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Canal Configuration of Maxillary Premolars in Cukurova Population: A CBCT Analysis

SUMMARY

Background/Aim: *Aim of this study was to evaluate the anatomy of root-canal systems and numbers of permanent maxillary premolars' roots and canals, using* cone *beam computed tomography scans.* ***Material and Methods:*** *In this retrospective and observational study, maxillary right/left and first/second premolars of patients who were screened with cone beam computed tomography for various reasons in a Turkish dental school, were examined. Evaluated parameters were age, gender, canal configuration (Vertucci classification) and numbers of roots and canals. Chi-square test was used for statistical analysis. The level of significance was set at p<0.05.* ***Results:*** *A total of 1086 maxillary premolars including 555 first premolars and 531 second premolars were examined in 331 patients (186 female, 145 male). Presence of two roots was shown in 75% of first premolars. 76.3% of second premolars were found to have a single root. Most common canal configuration was type IV (73.2%) for first premolars and type II (32.4%) for second premolars. There was a significant relationship between gender and numbers of first and second premolars' roots and canals.* ***Conclusions:*** *High heterogeneity of maxillary premolar root-canal system anatomy should be considered during endodontic treatment.*

Key words: Cone Beam Computed Tomography, Maxilla, Premolar, Vertucci classification

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Introduction

The morphology of canal and root systems is complex and variable[1]. Failure in endodontic treatment; may occur due to the presence of lateral canals, lack of interpreting of root canal anatomy or unhealed canals[2]. Therefore, all canal types should be accurately understood before endodontic treatment[1,3]. Root canal system varies between different populations and even between different individuals in the same population[4]. Premolar teeth show the highest anatomic heterogeneity among all teeth groups in terms of root canal numbers and characteristics[5].

Cone beam computed tomography (CBCT), which requires a lower dose of radiation than conventional computed tomography (CT), was improved separately by two groups of researchers in the late 1990s to be an adaptable device for dental radiology[6,7].

In literature, it has been shown that variability in root and root canals may be effective in endodontic treatment success[8]. Various *in vivo* and *in vitro* methods have been used to investigate root and canal anatomy and morphology. Removing a tooth is the most important disadvantage of *in vitro* methods[9-11]. There are studies in the literature indicating that CBCT can accurately detect the root canal system as staining techniques used to examine extracted teeth[12].

The most commonly used classification which proposed by Vertucci *et al.* has been useful when categorizing root canal configurations[13,14]. This study aims to determine root and canal numbers and canal configurations according to Vertucci classification of maxillary first and second premolar teeth in Cukurova population using CBCT. According to our knowledge, the present study is the first study investigating root canal number and morphology in Cukurova population.

Material and Methods

In this observational and retrospective study, the ethical approval was obtained from the Non-Interventional Clinical Research Ethics Committee (Protocol no: 2019/86-82). CBCT (Planmeca ProMax® 3D Mid, Helsinki, Finland, at 90 kV, 10 mA; scan time: 27 seconds) scans of patients who referred to Cukurova University Faculty of Dentistry between August 2017 and January 2019 for various reasons (Jaw/implant surgery, the position of impacted teeth, odontogenic/non-odontogenic tumours, cysts etc.) were included in the study. All CBCT scans were examined in coronal, sagittal and axial sections. Digital CBCT sections were made at 0.2-mm intervals. DICOM format data obtained as a result of the scan was transferred to the Romexis 5.2.0 software (Planmeca Oy, Helsinki, Finland).

Mean age of 331 participants (186 females- 56.2% and 145 males- 43.8%) was 31.72 ± 10.13 years. Inclusion criteria were; the absence of cysts, neoplasms or similar lesions that may affect the anatomy of the maxillary premolars, the completed root formation (patients older than 18 years), the presence of at least one first or second maxillary premolar teeth, CBCT scans with high image quality to identify accurately anatomy of canal systems and numbers of roots. Teeth with root canal treatment were excluded. The study was conducted at all stages following the principles of Helsinki Declaration.

The primary outcome of the study was to define the classification proposed by Vertucci[13] for root canal system anatomy of maxillary first and second premolars (Figure 1). A secondary result was to evaluate the number of roots and canals of maxillary first and second premolar teeth. Finally, it was aimed to evaluate the effect of gender on the number of root and canal.

All evaluations were performed independently by two radiologists (BE and HD) and any conflicts were resolved by discussion. Age and gender of patients were recorded. Data were analyzed and tabulated using SPSS statistical package 20.0 (IBM, Armonk, NY, USA). Chi-square test was used to determine the relationships between the categorical variables. The level of significance was set at $p<0.05$.

