]. The maxillary second premolars are among the most difficult teeth to treat endodontically. This could be due to many factors, namely the number of roots, the number of canals, the direction and longitudinal depressions of the roots, the various pulp cavity configurations, and the difficulties in visualizing the apical limit by radiograph.

It must be remembered that the root canal morphology varies greatly among different populations and even among persons within the same population. So, we need to be familiar with the accurate knowledge of root canal morphology and its anatomical alterations as the essential aspects of successful endodontic treatment [4].

The maxillary second premolar is considered to be one of the challenging teeth for endodontic treatment.

Some techniques have been used by dentists to evaluate the root canal morphology, such as radiographs, decalcification, sectioning, replication, and computerized-aided techniques [5–8].

Cone-beam computed tomography (CBCT) imaging may be indicated to obtain information about the nature of complex root canal anatomy. CBCT gives an increased appreciation of the root canal anatomy, which should result in more conservative access preparation. The poor resolution of CBCT means that sclerosed and/or accessory anatomy may not be readily identified. CBCT uses extraoral scanning to produce 3D orthogonal images of the maxillofacial skeleton and its structures, with a lower dose of radiation than conventional CT, and it has proven more accurate than digital X-rays in determining root canal systems [9, 10].

It is important to determine the root and canal morphology of the Kurdish population to decrease the number of errors during endodontic treatment. Until now, there has been no comprehensive study conducted on a wide geographic area of Iraqi Kurdistan.

Aim of the research

Therefore, this study aimed to explore the variations in the root canal systems of permanent maxillary second premolars in Kurdish pupations in Iraqi Kurdistan.

Material and methods

The study protocol was approved by the institutional Ethics Committee of the College of Dentistry, University of Duhok, Kurdistan Region, Iraq. The case records of 300 patients (165 males and 1135 females), who had CBCT scans between January 2020 and September 2021, were retrieved from the database of 3 private dental imaging centres from 3 governorates in the Kurdistan Region of Iraq. In this retrospective study, CBCT images with permanent maxillary second premolar teeth were included from 3 Kurdish governorates in Iraqi Kurdistan, i.e. Duhok, Erbil, and Sulaymaniyah. In this regard, to obtain a representative sample of the Kurdish population in this region, we considered the main public dental clinic in the capital of these governorates as the settings of data collection. The CBCT images were selected from 2 types of CBCT machines (NewTom Giano Verona, Italy, Villa 3D Planner, Italy, and Anatomage ivivodental viewer, Italy), and different fields of view (FOV). An experienced radiologist evaluated data acquisition, reconstruction, and other test parameters for image quality. Voxel sizes equal to or less than 0.25 mm were required. These reproducible objective measures were conveniently assessed by computer software. As an inclusion criterion, at least one fully developed permanent maxillary second premolar should be present in any CBCT image. Teeth with open apices (not fully formed), root resorption, or calcification (partial or complete radiographic obliteration of the pulp chamber and root canals), and teeth with prior endodontic treatment were excluded. The patients who attended the dental clinics were screened for the eligibility criteria. The CBCT of patients aged 18 years and older of both genders with no previous dental disease were eligible for this study. To obtain a representative sample of the population in this region, we tried to include patients from different age groups of both genders through a different and wide period. In this regard, the data collection was conducted between January 2020 and September 2021, as appropriate.

The images were then evaluated based on the number of roots, root canals, canal orifices, number of apical foramina, and root canal configuration using Vertucci's classification by one radiologist, one endodontist, and one general practitioner using I-Dixel imaging software in axial, coronal, and sagittal planes.

The classification of root canals was performed using Vertucci canal types. The Vertucci canal types were the number and type of root canals, the presence and location of both accessory canals and inter-canal communications (ICCs), and the location and number of apical foramina and the presence of apical deltas [11].

