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Gross Anatomy and Histology of First Premolar Teeth in Baghdad Population

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KEY WORDS:
dental anatomy, first premolar, root length, dentin, cementum.

ABSTRACT
Introduction: Dental anatomy involves the study of the morphology, growth, identity, and function of each tooth in human dentition. This study evaluates the descriptive anatomy, histology, and geometry of the human first premolars in both jaws to enhance dental care quality. Various techniques, including in vivo and in vitro methods, have been employed to study root and root canal morphology.
Methodology:A total of 51 sound teeth were collected from Ghazi Al-Hariri Hospital for Surgical Specialties and Al-Amiria Specialized Dental Center. These teeth, extracted due to orthodontic procedures, belonged to individuals aged 20-40 years and were collected from November 2023 to April 2024.
Results: The study found that double-rooted teeth were predominantly present in the maxillary first premolars, while single-rooted teeth were more common in the mandibular first premolars. In the histological analysis, acellular cementum was observed at the cementoenamel junction (CEJ) and the coronal one-third of the root, whereas more cellular cementum was present in the apical two-thirds of the tooth. The radicular dentin adjacent to the cementodentinal junction exhibited Tomes' Granular Layer. Dentinal tubules were present throughout the dentin thickness. The pulp showed four zones: odontogenic, cell-free, cell-rich, and pulp.
Conclusion: There was a morphometric variation between upper and lower first premolars, with no differences observed in histological sectioning

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INTRODUCTION

Anatomy of Dentition

Humans have two dentitions over their lifetime, which support physical structures, enable orofacial functions like speaking and mastication, and contribute to facial aesthetics. The alveolus, or bony sockets in the jaws, support the teeth, which are highly calcified structures with unique tissues. The four types of permanent teeth are canines, molars, premolars (bicuspids), and incisors [1].

Maxillary teeth are those supported by the upper jaw, while mandibular teeth are supported by the lower jaw [2]. The first permanent teeth typically erupt at age six. The transitional or mixed dentition phase lasts until around age 12 or 13, ending when all permanent teeth have emerged and deciduous teeth are lost. Permanent dentition consists of 32 teeth: 16 maxillary and 16 mandibular [3]. The crown of the first premolar teeth, often referred to as "bicuspids," features two primary cusps: a buccal and a palatal (or lingual) cusp. The roots are typically buccal and palatal, though occasionally there is only one root with deep grooves on both distal and mesial surfaces, premolars are unique to the permanent dentition, usually erupting around age 10. The crown of premolars has one occlusal surface and four axial surfaces: buccal, lingual, distal, and mesial [4].

The average root length of the maxillary first premolar is 14.5 mm, while the mandibular first premolar root length is 14 mm [5]. The root comprises three tissues: dentin, cementum, and pulp. Dentin and cementum are hard, mineralized tissues, while the pulp is loose connective tissue [6].

MATERIAL AND METHOD

Subjects

A total of 51 sound teeth, including six were exposed for histological analysis, were collected from Ghazi Al-Hariri Hospital and Al-Amiria Specialized Dental Center. Specimens were collected from November 2023 to April 2024.

Inclusion and Exclusion Criteria

Included teeth had no root canal therapy, no proximal caries, crown fractures, or malformations, and complete morphology with fully formed roots. Excluded were teeth affected by conditions or illnesses and broken roots.

Collection of the Extracted First Premolar

Teeth were placed in normal saline for 30 minutes, cleaned using an ultrasonic scaler, stored in 10% formalin for 48 hours, and then placed in separate collection tubes with labels at room temperature until use (figure 1).

Gross Anatomical Study of the Teeth

A digital vernier caliper measured the root lengths of extracted teeth. Root length was measured from the cervicoenamel junction to the root apex, considering the longest root in case of discrepancy (figure 2).

The Number of Roots

Root forms were categorized as single, double, triple, or fused roots. Single-rooted teeth had one root, double-rooted teeth had roots split into two, three-rooted teeth had three roots, and fused roots had two roots fused into one.