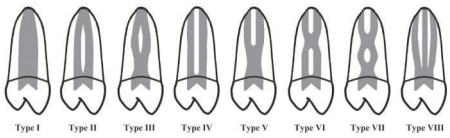


Figure 1. The classification proposed by Vertucci[13] for root canal system anatomy of maxillary first and second premolars

Results

In 331 patients, 1086 premolar teeth (555 first premolar and 531 second premolar) were examined. All scans belonged to Turkish patients who were originating from Cukurova population. One-hundred eighty-six of 331 patients were female and 145 were male. In the first premolars, 138 (24.9%) had one root, 416 (75%) had two separate roots and 1 (0.1%) had three separate roots. It was found that 405 (76.3%) second premolars had one root, 123 (23.2%) second premolars had two separate roots and 3 (0.5%) second premolars had three separate roots (Table 1). 117 (21.1%) of first premolars, 370 (69.7%) of second premolars terminated with a single canal, 436 (78.6%) of first premolars, 156 (29.4%) of second premolars terminated with two canals and 2 (0.3%) of first premolars, 5 (0.9%) of second premolars terminated with three canals (Table 2). When the root canals were examined according to Vertucci classification[13], first premolars were highest in type IV with 73.2%, type II was second with a ratio of 11.7%; second premolar teeth were highest in type II with 32.4%, type I was second with a ratio of 23.5% (Table 3).

Table 1. Distribution of maxillary premolars' root numbers

	First premolar				Second premolar			
	One root	Double roots	Three roots	Total	One root	Double roots	Three roots	Total
Female	95	211	-	306	239	57	2	298
	31%	69%	-	100%	80.2%	19.1%	0.7%	100%
	68.8%	50.7%	-	100%	59.0%	46.3%	66.7%	56.1%
Male	43	205	1	249	166	66	1	233
	17.3%	82.3%	0.4%	100%	71.2%	28.3%	0.4%	100%
	31.2%	49.3%	100%	100%	41%	53.7%	33.3%	43.9%
Total	138	416	1	555	405	123	3	531
	24.9%	75%	0.2%	100%	76.3%	23.2%	0.6%	100%
	100%	100%	100%	100%	100%	100%	100%	100%
p		0.000*				0.016*		

* shows significant differences between groups ($p<0.05$).

Table 2. Distribution of maxillary premolars' canal numbers

	First premolar				Second premolar			
	Single Canal	Double Canals	Three Canals	Total	Single Canal	Double Canals	Three Canals	Total
Female	79	227	-	306	223	72	3	298
	25.8%	74.2%	-	100%	74.8%	24.2%	1%	100%
	67.5%	52.1%	-	55.1%	60.3%	46.2%	60%	56.1%
Male	38	209	2	249	147	84	2	233
	15.3%	83.9%	0.8%	100%	63.1%	36.1%	0.9%	100%
	32.5%	47.9%	100%	44.9%	39.7%	53.8%	40%	43.9%
Total	117	436	2	555	370	156	5	531
	21.1%	78.6%	0.4%	100%	69.7%	29.4%	0.9%	100%
	100%	100%	100%	100%	100%	100%	100%	100%
p		0.002*				0.003*		

* shows significant differences between groups ($p<0.05$).

Table 3. Distribution of maxillary premolars' canal configuration

	Type I	Type II	Type III	Type IV	Type V	Type VI	Type VII	Type VIII	Total
First	15	65	39	406	10	10	8	2	555
p.	2.7%	11.7%	7%	73.2%	1.8%	1.8%	1.4%	0.4%	(100%)
Second	125	172	72	99	14	24	20	5	531
p.	23.5%	32.4%	13.6%	18.6%	2.6%	4.5%	3.8%	0.9%	(100%)
Total	140	237	111	505	24	34	28	7	1086
	12.9%	21.8%	10.2%	46.5%	2.2%	3.2%	2.6%	0.6%	(100%)

P: premolar.

There was a significant relationship between gender and numbers of first (respectively p=0.000 and p=0.002) and second (respectively p=0.016 and p=0.003) premolars' roots and canals. Accordingly, single-rooted and single-canalled first and second premolars were more prevalent in females. Double-rooted and double-canalled first and second premolars showed similar prevalence in both genders. In addition, the vast majority of the first premolars had double roots and canals, while the vast majority of the second premolars had one root and one canal (Table 1 and 2).

Discussion

It is important to correctly interpret canal morphology and root anatomy for successful endodontic treatment[6,7]. CBCT is a non-invasive technology that provides a three-dimensional assessment of canal and root morphology[15]. Clinical and various experimental CBCT studies have been managed to explore root and canal morphology in diverse tooth types[12,16,17]. CBCT provides axial, sagittal, coronal sections and three-dimensional diagnostic images without superposition. The number of canals, crown and root length and root canal morphology can be evaluated clearly. Therefore, CBCT is a good imaging method to evaluate canal morphology[18].