The classification of second premolars was performed by Vertucci's classification system:

– Type I was determined as a single canal (extending from the pulp chamber to the apex);

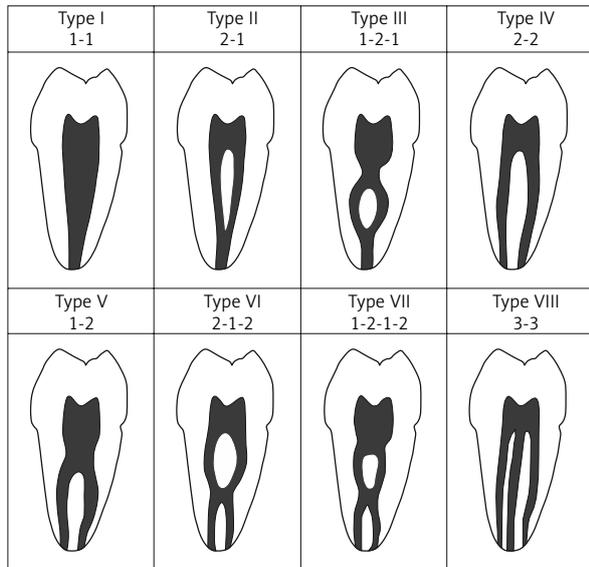


Figure 1. Vertucci classification of root canal systems (types I–type VIII) [1]

- Type II was determined as 2 separate canals (leaving the pulp chamber and attaching the apex short to create one canal);
- Type III was determined as one canal (leaving the pulp chamber, separating into 2 canals within the root, and joining together in one canal);
- Type IV was determined as 2 separate distinct canals (extending from the pulp chamber to the apex);
- Type V was determined as a single canal (leaving the pulp chamber and separating into 2 independent canals with 2 separate apical foramina);
- Type VI was determined as 2 separate canals (leaving the pulp chamber to join the midpoint, and separating into 2 canals with 2 separate apical foramina).

In addition, type VII was determined as one canal (leaving the pulp chamber and separating within the canal and re-dividing into 2 clear canals with 2 separate apical foramina) (Figure 1) [4].

Statistical analysis

Descriptive statistics were performed in this study. In this regard, the prevalence of the roots, root canals,

orifices, apical foramina, and types were determined by number and percentage, as appropriate. The collected data were assessed using SPSS software (Version 25; IBM Corp, Armonk, NY). Person’s χ^2 test was performed for statistical analyses, and $p < 0.05$ was considered significant.

Results

The study found that one orifice was the most prevalent number of orifices in 3 governorates in Iraqi Kurdistan (86.33%). In addition, the teeth with one canal and one root were the most prevalent in this region. The study found that 67.0% and 89.33% of the population had one canal or root in this region. In addition, the study found that one foramen was the most prevalent number of foramen in 3 governorates of Iraqi Kurdistan (86.7%), followed by 2 foramina (13.3%). The study did not find a significant difference in the morphology of Kurdish populations in this region (Table 1, Figure 2).

The study found that the first canal type was the most prevalent in the Kurdish population with permanent maximally second premolar (69.0%), followed by class V (12.3%), class II (11%), and class IV (5%). Classes VI (0.7%) and III (2%) were rare canal types in this region. There was no class VII canal type in the Kurdish population in Iraqi Kurdistan (Table 2, Figure 3).

Discussion

A clear understanding of root anatomy and canal morphology is vital for performing efficient biomechanical cleaning and shaping for the predictable endodontic outcome. Nevertheless, the variation of the root canal morphology presents clinical difficulties that might lead to unfavourable endodontic treatment [11].

