

Root Canal Morphology of Permanent Lower Premolars in Qatari Population: A Cone-Beam Computed Tomography Study

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Abstract

The aim of this study was to evaluate the root anatomy of lower first and second premolar teeth in Qatari population using a cone-beam computed tomography (CBCT).

A total of 544 CBCT images of Qatari population were analyzed to investigate tooth position, number of roots, canal configuration and number of canals in permanent lower premolars. The most common root anatomy in lower first premolar (LFP) and lower second premolar (LSP) was one root with a single canal per root (98%) for both. Type I Vertucci canal morphology was predominated in a single rooted LFP (66%) and in two-rooted LFP (75%), in addition to a single-rooted LSP (84.2%). A symmetrical pattern was observed in LFP anatomy, including the same number of roots (95.3%), number of canals per root (92.7%) and the same types of canal configuration (66.8%). In LSP teeth, the percentage of symmetry was high among number of roots (98.1%), number of canals per root (95%) but dropped to (77.1%) for the types of canal configuration.

CBCT is an effective, noninvasive diagnostic tool to investigate root anatomy and canal morphology to improve endodontic treatment outcome.

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Introduction

A thorough knowledge of root canal morphology is one of the prerequisites for successful root canal therapy.^{1,2} Therefore, careful assessment of preoperative radiograph can help in predicting complicated root canal morphology and to locate and clean all the canals effectively, then to do three-dimensional obturation to avoid incomplete instrumentation and persistence of the etiologic factors, that can cause apical periodontitis.^{3,4,5,6} However, CBCT imaging has exceeded conventional radiography in its ability to determine root canal anatomy and its complications,^{7,8} since it has a reproducible technique that can be applied quantitatively and qualitatively for 3-dimensional evaluation of the root canal system.^{2,4,5,9}

Many factors such as ethnic differences,

origin, age, gender, and sex, in addition to study design can contribute to the variation of internal anatomy of the root canal system.^{10,11,12} Lower premolar with its high variation morphology and complex anatomy is one of the most difficult teeth to treat.^{2,7} A wide range of anatomical variations in these teeth can lead to endodontic treatment failure.¹³

The purpose of this study was to describe the root canal configuration of permanent lower premolar teeth in a selected sample of Qatari population using CBCT.

Materials and methods

This retrospective descriptive study was performed with the approval of the Medical Research Center and the Institutional Review Board at Hamad Medical Corporation (Approval #17228/17). A total of 544 CBCT images were requested for different treatment purposes including examination, diagnosis, or treatment planning, from Qatari population between 2014 and 2016 and they were performed with expert radiologists. CBCT images were taken using a D-CAT scanner (Imaging Sciences International, Hatfield, PA, USA) operated at 120 KVp (eff)

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tube voltage, 20 mA tube current with 14.7s scanning time, 0.4 to 0.2 mm voxel size, and a field of view of 160 mm x 40 mm. After the acquisition, data was transferred to Infiniti Dental PACS (Infiniti Healthcare, Seoul, South Korea) as DICOM files, and these files were not anonymized, exported with the patient's data.

The CBCT images were reviewed by two Endodontists with more than 10 years of clinical experience independently. The teeth included in this study were selected according to the following criteria: (1) permanent teeth with fully formed roots; (2) teeth with no restoration (intracanal or coronal); (3) teeth with no apical pathosis; (4) no calcification or resorption in the canals; (5) Clear CBCT images with no artifact or distortion. When one of these criteria was not applicable, these teeth were excluded and the reason for exclusion was mentioned. Vertucci classification (Vertucci 1984) was used to determine the canal configuration type.

Statistical Product and Service Solutions (SPSS) version 20 (SPSS Inc, Chicago, IL) was performed for the statistical analysis. To identify the characteristics of the root anatomy of lower permanent teeth, such as: frequency, percentages, mean, and standard deviation, a descriptive analysis was used.

Results

A total of 544 CBCT records were evaluated. The inter-examiner agreement result was 95.13% (range 74% to 100%) and the intra-examiner agreement was 91.7% (range 87.4% to 98.1%). The number of LFP included in this study was 544 (50 %) teeth out of 1088. Most of the teeth were from female patients 375 (68.9%) compared to 169 (31.1%) from male patients. The age average was 37.6 years ranging from 12 to 76 (Table 1).