Various studies have reported that the external and internal anatomy of the maxillary premolar teeth was highly variable according to geographical origin and race[13,19,20]. Interestingly, studies on fossils have shown that factors such as ethnicity, age and gender may also have an impact on this heterogeneity[21,22]. This is the first study to show the root-canal morphology and configuration according to Vertucci classification[13] in the Cukurova population.

In Egyptian, American, Singaporean and Andalusian populations, slightly more than half of the maxillary first premolars were found to have two roots[14,23-25]. In Jordanian and German populations, this ratio was reported to be about two-thirds[26,27]. In the present study, a high rate (75%) of double-rooted maxillary first premolars were detected. Single rooted maxillary first premolar prevalence was found to be higher in contrast with Brazilian and Chinese populations[9,28].

In the present study, maxillary second premolars (76.3%) were mostly single-rooted. This was reported

to be more than the rate (about two-thirds) detected in the Saudi Arabian populations[29]. In addition, many studies have reported that single-rooted maxillary second premolar teeth are more than 80%[30-33].

In the current study, three-rooted maxillary first premolars which were seen as a rare condition was found only one first premolar (0.2%), similar to results of Saber *et al.*[14]and Awawdeh*et al.*[26]. Whereas in some studies, higher rates have been reported for three-rooted maxillary first premolars[9,20,25-27]. In the study of Lipski *et al*.[34] this rate was found to be more than 9%. Nevertheless, in the present study, three-rooted maxillary second premolars (0.6%) were also rarely observed similar to with studies of Kartal *et al*.[19], Saber *et al*.[14] and Al-Ghananeem *et al*.[35].

Maxillary first premolar teeth were reported as single-canalled (3.92-26.2%), double-canalled (73.3-97%), and three-canalled (0.0-5.0%) in the studies about the numbers of root-canals[19,36,37]. In this study, the rate of single-canalled maxillary first premolars were 21.1%. This rate was higher than previous studies on the Turkish population[19,36,37]. In the present study, the rate of double-canalled maxillary first premolar teeth were 78.6% and this was significantly lower than previous studies on the Turkish population[19,36,37]. In previous studies in the Turkish population, rate of three-canalled maxillary premolar teeth was between 0% and 1.6%[19,36,37]. Similarly, this rate was 0.4% in the present study.

In previous studies, maxillary second premolar teeth were reported as single-canalled (44-55%), double-canalled (45-56%) and three-canalled (0-1%) (19,37). In the present study, the rate of single-canalled maxillary second premolar teeth were 69.7%. This ratio was higher than previous studies on the Turkish population[19,37]. In the present study, the rate of double canalled maxillary second premolar teeth was 29.4% and this was lower than previous studies on the Turkish population[19,37]. Interestingly, while the rate of three-canalled maxillary premolar teeth in the Turkish population was between 1.2% and 1.6% in previous studies; this rate (0.9%) was lower in the present study[19,36,37].

The current study showed that there was a significant relationship between the root and canal numbers of the first and second premolars and gender Similar to the findings of Martins *et al*., single root and single canal in the maxillary first and second premolars were more common in female[38]. Male patients had a higher percentage of two roots compared with female patients in the de Lima *et al.*'s study[39].Unlike these results, Alqedairi *et al*.[40] and Nazeer *et al*.[41] reported that there was no significant relationship between gender and root number in maxillary first and second premolars.

Kfir *et al.* showed that the canals of single-rooted first maxillary premolars often had a Vertucci Type II configuration, with substantial curvatures in the bucco-palatal plane.[42] In the present study, type IV (73.2%) was most common canal configuration in maxillary first premolar teeth same as Buchanan *et al*.'s study[43], followed by type II (11.7%), type III (7%) and type I (2.7%). In other studies on the Turkish population, similar to this study, rate of type IV in maxillary first premolar teeth ranged from 60% to 78% [19,36,37,44]. In the previous studies, type I (32-48%) was seen as the most common canal configuration in maxillary second premolar teeth[19,36,37,39,41,43,44]. However, in the present study, type II (32.4%) was more common, followed by type I (23.5%), type IV (18.6%) and type III (13.6%). Although a significant relationship was found between root and canal numbers and gender in the present study, the reason for this situation is not fully understood. Further studies that examine the relationships between the difference in bone density between female and male and root-canal numbers can be conducted. Also, the differences between results of studies can be attributed to differences in populations and size of samples.

Conclusions

There were various differences in the anatomy of maxillary premolar root-canal systems which could complicate endodontic treatment. Despite its limitations, this study showed that presence of a high rate of two separate roots and two separate canals in the first premolars, a high rate of a single root and a single canal in the second premolars. Also, more common canal configuration in first premolars were type IV and in second premolars were type II.

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