CBCT is an excellent *ex vivo* and *in vivo* method to evaluate external and internal root morphology compared to conventional 2D radiography. Many studies have used CBCT methodology to evaluate the external and internal anatomy of maxillary premolars [12]. In the present *ex vivo* study, we evaluated 300 extracted second maxillary premolars through CBCT. The most

Table 1. Variations in the root canal morphology of Kurdish populations with permanent maximally second premolars

Area (n = 300)	Orifice		Canal		Root		Foramen	
	1 orifice	2 orifices	1 canal	2 canals	1 root	2 roots	1 foramen	2 foramina
Duhok	86	14	69	31	91	9	75	25
Sulaymaniyah	85	15	66	34	87	13	64	36
Erbil	88	12	66	34	90	10	67	33
Iraqi Kurdistan	259 (86.33%)	41 (13.66%)	201 (67.0%)	99 (33.0%)	268 (89.33%)	32 (10.67%)	206 (68.7)	94 (31.30)
P-value	0.821		0.873		0.635		0.223	

Person’s χ^2 test was performed for statistical analyses.

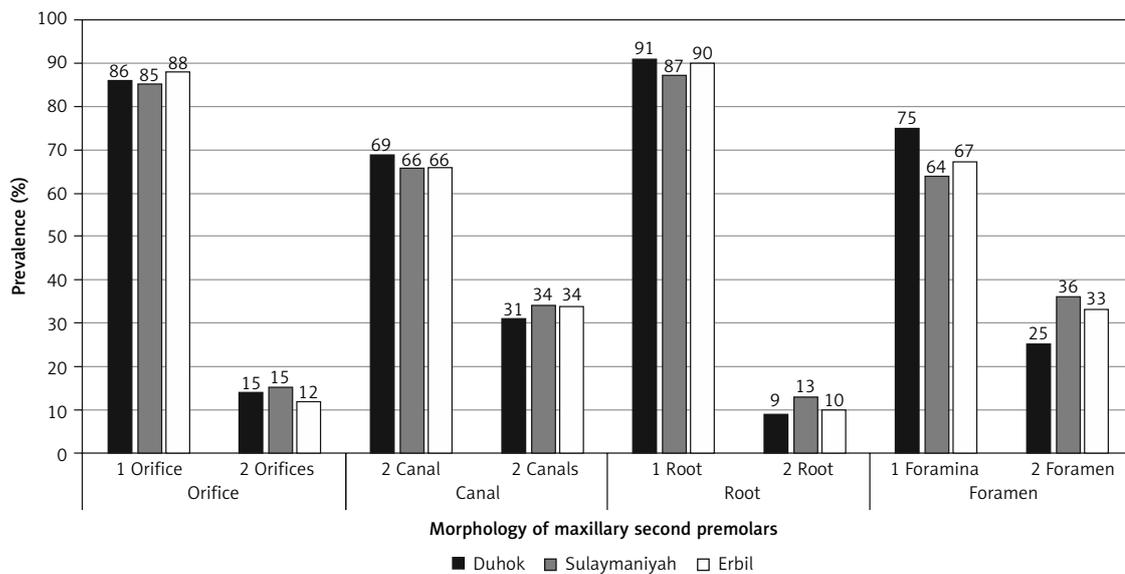


Figure 2. Root canal morphology of Kurdish populations with permanent maxillary second premolar

Table 2. Vertucci canal types of teeth of the Kurdish population with permanent maxillary second premolar

Area (n = 300)	Vertucci canal types							
	Type I	Type II	Type III	Type IV	Type V	Type VI	Type VII	Type VIII
Duhok	72	14	4	3	6	1	0	0
Sulaymaniyah	69	7	1	2	20	1	0	0
Erbil	66	12	1	10	11	0	0	0
Iraqi Kurdistan	207 (69%)	33 (11%)	6 (2%)	15 (5%)	37 (12.3%)	2 (0.7%)	0 (0.0%)	0 (0.0%)

commonly observed root morphology in this region was one orifice, one canal, and one root. The first canal type was the most prevalent in the Kurdish population with permanent maxillary second premolar, followed by class V, class II, and class IV. Classes VI (0.7%) and III (2%) were rare canal types, and there were no class VII canal type in the Kurdish population in Iraqi Kurdistan. The study found that one foramen was the most prevalent number of foramen in 3 governorates of Iraqi Kurdistan followed by 2 foramina.

