

# The variation in the number of roots and canals morphology of permanent mandibular first molar teeth by using cone beam computed tomography imaging in a sample of Erbil city

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**Background and Objectives:** Adequate knowledge about the number of roots, canals, and morphology of lower first molar teeth is a basic requirement of root canal therapy and any surgical treatment in this region, was carried out to investigate root and canal morphology of permanent mandibular first molars in a sample from Erbil population using cone beam computed tomography (CBCT).

**Methods:** This study was carried out during a period from October 2017 till June 2018. The sample selected from patients visited (college of Dentistry, Denta Plus, Hollywood Smile Design) centers in Erbil city according to specific criteria. One hundred patients have been selected from those patients who referred to obtain CBCT for the lower mandibular region, after obtaining consent from these patients and about 141 mandibular first molar teeth were used in this study. Different measurements were done on the CBCT of each patient by investigating the root numbers, the number of canals and root canal configuration which classified by using Wein's and Vertucci's classification. The data were analyzed statistically by Pearson's Chi-square test.

**Results:** The result indicated that the first molar tooth had two roots one mesial and one distal, while about the numbers of extra roots the result indicated that only the distal root showed five extra roots (3.5%). The data analysis for the number of canals in study sample indicated that the mesial root had two canals in all sample while in distal root showed that 41 mandibular first molars showed two canals which were about 29.1% and 100 mandibular first molars showed one canal which was about 70.9%.

The result indicated that morphology of distal root canal of mandibular first molars according to Wein's classification, it that 70.9% of the study sample was of type I morphology, both type II and type IV were about 5% of the sample, type III morphology was about 12.8%, and about 6.4% of study sample classified according to Vertucci classification which showed type III morphology while for the morphology of mesial root canal of lower first molar tooth the result indicated that 100% of the samples had type III Wein's morphology.

**Conclusion:** The prevalence of extra root was about 3.5% in distal root. Wein's type I was the most prevalent configurations in distal root and type III Wein's in the mesial root of the first mandibular molars. CBCT analysis of root canal system provides good information and details which is very helpful in different treatment modalities.

**Keywords:** Mandibular first molar teeth, cone beam computed tomography, root, and canal morphology.

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## Introduction

The radiographic examination provides information regarding tooth morphology such as pulp chamber size and degree of calcification, root structure, root curvature, location and number of canals, fractures, and iatrogenic defects. The use of two-dimensional radiographic images for interpretation of a three-dimensional (3D) object such as complex dental

anatomy, root canal morphology, and surrounding structures are difficult and can contribute to non-healing of endodontic cases.<sup>1</sup> To overcome this drawback, which may also be encountered in several fields of dentistry, 3D imaging techniques have become essential.<sup>2</sup>

Cone beam computed tomography is an extra-oral imaging system specifically designed for three-dimensional imaging of the oral and maxillofacial structures. Most of the limitations associated with conventional radiography like compression of a three-dimensional object into a two-dimensional image, image distortion, anatomic superimposition are overcome with cone beam computed tomography. CBCT produces clear images with high resolution at reduced radiation and lower cost.<sup>3</sup> It is a more compact, fast and safe version. The time needed for a full scan is typically less than C.T. and the radiation dosage is several times lesser than that of a CT scanner.<sup>4</sup>

The knowledge about the morphology of the root canal system has a great role in the success of the endodontic treatment and any surgical treatment involves this region.<sup>5</sup>

The mandibular first molars (MFMs) had the most complex root and canal morphology of the mandibular dentition, and many studies had attempted to assess their entire anatomic characteristics. It is generally accepted that the most common form of mandibular first molar had two roots and three canals. The most apparent variation related to the number of roots in the presence of a third distolingual root and its incidence has been joined to specific ethnic groups.<sup>6,7</sup>

Since extra root and canals are common phenomena, and their incomplete treatment is one of the reasons for the failure of root canal treatment, so the knowledge about the morphology and anatomy of the root canal system and its variations is of at most importance in any treatment.<sup>8</sup> Most of the periapical radiographical image may not show the presence of all canals within the root, especially in the buccolingual plane, such missed canals may be responsible for persistent infection and post-treatment disease. The mandibular first molar is one of the most frequently treated teeth, accounting

for 17.4% of all root canal procedures. Many studies indicated that the mandibular molars were the most frequently extracted teeth, and one of the main reasons for extraction is the failure of endodontic treatment (19.3%).<sup>9</sup> The most frequent variation in the number of roots in the presence of a third root, which is located in the distolingual position and is found with a prevalence >30% in Asian populations. The mesial root generally contains two canals in 94.4% of cases,<sup>7</sup> and there is a lot of variation in their morphology of these canals between the patients and different ethnic groups.