Histological Study

Histological techniques included fixation, decalcification, dehydration, clearing, paraffin infiltration, embedding, sectioning, mounting on slides, and routine staining (Hematoxylin and Eosin) according to the following references

Statistical Analysis

Data were analyzed using SPSS version 26. Categorical variables were presented as frequencies and percentages, with associations tested by Pearson's chi-square or Fisher's exact test.. Continuous variables were presented as mean, standard deviation, and median, with comparisons made using the Mann-Whitney U nonparametric test. A p-value of 0.05 or below was considered significant.

RESULTS

In relation to the sound tooth samples, there were 16 men and 35 females, with a mean age of 27.4 ± 4.4 and 24.9 ± 4.4 respectively with P-value 0.07 as seen in (Table 1).

The number of roots and gender did not significantly correlate, although the maxillary arch is more likely to have double roots. p value is <0.001 (figure 3), but there was no significant difference between root number and the age group of the patients (Table 2). Between the maxillary and mandibular arches, the mean root length was 13.2 mm and 14 mm, respectively, the mean of root length in the age group between 20-29 years and 30-40 years were the same,13.5mm. The mean length in males was 13.2 mm while in females was 13.7 mm as explained in (Table 3) which are not significant in the all three variables.

The histological study made by sectioning the root at (5um) thickness of decalcified section and different planes longitudinal mesiodistal section and horizontal sections through the root(s): (above) 3 mm from apex; (below) at the cervical level.

Dentinal tubules were seen arranged compactly and show S-shaped curvature in the primary dentin. Secondary dentin contained lesser number of dentinal tubules compared to primary dentin. A bend or angle in the dentinal tubules noticed in the region where primary and secondary dentin met (Figure 4.). Predentin was a band of newly formed, unmineralized matrix of dentin at the pulpal border of the dentin (Figure5). Radicular pulp was present in the root portion of pulp cavity known as root canal (Figure 6).

There were four recognizable areas or zones in the pulp. Starting from the periphery (dentinal side), and were:

1. The odontogenic zone contains the cell bodies of the odontoblasts, arranged parallel to each other, immediately subjacent to the Predentin.
2. Cell-free zone, immediately beneath the odontoblasts.
3. Cell-rich zone, as the name indicated, was more cellular in nature.
4. The pulp core was the central portion of pulp, and contained the main trunk and branches of the blood vessels and nerve fibers that supply the pulp. (Figure 7).

Odontoblasts were larger in coronal pulp than in the root and appear columnar in pulp horns (Figure 8) and Fibroblasts were the most numerous cells in pulp because they are located throughout pulp. (Figure 9). In acellular cementum the entrapped cementocytes was not present. It was seen in the cervical third of the roots. Sharpey's fibers in it were well mineralized while in cellular cementum numerous cementocytes was seen entrapped in

lacunae. The lacunae had many extensions called canaliculi that house the cell processes of cementocytes. These canaliculi were directed toward the outer surface of the cementum (toward periodontal ligament). This type of cementum was more seen in the apical third of root (Figure 10). When a thin, calcified section of root was studied under transmitted light, a granular-appearing layer of dentin was seen underlying the cementum that covers the root. This layer is known as the granular layer or granular layer of Tomes (Figure 11).

Table 1: Comparison of age according to gender.

Age Years	Gender		P-value
	Male (n=16)	Female (n=35)	
Mean ± Std. Deviation	27.4 ± 4.4	24.9 ± 4.4	0.07
Median	30	24	Not significant

*Significant at 0.05 by independent t-test, ** significant at 0.05 by Mann-Whitney U test

Table 2: Root number according to gender, arch, and age groups.