No. Of Teeth Included	No. Of Teeth Excluded	Left	Right	Female	Male	Age	Mean	SD	Median
LFP No.									
544	544	267	277	375	169	37.64	14.4	37	
%	50	50	49.1	50.9	68.9	31.1	-	12-76	-
LSP									
No.	417	671	218	199	263	154	36.69	14.33	36
%	38.3	61.7	52.3	47.7	63.1	36.9	-	12-76	-

Table 1. Shows the age, gender, and number of teeth in the lower first premolar (LFP)and lower second premolars (LSP) that were included and excluded.

[No: Number, %: Percentage, SD: Standard Deviation]

The number of roots that most observed in LFP was one root (94.1%). Two roots were also observed in (5.9%). In a single-rooted LFP, the prevalence of a single canal was (98%) and the prevalence of the two canals was (1.8%). In two-rooted LFP, a single canal was observed in each root in 31 teeth (96.9%). Interestingly, two teeth which had 2 roots, located mesially and distally, had a single canal in the mesial root and 2 canals in the distal root (6.2%) (Table 2). The most common root canal configuration in a single-rooted LFP was type I (66.4%) followed by type III (16.4 %), and type V (14.0%). Other types such as type II, 1-3,1-3-1, VII and 2-1-2-1 were also observed in a single-rooted LFP but in a lesser quantity (1.7 %, 0.6%,0.4%, 0.2% and 0.2% respectively).

Single-Rooted		Two-Rooted		
No. of Roots (%)	512 94.1	32 5.9		
Total: 544				
	1 Canal	2 Canals	2 Canals	
LFP No. (%)	502 98	9 1.8	31 96.9	2 6.2
Total: 544				

Table 2. Number of Roots and Canals in Lower First Premolars (LFP)

[No: Number, %: Percentage]

Single- Rooted							
Vertucci Classification	I	II	III	IV	V	VII	Other
LFP No. (%)	339 66.2	9 1.7	84 16.4	0 0	72 14	1 0.2	7 1.4
Double - Rooted							
Vertucci Classification	BI, LI	BIII, LI	BV, LI	BVII, LI	B1, LV		
LFP No. (%)	24 75	4 12.5	2 6.3	0 0	2 6.2		

Table 3. Root Canal Morphology (Vertucci Classification) of lower first premolar (LFP).

[No: Number, %: Percentage, B: Buccul, L: Lingual]

In two-rooted LFP, the root canal configuration of the canals was found to be mainly type I in both buccal and lingual root (BI, LI) (75%). Other variations were also found such as buccal type III combined with lingual type I (BIII, LI) (12.5%), (BI, LV) (6.2%), and (BV, LI) (6.3%) (Table 3). Two hundred and twenty-one (95.3%) of 232 patients had symmetrical roots between right and left LFP. Out of 221 patients with symmetrical root, 212 (95.9%) patients had 1 root and 9 (4.1%) patients had 2 roots.

Moreover, 215 (92.7%) out of 232 patients had symmetrical number of canals per

root. The root canal configuration was found to be symmetrical in 155 (66.8%) of 232 patients and 116 (74.8%) of them had Vertucci type I. For LSP, 417(38.3%) teeth were included out of 1.088. Most of the teeth were from female patients 263 (63.1%) compared to 154 (36.9%) teeth from male patients. The age average for the included patients was 36.7 years ranging from 12 to 76 (Table 1).

The number of roots that mostly observed in LSP was one root (98.3%) and two roots were only observed in (1.7%) of the teeth (Table 4). In a single-rooted LSP, one canal observed in (98%), two canals in (1.7%), and 3 canals in only (0.2%) while in two-rooted LSP, only one canal was observed in each root (Table 4).

Single-Rooted			Double-Rooted	
No. of Roots (%)			7 1.7	
Total: 417				
LSP No.	1 Canal	2 Canals	3 Canals	2 Canals
(%)	98	1.7	0.2	1.7
Total: 417				

Table 4. Number of Roots and Canals in Lower Second Premolars (LSP)
 [No: Number, %: Percentage]

The most common Vertucci classification in a single and two-rooted LSP observed was type I (84.2%). In a single-rooted LSP, other Vertucci classifications were observed such as type III (9%), type V (2.4%) and type II (2.4%). One hundred fifty-nine (98.1%) of 162 patients had symmetrical number of roots between right and left LSP. On the other hand, out of the 159 patients with symmetrical root, 157 (98.7%) had a single root and only 2 (1.3%) had two roots. From 162 patients, 154 (95%) had symmetrical number of canals per root. Furthermore, 125 patients (77.1%) had symmetrical root canal configuration. The percentage of Vertucci type I root canal configuration found to be (95.2%), that was 119 from 125 patients.

