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METRIC AND NON-METRIC DENTAL TRAITS OF PREMOLARS WITH ROOT CANALS CONFIGURATION AMONG THE EGYPTIANS

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ABSTRACT

Objective: To evaluate and compare metric, non-metric dental traits with root canals configuration in Egyptian premolars.

Materials and methods: 200 extracted premolars were assorted in four groups; maxillary 1st (UP1), maxillary 2nd (UP2), mandibular 1st (LP1) and mandibular 2nd (LP2). Assessment of metric and non-metric dental traits with root canals configuration were performed. Metric data were statistically analyzed using F-one-way analysis of variance and Tukey's Post Hoc test, while Chi-square test for non-metric data and canals configuration.

Results: Root length/Crown height mean was significantly higher in 2nd than 1st premolars. Mesio-distal mean of UP1 was the highest, then mandibular premolars, then UP2. Bucco-lingual and inter-cuspal distance means of maxillary were larger than mandibular premolars. Distal accessory ridges occurrence was higher than mesial ridges, and showed higher values in 1st than 2nd premolars. Odontome only expressed in LP1. Mesial accessory cusps occurrence was lower than distal ones in UP1, while the UP2 showed only mesial cusps. The most common pattern was one lingual cusp and two lingual cusps in LP1 and LP2 respectively. The frequency of one-rooted maxillary premolars was higher than two-rooted ones. The occurrence of radicular groove was significantly higher in LP1 than LP2. The most common root canal anatomy was type IV in maxillary premolars. UP2 showed types XIII, XVI and XIX. Most of mandibular premolars exhibited type I. LP1 showed types IX and 1-3-2 canals.

Conclusion: There were differences in metric/non-metric dental traits and canals configuration between Egyptian premolars with difference in their expression amongst populations.

KEYWORDS: Accessory cusps; Accessory ridges; CBCT; Furcation groove; Odontome.

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INTRODUCTION

Human dental morphology is varied to a large extent amongst individuals and populations. It is greatly utilized to provides a valuable information about human evolution, clinical and forensic odontology (**Brook and Scheers, 2006; Hanihara, 2008**). Assessment of dental morphology seeks the observation, evaluation, recording and analyzing the metric and non-metric morphological features that are presented in the crown and root of human teeth (**Litha et al., 2017; Srivastav et al., 2018**).

Awareness of metric dental traits, also known as dental metrics or odontometrics, is critical to obtain normal occlusion, right alignment, suitable overbite and overjet, appropriate intercuspation with occlusal stability. However, normal dental measurements for a race or group of people should not be considered normal for the others and must be diagnosed and treated according to their own features (**Freiro et al., 2007**). The common metric dental traits determined in literatures are mesio-distal (MD) and bucco-lingual (BL) dimensions of the crown, in addition to crown height and root length (**El-Messiry et al., 2016; Sujitha et al., 2022**).

Non-metric dental traits have a crucial role in establishment of racial classification as they show heritable characteristic and are independent of aging, although some features may be lost by physical or chemical means (**Baby and Sunil 2019**). Non-metric traits are qualitative as they can be absent or present, moreover, if present, they exhibit quantitative feature as variable degree of expression (**Aguirre et al., 2007**). The observation of these dental traits is routinely classified using the standardized scoring protocols of Arizona State University Dental Anthropology System (ASUDAS) which is considered the “gold standard” for non-metric dental researches (**Irish, 2015**). ASUDS categorizes a huge number of coronal and radicular morphological variants in the permanent dentition (**Turner et al., 1991; Scott and Irish, 2017**). The common non-metric dental traits include the variable number and relative sizes of cusps and roots, pattern of grooves and ridges on the crown, accessory cusps and roots (**Abrantes et al., 2015; Scott et al., 2018; Baby et al., 2017; Rahamneh et al., 2020; Rathmann and Reyes-Centeno, 2020**).