Variables	Root number			P-value
	One	Two	Total	
	n (%)	n (%)	n (%)	
Gender				
Male	6 (37.5)	10 (62.5)	16 (100)	0.266
Female	19 (54.3)	16 (45.7)	35 (100)	Not significant
Total	**25 (49)**	**26 (51)**	**51 (100)**	
Arch				
Maxillary	4 (13.3)	26 (86.7)	30 (100)	<0.001**
Mandibular	21 (100)	0 (0)	21 (100)	Significant
Total	**25 (49)**	**26 (51)**	**51 (100)**	
Age groups				
20 - 29 years	18 (48.6)	19 (51.4)	37 (100)	0.931
31 - 40 years	7 (50)	7 (50)	14 (100)	Not significant
Total	**25 (49)**	**26 (51)**	**51 (100)**	

Table 3: Root length according to gender, arch, and age groups.

Arch	N	Root length (mm)		P-value
		Mean	Std. Deviation	
Maxillary	30	13.2	1.7	0.108
Mandibular	21	14.0	2.2	Not significant
Age groups				
20 - 29 years	37	13.5	1.9	0.974
31 - 40 years	14	13.5	2.1	Not significant
Gender				
Male	16	13.2	1.7	0.388
Female	35	13.7	2.0	Not significant

Abbreviations:
(CEJ): cementoenamel junction
Mm: millimeter
MD:mesodistal
H&E: Hematoxylin and Eosin

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Figure 1:

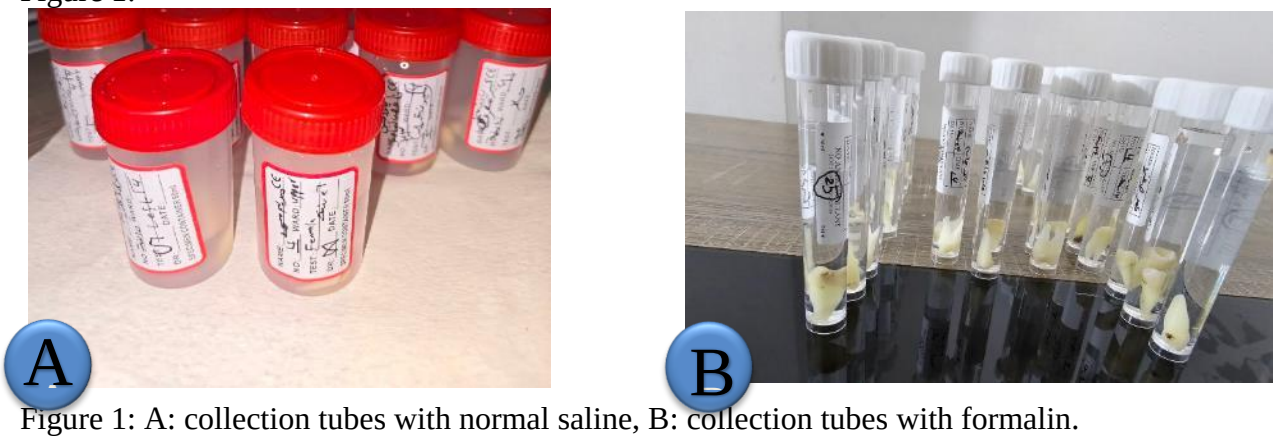

Figure 1: A: collection tubes with normal saline, B: collection tubes with formalin.

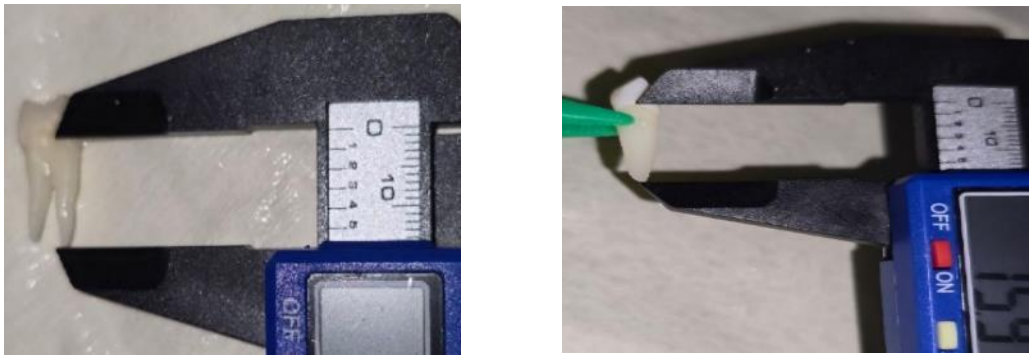

Figure 2 measurements of root length of first premolar tooth using digital vernier for different types of roots.