Therefore the aim of the present study is to determine the variation in the number of roots, canals and canals morphology of the mandibular first molar in a sample of patients from Erbil city by using CBCT imaging.

## Methods

**Study design.** This study was a prospective study was done on 100 selected sample cases with (141 lower first molar teeth) from Erbil city, and these cases selected from patients taking CBCT for lower molar teeth in Oral Diagnosis Department clinic at College of Dentistry, Hawler Medical University and two private centers (Denta Plus, Hollywood Smile Design) located in Erbil, Kurdistan region, the period of study was from October 2017 till June 2018, all the patient had been examined and the information about the patients were recorded in a special case sheet as shown in appendix. CBCT images had been done for these patients as part of their dental examination and treatment for a different reason such as (CBCT scans were mainly obtained for implant surgery, surgical removal of impacted teeth, orthodontic treatment, and endodontic treatment). Therefore, the subjects of this study were not exposed the patient to unnecessary additional radiation to get the information on the root canal anatomy of the lower first molar tooth in this sample of the study.

**Inclusion criteria.** Images of the first mandibular permanent molars are selected according to the following inclusion criteria:  
1. Patients age above 18 years old.

2. Intact roots without fractures and history of trauma.

3. No missing or unerupted first molars.

**Exclusion criteria.**

1. Odontogenic or non-odontogenic pathology.

2. Mandibular molars with developmental anomalies.

3. External or internal root resorption and badly carious tooth.

4. Previous root canal treatment.

5. Posts or crown restorations and extensive coronal restorations.

6. Root caries especially reaching the bifurcation area and canal calcification.

**CBCT usage and specification.** CBCT images were prepared in high-resolution zoom mode with a voxel size of 0.15 mm using NewTom VGi 9000 CBCT device (Quantitative Radiology SRL Co., Verona, Italy) with a 12×7.5 cm background using 110 kVp, 19 mA and 18 sec of exposure time. Volume-rendering and multi-planar reconstructions were performed using the NTT viewer software program.

**Data Sources / Measurements (Radiographic technique).**

CBCT images were interpreted by two oral radiologists independently; blinded from demographic data of the patients (inter and intra examiners calibration were done in order to decrease the error in a sample study), in this study evaluation were done by CBCT for root canal morphologies which classified by depending on both Weine's classification (Figure 1) and Vertucci classification.

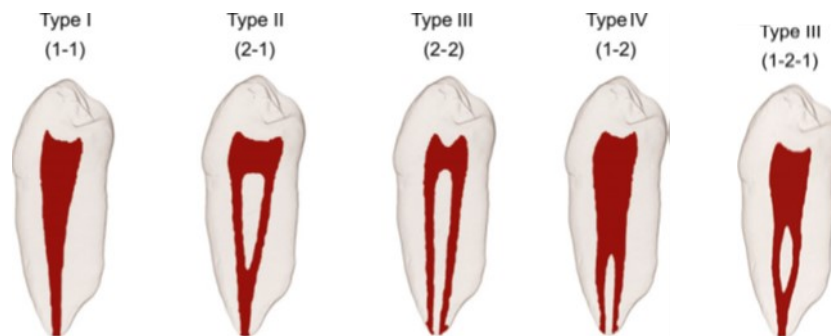
To categorize the morphology of the root canal system in each root<sup>10</sup> Weine's described 4 different configurations:

Type I (a single canal from the pulp chamber to the apex).

Type II (2 separate canals that leave the chamber but merge shortly of the apex to form a single canal).

Type III (2 separate canals that leave the chamber and exit the root in separate foramina).

Type IV (1 canal that leaves the chamber but divides short of the apex into 2 separate and distinct canals with separate foramina).



**Figure 1: Classification of root canal morphology by Weine's (A,B,C,D)<sup>10</sup> and Vertucci (F) classification.<sup>8</sup>**

In this study, the class III Vertucci<sup>8</sup> was used to classify some cases which not fit with Weine's classification.

Type III: a single canal that divides into two and subsequently merges to exit as one (1-2-1 configuration).

**CBCT image views.** Each tooth in study samples was evaluated in three axial, sagittal and coronal planes. An axial view was used mainly to analyze the numbers of roots, canals, and the apical foramen. All views were used to determine the number of roots in each tooth by evaluating tooth in the sagittal, coronal and axial planes. In order to determine the number of root canals, we

evaluated the axial plane from the neck of a crown to the apical orifice of the root canal system. The thickness of the images slices was 0.5 mm.

Then the 3D reconstructed images were evaluated by two radiologists who were assigned to evaluate the configuration of mesial and distal canals. Each classification needed to be agreed by both radiologists.

**Ethical consideration.** This study was based on the prospective evaluation of CBCT and approved by the Medical Ethics Committee of a College of Dentistry, Hawler Medical University.