Comprehensive investigation and understanding of tooth internal structure due to the complicity of root canals morphology are considered of the pre-requisites for anthropologic significance and successful endodontic treatment. Several traditional and modern techniques have been utilized for analyzing the pulp cavities of the teeth (**Awawdeh et al., 2008; Weng et al., 2009; Kato et al., 2016; Alenezi et al., 2022**). Cone beam computed tomography (CBCT) is one of the most widely employed techniques. It simply provides non-invasive three-dimensional aspect of the teeth and their internal structure, analyzing the number and configuration of the root canals (**Abella et al., 2015; Monsarrat et al, 2016; Mohamed and Abdallah, 2021**).

Maxillary and mandibular premolars have showed a high incidence of diversity in crown morphology, depressions on roots, number of roots in addition to their complex root canals configuration. The prevalence of these variations seems to vary among different populations (**Boschetti et al., 2017; Alqedairi et al., 2018; Louail and prat, 2018; Nashat et al., 2020; Mohamed and Abdallah, 2021; Olczak et al., 2022**).

The aim of the present study was the assessment and comparing of a selected set of metric and non-metric dental traits in both maxillary and mandibular premolars with investigating their root canals configuration in the Egyptian population.

MATERIALS AND METHODS

Ethical statement

This study was approved by the "Research Ethics Committee" of Faculty of Dentistry, Ain Shams University, Cairo, Egypt, (FDASU-Rec ER092215).

1. Study samples preparation

A total of 200 extracted premolars were categorized in four groups (50 teeth/premolar group); maxillary 1st (UP1), maxillary 2nd (UP2), mandibular 1st (LP1) and mandibular 2nd (LP2) premolar groups. These teeth were selected from the Department of Oral Surgery, Faculty of Dentistry, Ain-Shams University, that extracted for orthodontic purpose.

All selected teeth were free of attrition, occlusal or proximal caries, crown restoration, fractured root, incompletely formed root or root canal filling. Hand scaler was used to remove any attached calculus, after that, the teeth were stored in saline at room temperature **(Gupta et al., 2015; Saber et al., 2019)**.

2. Metric dental traits

Different crown and root dimensions were measured by using Vernier Caliper (150x0.05mm/6"x1/128) that performed by single examiner **(Barbería et al., 2009)**. Each measurement was done three separate times that recorded in different sheets and the mean value was used. These measurements were discarded, if there was a difference between the recordings greater than 0.4 mm **(Huang et al., 2012)**. The metric traits were assessed according to the following parameters:

2.1. *Crown height and Root length*

The Crown height was measured as the distance between the buccal cusp tip and the cervical line on the buccal surface, whilst the root length as the distance between the cervical line on the buccal surface and the root apex. Both measurements were done by the Vernier caliper. Root length/Crown height ratio (R/C) was calculated **(Abdelkhalik et al., 2018)**.

2.2. Mesio-distal and Bucco-lingual dimensions of the crown

The MD measurement was done by placing the caliper blades at the mesial and distal contact areas parallel to the tooth long axis, while for BL size, the blades of the caliper were placed perpendicular to the MD width at the maximum convexities of the buccal and lingual surfaces **(Barbería et al., 2009)**. In addition, BL/MD ratio was calculated.

2.3. Inter-cuspal distance

For measuring the inter-cuspal distance, the tips of the caliper blades were placed over the buccal and lingual cusp tips in bicuspid tooth or over the mesio-lingual cusp tip in tooth with more than two cusps **(Yoo et al., 2015)**.