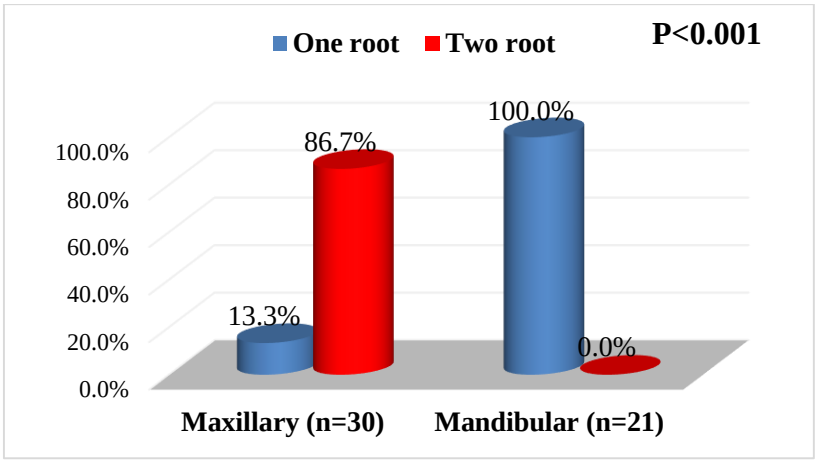

Figure 3: Root number according to their arch

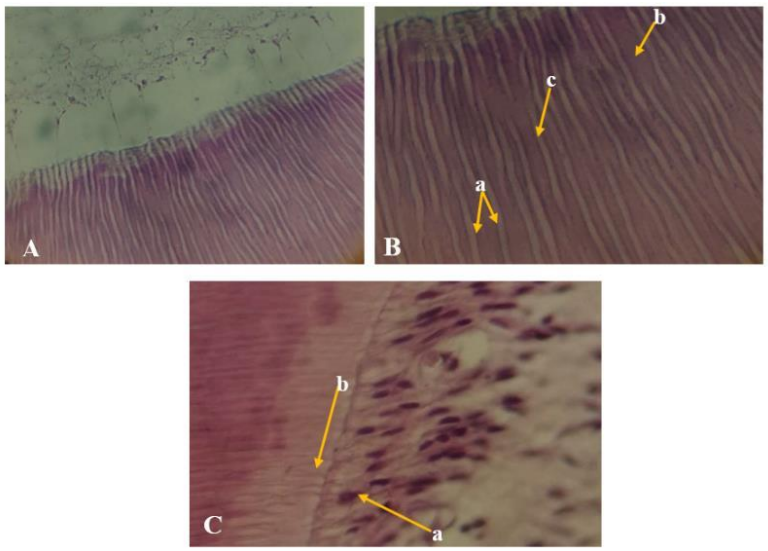

Figure 4 A: dentinal tubules (decalcified longitudinal M.D Section H&E X10). B: dentinal tubules(a) intertubular dentin(b), peritubular dentin(c), (decalcified longitudinal M.D Section H&E X40). C: odontoblast cells(a), odontoblast process,(b) (decalcified longitudinal M.D Section H&E X40).