The purpose of this study was explained to

each participant and written and verbal consent agreement obtained to use their data in this study.

**Statistical analysis.** Data were analyzed using the Statistical Package for Social Sciences (SPSS, version 22). Chi-square test of association was used to compare proportions. A p value of less than 0.05 was considered statistically significant.

## Results

The result of this study done by depending on the data analysis of CBCT of 141 mandibular first molar teeth of 100 patients. Table 1 showed the distribution of 141 mandibular first molar teeth according to these variables (gender, number of mesial, distal, and distal extra roots, number of the

mesial and distal canal). The distribution of teeth among the gender in the sample of this study was (50) male which is (35.5%) and 91 female which is (64.5%) patients teeth, the numbers of mesial and distal roots of mandibular first molar teeth in this sample indicated that all cases of this sample have one mesial root and one distal root, the numbers of extra root was five at distal root which is about (3.5%) as shown in the Table 1. The study sample indicated that the number of canal in mesial root of mandibular lower first molar teeth had 2 canals in the total samples, but about the number of canal in distal root it had 1 canal in 100 teeth which equal to 70.9% of the study sample and 2 canals in 41 teeth which were about (29.1%) of study sample.

**Table 1: Frequency distribution of the numbers of root and canal in lower first molar teeth.**

Variables		Count	%
Gender	Male	50	35.5%
	Female	91	64.5%
Number of mesial roots of lower first molar teeth	1	141	100.0%
Number of distal roots of lower first molar teeth	1	141	100.0%
Number of distal extra roots of lower first molar teeth	5	141	3.5%
Number of the mesial canal of lower first molar teeth	2	141	100.0%
Number of the distal canal of lower first molar teeth	1	100	70.9%
	2	41	29.1%

Table 2 showed the morphology of distal root canal of all teeth according to Wein's and Vertucci classification, where it was evident that 70.9% of the sample where of type I morphology, 5% of type II morphology, 12.8% of type III morphology and 5% of type IV morphology of Wein's classification, and the result also showed that about 6.4% of the sample had type III morphology of Vertucci classification, while morphology of mesial root canal of lower first molar tooth by Wein's classification,

where it was evident that 100% of the samples were showed type III Wein's classification.

The result from the Table 3 which chi-square test applied for the morphology of the distal root canal of the lower first molar teeth by Wein's and Vertucci classification between all types of canal morphology. It showed a highly significant difference were detected between the morphology of these types of the entire group ( $P=0.000$ ).

From the Table 4 which showed the

**Table 2: Frequency morphology of root canals of 141 mandibular teeth.**

Morphology of a distal root canal of the lower first molar tooth by Wein's classification	Type I	100	70.9%
	Type II	7	5.0%
	Type III	18	12.8%
	Type IV	7	5.0%
	Vertucci Type III	9	6.4%
Morphology of a mesial root canal of the lower first molar tooth by Wein's classification	Type III	141	100.0%

**Table 3: Morphology of distal root canal of a lower first molar tooth by Wein's and Vertucci classification.**

	Observed N	Expected N	Residual	P-Value
Type I	100	28.2	71.8	(0.0001)
Type II	7	28.2	-21.2-	
Type III	18	28.2	-10.2-	
Type IV	7	28.2	-21.2-	
Vertucci Type III	9	28.2	-19.2-	
Total	141			

variation in all variable of this study between males and females for (Number of roots, canals and Morphology of distal and mesial root canal of lower first molar tooth), the statistical analysis done by chi-square test to show the differences between these variables as shown in the Table 4. The result indicated that all first molar teeth in sample of study showed one mesial root and one distal root, so no variation between male and female, The result showed that the distal extra root present only in one case of male tooth and 4 cases of female teeth and the Statistical analysis showed non-significant different between males and females ( $P=0.462$ ). In all study sample the male and female showed that mesial root had two canals in lower first molar teeth as showed in the Table 4 which also showed that the number of the canal of distal root of lower first molar teeth as following: 1 canal in 26.24% of male cases and 44.68% female teeth cases, while it had two canals for 9.22% male cases and 19.86% female teeth

cases. No significant differences were detected between the males and females ( $P=0.551$ ).