3. Non-Metric dental traits

In this study, ASUDAS standardized scoring protocols, that have been described in recent volume of **Scott and Irish (2017)**, were used for the observation of the following non-metric dental features:

3.1. Crown traits

- ***Premolars mesial/distal accessory ridges***

The mesial/distal accessory ridges of the maxillary and mandibular buccal cusps are located between the occlusal central ridge and mesial/distal marginal ridges respectively. These ridges were scored according to **Burnett et al. (2010)** into:

- Grade 0: No ridge.
- Grade T: truncated ridge (does not continuously extend from the buccal ridge to the sagittal sulcus). The truncated ridges are scored by size and not differentiated in analysis from the continuous ridges using the following grades;

- Grade 1: Trace continuous ridge that is barely discernible, however may be noticed under strong light.
- Grade 2: Thin continuous ridge which can be easily palpated.
- Grade 3: Moderately continuous ridge.
- Grade 4: Thick continuous ridge dominating the locus.

- ***Premolars odontomes***

The odontomes can be expressed in the central sulcus of both maxillary and mandibular premolars.

- Grade 0: Absence.
- Grade 1: Presence.

- ***Maxillary premolars mesial/distal accessory cusps***

These accessory cusps must be separated from the buccal and lingual cusps.

- Grade 0: Absence of accessory cusps.
- Grade 1: Presence of well-defined mesial accessory cusp.
- Grade 2: Presence of well-defined distal accessory cusp.
- Grade 3: Presence of well-defined both mesial and distal accessory cusps.

- ***Mandibular premolars lingual cusp number***

The cusp number of lower premolars was assorted as **Scott (1973)** into;

- Grade 0: Lingual cusp that is fused with the occlusal ridge of the buccal cusp and lacks the free apex.
- Grade 1: One lingual cusp that has an easily distinguishable and palpated independent apex.
- Grade 2: Two lingual cusps.
- Grade 3: Three lingual cusps are present.

3.2. Root traits

- ***Maxillary premolars root number***

The upper premolars were categorized according to **Turner (1981)** into;

- One-rooted premolar: Tooth with a clear single root and single apex, in addition to tooth which seemed to have two roots but either completely fused, showed small double apex or partially fused with the bifurcation not more than one-fourth the root length.
- Two-rooted premolar: Tooth with bifurcation exceeds one-fourth to one-third the root length where the furcation can be detected at coronal, middle or apical third.
- Three-rooted premolar: Length is defined as two-rooted with two buccal and one lingual roots.

The present research investigated the potential existence or absence of a furcation groove in the palatal surface of the buccal root in two-rooted upper premolars **(Li et al., 2013)**.

- ***Mandibular premolars root groove pattern and number***

In the Tomes' root six-graded scale, developed by **Turner et al. (1991)**, the first four grades show root grooves that are presupposed anticipating a Tomes' root while grade 5 shows a separated extra root.

- Grade 0: Developmental groove is absent, or rounded instead of being V-shaped in cross section if present.
- Grade 1: Shallow V-shaped developmental groove is present.
- Grade 2: Moderately deep V-shaped developmental groove is present.
- Grade 3: Deep V-shaped developmental groove is present and extends at least one-third the root length.

– Grade 4: Deep developmental grooves are present on both proximal root surfaces.

– Grade 5: Two free roots (large buccal root and smaller mesial/lingual root) are present separated at least one-fourth to one-third the root length.

In addition, the current study examined the presence or absence of a groove on the buccal aspect of premolars root **(Dou et al., 2017)**.

4. Root canals configuration

For assessing the configuration of the root canals, CBCT was used.

4.1. Cone beam computed tomography scanning technique

The extracted premolars in each group were placed vertically onto white foam mold with one cm between them. Then, the four molds were subjected for CBCT scanning by using CBCT unit (i-CAT next generation). The device was operating with 120 kilovoltage peak tube voltage, 37.07 milliamperes, 0.2 mm voxel size for scanning time 26.9 seconds and field of view (6 cm height and 16 cm diameter). The data after acquisition were exported to a compact disc for personal computer to be assessed. All study samples were examined in three planes (coronal, axial and sagittal) **(Saber et al., 2019)**.

CBCT scanning was performed at Oral Radiology Department, Faculty of Dentistry, Ain-Shams University.