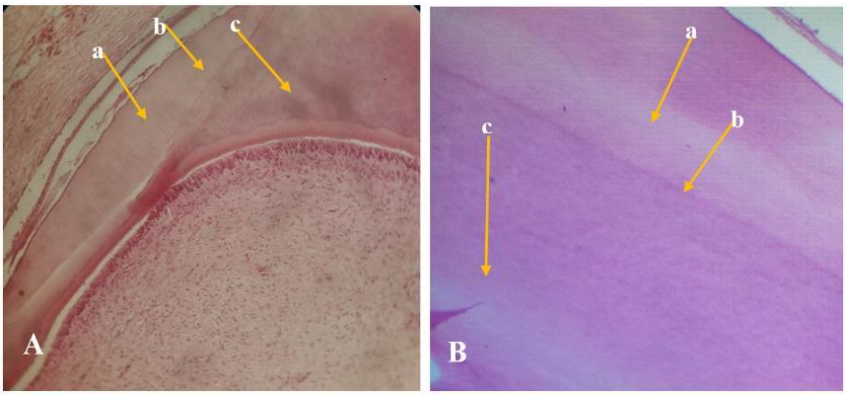

Figure 5 A: primary dentin (a),bend of dentinal tubules between primary and secondary dentin (b),secondary dentin(c),(decalcified cross-section H&E X40).B: primary dentin(a),bend of dentinal tubules between primary and secondary dentin(b), secondary dentin(c),(decalcified longitudinal section M.D H&E X40).

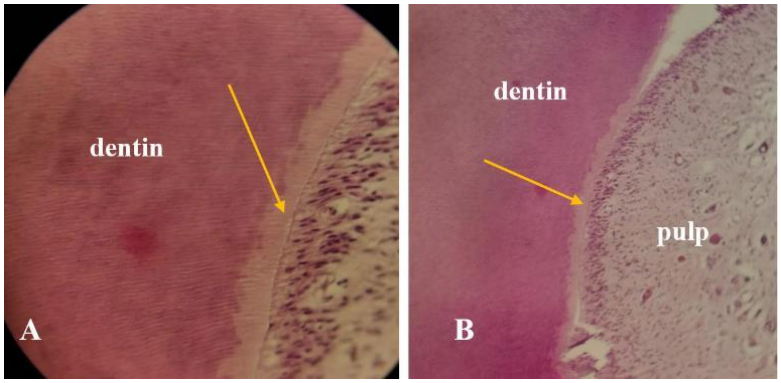

Figure 6: Predentin A and B -solid black arrows- (decalcified longitudinal M.D Section H&E X40).

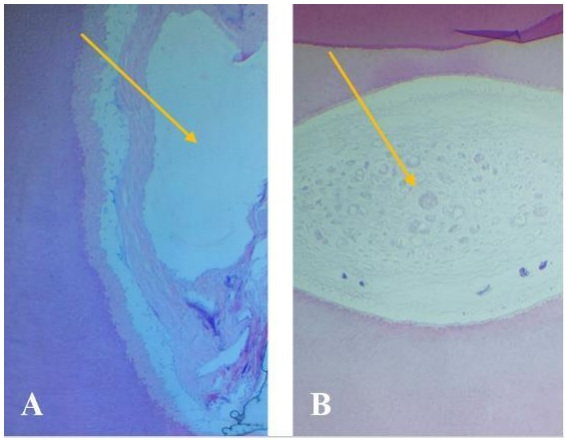

Figure 7: Radicular pulp A (decalcified longitudinal section M.D Section H&E X10) – yellow arrow-. Radicular pulp B (decalcified cross section X10) -yellow arrow-

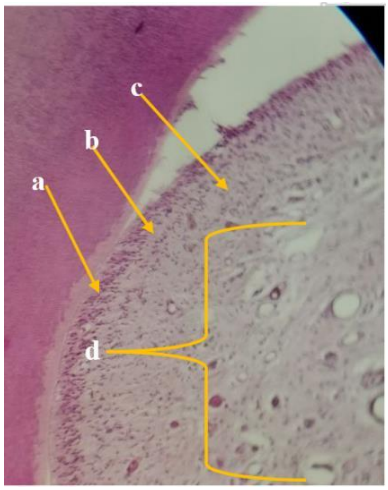

Figure 8: Zones of the pulp, odontogenic zone(a), Cell-free zone (b), Cell-rich zone (c), pulp core (d), (decalcified longitudinal section M.D Section H&E X10).