The result in Table 5 showed the classification of morphology of the distal root canal of lower first molar tooth, it was evident that large percent of 26.24% of male and 44.68% of female teeth had type I Wein's classification, 5.67% of male and 7.09% of female teeth had type III Wein's classification, and only 4.96% of female teeth of type II Wein's classification and 2.84% male and 2.13% female teeth of type IV Wein's classification, while 0.71% of male and 5.67% of female teeth had type III Vertucci classification as shown in the Table 5. No significant difference was detected by chi-square test between all the type of canal morphology between male and female ( $P=0.079$ ), while for the morphology of a mesial root canal of the lower first molar tooth by Wein's classification, where it is evident that 100% of the samples type III Wein's classification

**Table 4: Distribution of sample variables among gender.**

Variables		Gender		Chi-Square (p-value)
		Male	Female	
		Count	Count	
Number of mesial roots of lower first molar teeth	1	50	91	N/P
Number of distal roots of lower first molar teeth	1	50	91	N/P
Number of distal extra roots of lower first molar teeth	0	49	87	<b>0.541</b> <b>(0.462)</b>
	1	1	4	
Number of a mesial canal of lower first molar teeth	2	50	91	N/P
Number of a distal canal of lower first molar teeth	1	37	63	<b>0.356</b> <b>(0.551)</b>
	2	13	28	

**Table 5: Distribution of morphology among gender.**

Variables		Gender		Chi-Square (p-value)
		Male	Female	
		Count	Count	
Morphology of a distal root canal of the lower first molar tooth by Wein's classification	Type I	37	63	<b>8.354 (0.079)</b>
	Type II	0	7	
	Type III	8	10	
	Type IV	4	3	
	Vertucci Type III	1	8	
Morphology of a mesial root canal of the lower first molar tooth by Wein's classification	Type III	50	91	<b>N/P</b>

## Discussion

**Root and canals in mandibular first molar teeth.** The present study showed a non-significant difference in the number of (mesial, distal and extra distal) root among males and females; this finding agreed with a study in Taiwanese population were done in 2009.<sup>11</sup> Mandibular first permanent molars usually have two roots located one mesially and one distally, many studies showed that populations with mongoloid traits there was an additional root located distolingually is considered to be a normal morphologic variant and can be identified as an Asian trait.<sup>12,13</sup> The presence of additional third root which can be found distolingually is termed as Radix Entomolaris (RE); this was first mentioned by Carabelli in 1844. In the Indian population, the frequency of Re is <5%.<sup>14</sup> In the present study, it was about 3.5%, this percentage it was higher than the results of some other studies on Asians<sup>15,16</sup> but it was lower than the study done on Korean children (33.1%) and Eskimo adults which was (32.0%) by Song JS in 2009 and they used a two-dimensional radiograph in this study,<sup>17</sup> this variation in the result could be attributed to the use of 2D image analysis in the previous study while in present study 3D image (CBCT) used which provides more accurate determinations, leading to clearer estimation about this anatomic variation which was distolingual root in first molars and also for the variant may attribute to ethnic groups and genders. The variant between male and female predilection for the distolingual root in the mandibular first molar had been reported by several investigators. Some studies suggested sex-related differences<sup>17</sup> However, our current study supported that the prevalence of the distolingual root according to sex showed no

statistical significance, which was similar to the study in the Taiwanese.<sup>11</sup> The predilection for the presence of the distolingual root in the mandibular first molar is also a controversial issue and there was diversity in the outcomes of the previously mentioned studies may result from their differences in sample sizes and methods of case selection. The imaging modality which used in this study besides the difference in ethnic groups and other factors.

**Morphology of root canal system.** The root canal morphology of mandibular first permanent molars was showed a large diversity. Some studies reported that nearly half of the mesial root of mandibular first molars exhibited type IV Vertucci canal configuration which is same type III Weine's. However, in the present study, the prevalence of type III Weine's canals in the mesial roots was 100%, which was greater than the reported figures of those previous studies.<sup>18,19</sup> This difference may be related to study design (in vivo vs in vitro), the technique of canal identification (CBCT examination and clearing) and method, beside an ethnic variant and sample size. The most common canal configuration of distal roots is type I, with a reported frequency of between 54% and 72%<sup>20,21</sup> Gu et al<sup>22</sup> examined 20 extracted three-rooted mandibular first molars by a micro-computed tomography study of Chinese patients. They found that almost all of the distolingual and distobuccal roots contained a type I canal. The results of the present investigation were in agreement with this study. The most prevalent canal morphology in the distal roots was type I (70.9%) followed by type II (5%), type III (12.8) and type IV (5%) and type III Vertucci (6.4%).

These results are in agreement with the findings of de Pablo et al<sup>6</sup> and disagree with studies done on Turkish population.<sup>18,23,24</sup> These differences may be related to study design (in vivo vs. in vitro) or to the technique used for canal identification (CBCT examination and clearing).

### Conclusion

The prevalence of extra root was about 3.5% in distal root. Wein's type I was the most prevalent configurations in distal root and type III Wein's in the mesial root of the first mandibular molars.

CBCT analysis of root canal system provides good information and details which is very helpful in different treatment modalities.

### Conflicts of interest

The authors reported no conflicts of interests in this study.

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