Discussion

Many variations in the root canal morphology of permanent lower premolars have been reported in the Endodontic Literature.⁴ Some studies stated that these teeth had a

greater increase in endodontic failure due to the wide variations in the canal morphology.¹¹ Moreover, other studies reported that the most difficult teeth to treat were the lower premolars.¹¹

The most observed number of roots in LFP in the current study was one root (94.1%), while, two roots were observed in a lesser quantity (5.9%) and this is in accordance to other many previous similar studies.^{10,14,15,16} At the same time, this percentage of two-rooted LFP (5.9%) is higher when compared to other studies, using the clearing method of extracted teeth in Turkey (0%), Iran (2%), Saudi Arabia (3.1%) and Jordan (3%).¹⁴ Additionally, another study reported a high incidence of two-rooted LFP teeth (15%) when a small sample size (20 teeth) and two-dimensional radiographic were used.¹⁴ In LFP, the prevalence of a single canal in a single-rooted and two-rooted LFP were (98% and 96.9% respectively). A Turkish study had reported that (62%) of LFP had a single canal.¹¹

In contrast, another study from Chinese population found that only (54%) of the LFP had a single canal and (22%) had two canals.¹¹ The most common root canal configuration in a single-rooted and two-rooted LFP was type I (66.2% and 75% respectively). This was in consistent with many other studies conducted in different populations.^{10,12,14,16}

In LSP, the most common number of roots observed was one root (98.3%) and two roots were only observed in (1.7%) of the teeth and this is consistent with other studies.^{7,14} Kottoor et al reported that the prevalence of two roots in LSP was (0.61%), whereas the prevalence of more than 2 roots was (0.01%).⁷

In a single-rooted LSP, one canal was mostly observed in (98%) while two canals were observed in only (1.7%) and this is in accordance with Cleghorn et al study (2007) that reported the incidence of LSP with one canal and two canals (91% and 9% respectively).¹⁴ On the other hand, this is different than some of other studies that stated the occurrence of one canal in LSP was (72%) and two canals was (27.5%).¹¹ Sert & Bayirli (2004) study stated that (71%) of LSP had a single canal, while others reported that the incidence of two canals in LSP was ranging from (1.2% to 15%).¹¹

The most predominate Vertucci classification in a single and two-rooted LSP was type I (84.2%), This is like a Turkish and other

studies that stated the most prevalent Vertucci classification in LSP was type I (98.5%).^{10,13,14}

In regards of symmetry, a high prevalence of symmetry between right and left LFP and LSP were reported in this study. A symmetrical pattern of tooth anatomy with the same number of roots in LFP and LSP were (95.3 % and 98.1% respectively). This is in consistent with a previous study that stated a high prevalence of symmetry in both LFP and LSP based on the number of roots and the canal configuration (93.8% and 97.8% respectively).¹⁴

On the other hand, this was opposite to other studies that stated a low prevalence of symmetry between premolar teeth.¹⁷ In a study of comparing the degree of symmetry between contralateral premolars done by Xu et al (2016) using CBCT, they found that only few pairs of premolars were matching,¹⁷ while Johnsen et al (2017) found a high degree of matching between contralateral premolars using micro-CT scans and they concluded that contralateral premolars had identical pulp space.¹⁸

Moreover, some studies evaluated the symmetry using micro-CT and stated that contralateral premolars and in terms of geometrical analysis can be viewed as a mirror image of each other.¹⁸ Opposite to this, other studies found just few matchings between contralateral premolars.^{14,17}

Although, just a few studies had reported the degree of symmetry in contralateral premolars in root canal morphology,^{18,19} a contralateral premolar considered as identical, even though, there is a lack of enough evidence in the literature and most of the present studies consider only the external anatomy than the internal anatomy of contralateral premolars.¹⁸

Conclusions

Clinicians should be aware of the complexity of root canal anatomy using the most recent and reliable armamentarium to achieve favorable treatment outcomes. Permanent lower premolars are associated with various types of root canal anatomy. Mostly, LFP and LSP teeth exhibited a single root with Vertucci classification type I. However, the incidence of more than one root with different canal configurations was detected.

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Declaration of Interest

The authors report no conflict of interest.

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