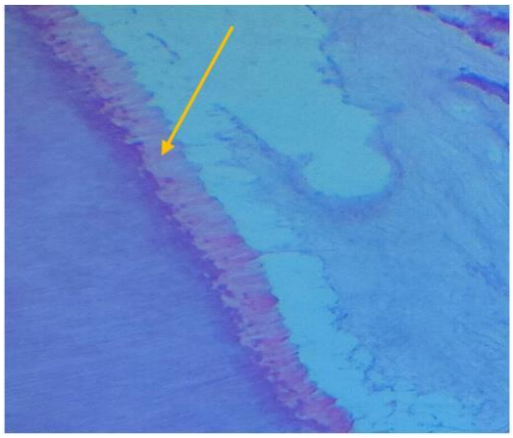

Figure 9: Odontoblast cell - yellow arrow- (decalcified longitudinal section M.D Section H&E X10).

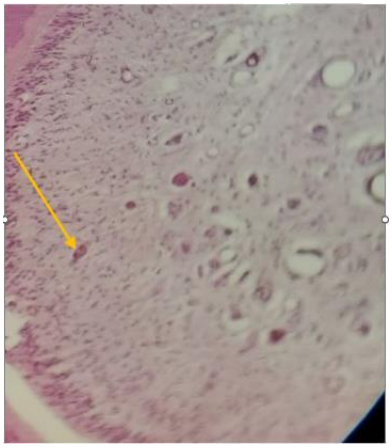

Figure 10: Fibroblast - black arrow- (decalcified cross section H&E X40).

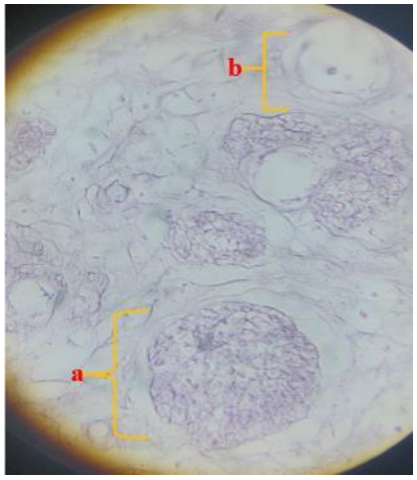

Figure 11: Nerve (a), blood vessels (b), (decalcified cross section H&E X40).

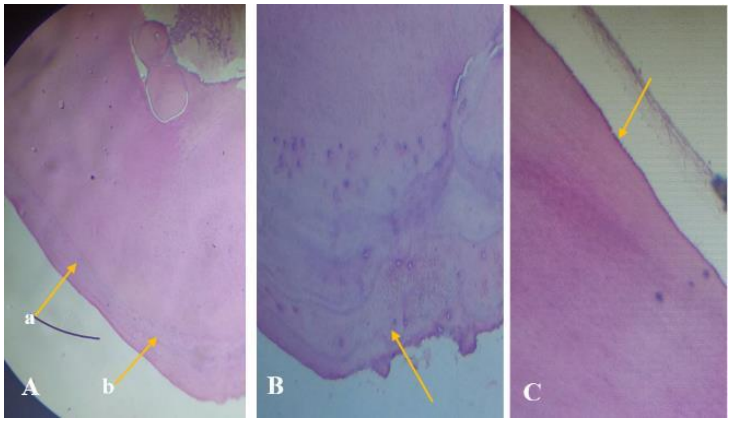

Figure 12: A: acellular cement (a), cellular cement (b) -yellow arrow-. (Decalcified longitudinal M.D section H&E X1o). B: cellular cement. C: sharps fiber -yellow arrow-.