Previous studies have reported variations in different populations across the world. For example, Senan *et al.* (2018) reported that 54.8% of the Yemeni populations have a single-root canal followed by double-root (44.4%) and 3 separated roots (0.8%). In addition, they reported that Vertucci type IV (55.6%) is the most prevalent type of canal [11]. However, canal type I followed by type V were the most prevalent types in Kurdish populations. Interestingly, they reported that 8 of the single-root premolars had new canal configurations that have not been seen in previous surveys. We did not find new configurations in the teeth of the Kurdish populations in Iraqi Kurdistan.

The results of the current study disagree with the results of Jayasimha and Mylswahi, 2010 in India,

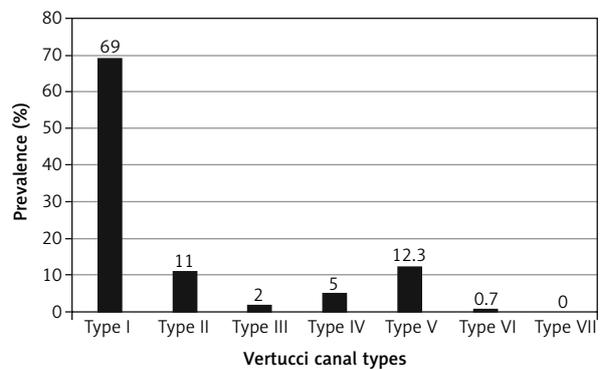


Figure 3. Vertucci canal types of teeth of Kurdish population with permanent maxillary second premolar

who concluded that the root canal morphology of the maxillary second premolar in Indians has a higher incidence of type II configuration (33.6%).

A study conducted in the Kurdish population in a single setting in this region reported that 3 roots is the most prevalent number of roots in the right and left, and first and second molars [12]; they used the same techniques of evaluation (cone-beam computed tomography).

There are some similarities and differences between the Kurdish populations and the Middle-eastern populations. For example, Alqedairi *et al.* (2018) reported that most of the Saudi population's teeth had 2 roots in maxillary first premolars and one root in maxillary second premolars. They added that type IV was the most prevalent configuration in maxillary first premolar. They found all types of canal configurations in maxillary premolars except for type VII for the maxillary second premolar [13]. The morphology of the Saudi population's teeth is similar to that of the Kurdish population (with some small differences).

The location of the apical foramen is of clinical importance during working length determination. It depends on the average position of the apical constriction relative to the root apex [14]. In this study, one and 2 foramina were the most prevalent number in Kurdish populations. We did not examine the location of the apical foramen in this study, but it is central in 84.9% of Yemenis compared to 12–60% in the literature [11].

Dentists must take into account the morphology of the apical region during surgical and non-surgical root canal procedures. The majority of the apical foramina did not coincide with the apical root tips. The deviation of the foramen is not easily detected by radiological imaging, especially when the opening occurs on the buccal or lingual root surfaces [15]. Hence, it is suggested that dentists approve the radiographic working length with electronic apex locators. This allows the dentists to detect the location of the apical foramen accurately [16].

The preparation and obturation of types I and IV canal system are relatively straightforward because each of the canals in these configurations is separate and distinct between the orifice and apex. However, the type II, III, V, VI, and VII systems are different because there are areas in the root in which the 2 canals join and share the pulp space, and others in which the canals are separate. This requires an individualized procedure for the location of the furcation area as well as the precise position of the root canal orifices, preparation, and filling in each of these conditions, to obtain the best results. If this cannot be achieved, the negotiation of the entire root canal system is questionable, and the long-term prognosis for the tooth may become extremely poor [17].

Conclusions

This study showed that one orifice, one canal, and one root with type I were the most prevalent morphology of the maxillary second premolar among Kurdish populations in Iraqi Kurdistan.

Conflict of interest

The authors declare no conflict of interest.

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