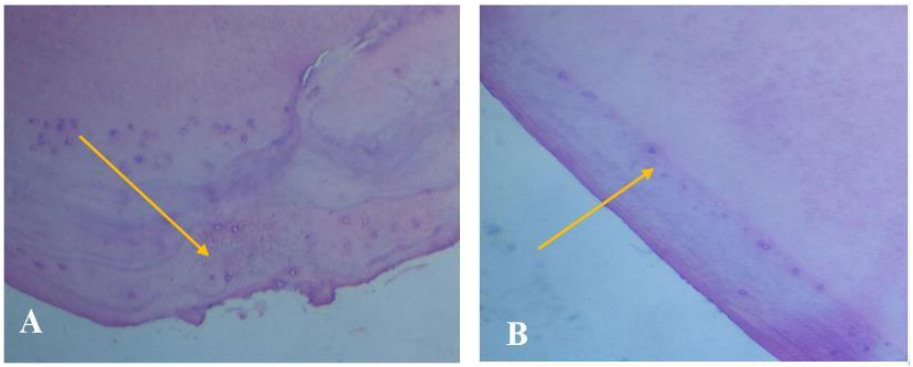

Figure 13: Tomes' Granular Layer A (decalcified cross section X40) -yellow arrow-. Tomes' Granular Layer B (decalcified longitudinal section M.D Section H&E X10) - yellow arrow-.

DISCUSSION

In current study the double root was mainly found in the maxillary FP (68.7% n =26) which is consistent with the studies that had been carried out in Saudi and Jordanian populations that showed the predominance of double rooted in maxillary FP, Atieh [7] and Awawdeh et al. [8] respectively, but disagree with study in southern Chinese population show that the maxillary FP had mainly a single root as in Walker [9]. While in Loh [10] in Singaporeans reported a similar distribution of single- and two-rooted teeth. Controversies in results amongst studies could be attributed to different population races and geographic distribution. In present study, the mandibular FP that had single root (100% n=21), this study was agree with Dou et al. [11], in a Chinese population, Martins J. et al.[12], in Portugal and Burklein et al.[13] in German were describe that nearly all mandibular FP have a single root whereas two roots were found in only 0.6%, 0.2% and 0.4 % respectively.

There was no significant association between root number with the gender which is consistent with Ok et al. in Turkish population [14] ،but, in a Chinese population, double-rooted teeth were twice as common in men (62.68%) than women (33.33%) [15] although it was near to this study that had 62.5% double rooted in male and 45.7% in female this difference was related to the limited sample size in this study, there were no significant variations between this narrow age groups and root numbers, this result was considered anatomically accepted because the growth of the FP is completed around the age of 14-15 years of age [3]. Regarding the root length there were no significant differences between male and female gender which is agree with D Kafle in Nepalese population [16] and in Ramón et al. in Chile population [17]. The mean root length in male and female were 13.2 ±1.7 mm and 13.7 ±2 respectively that is reliable with the research [16] in Nepalese population which had the mean root length were 13.08 ± 2.00 mm in male and 12.63 ± 1.50 mm in female, but lower than the 14 mm that reported by Ash & Nelson [18]. Although it was not significant in this study, but the mandibular FP root length was longer than maxillary FP root length in agreement with F Ramón et al. [17] ·Also no association between root length and age group which is reliable with Bishara et al.[19] in which there were no significant changes (increase or decrease) in root length between 25 and 45 years of age, for all tooth types (FP included) evaluated in both males and females.

In histological sectioning, the present description is in agreement with description of Som PM et al.[20], that stated dentin, like enamel, was avascular, and its substructure was a collection of minute channels called dentinal tubules that carry cytoplasmic extensions of the progenitor odontoblasts and run the length of the dentin thickness. The main component within the dentinal tubules was the odontoblastic processes, which may extend to the dentinoenamel junction in some cases. The cementum at the CEJ and for the coronal one-third of the root is known as acellular cementum because it lacks cellular components. In the apical two-third of the tooth, the more cellular cementum was present, while present description disagrees with description of Scheid et al. [21], who mentioned that since it lacks cellular elements, the cementum at the CEJ and for the coronal two-thirds of the root was known as acellular cementum. More cellular

cementum was found in the apical one-third of the tooth.

CONCLUSION

1. The maxillary first premolars primarily had double roots, whereas the mandibular first premolars in both samples displayed single roots.
2. The root length was slightly shorter in upper first premolars, while longer in male than female first premolars in CBCT sample.

CONFLICT OF INTEREST

There is no conflict of interest.

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