4.2. Classification of the root canals configuration

The types of root canals, regardless of root number, were classified according to **Vertucci (1984)** and **Sert and Bayirli (2004)** as shown in **(Table 1)**.

5. *Statistical analysis*

All data were statistically analyzed by using the statistical package for social sciences, (SPSS Inc., Chicago, Illinois, USA, version 23.0). The metric (quantitative) data were given as mean ± standard deviation (SD) and ranges. To compare between more than one means, F-one-way analysis of variance was performed, then Post Hoc test: Tukey's test was used for the multiple comparisons. However, the qualitative data of non-metric features and types of root canals were presented as frequency and percentage, where Chi-square (x^2) test of significance was done for proportions comparison. All used tests were done with 95% confidence interval and 5% margin of error accepted. P-value was considered highly significant <0.001; significant <0.05; and insignificant >0.05.

TABLE (1) The types of root canals

Vertucci (1984)	**Type**	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**							
	Canal/s	1	2	1	2	1	2	1	3							
			1	2		2	1	2								
				1			2	1								
								2								
Sert and Bayirli (2004)	**Type**	**IX**	**X**	**XI**	**XII**	**XIII**	**XIV**	**XV**	**XVI**	**XVII**	**XVIII**	**XIX**	**XX**	**XXI**	**XXII**	**XXIII**
	Canal/s	1	1	1	2	1	4	3	2	1	3	2	4	4	5	3
		3	2	2	3	2	2	2	3	3	1	1		1	4	4
			3	3	1	1				1		2				
			2	4		3						1				

RESULTS

1. Metric dental traits

1.1. Crown height and Root length

In regards to crown height, there was a highly statistically significant difference between the four groups. Pairwise comparisons between different groups revealed that there was an insignificant difference between LP1 and UP1, both showed significantly higher mean values, followed by UP2 and LP2 with insignificant difference between them **(Table 2 & Fig. 1)**.

Regarding root length, there was a statistically insignificant difference between the four groups **(Table 2 & Fig. 1)**.

Concerning R/C ratio, there was a highly statistically significant difference between all groups. There was an insignificant difference between LP2 and UP2, both showed significantly higher mean values, followed by LP1 and UP1 with insignificant difference between their means **(Table 2 & Fig. 1)**.

1.2. Mesio-distal and Bucco-lingual dimensions of the crown

According to MD dimensions of the crown, there was a highly statistically significant difference between different studied groups. There was an insignificant difference between UP1 and LP1, both showed the highest means. Furthermore, there was an insignificant difference between LP1 and LP2 values. LP2 showed a lower value with a significant difference from UP1. While UP2 showed the significantly lowest mean value **(Table 2 & Fig. 1)**.

Statistical analysis of BL dimensions of the crown revealed a highly significant difference between the four groups. There was an insignificant difference between UP1 and UP2, which had significantly higher mean values, followed by LP1 and LP2 with no significant difference between their means **(Table 2 & Fig. 1)**.

TABLE (2) Comparison between different premolars groups according to metric parameters.

		Maxillary 1st premolars (UP1) N=50	Maxillary 2nd premolars (UP2) N=50	Mandibular 1st premolars (LP1) N=50	Mandibular 2nd premolars (LP2) N=50	F-Test	P-value
Crown height	Mean ± SD	8.15±0.76 ^{A}	7.24±0.81 ^{B}	8.28±0.80 ^{A}	7.23±0.85 ^{B}	24.985	**<0.001****
	Range	6.5-10	5.5-9	7-10	5-8.5		
Root length	Mean ± SD	13.75±1.28	13.65±1.81	14.33±1.64	14.37±1.76	2.649	0.054
	Range	11-16.5	10.5-18	8.5-18	11-21		
R/C ratio	Mean ± SD	1.70±0.23 ^{B}	1.90±0.30 ^{A}	1.74±0.24 ^{B}	2.01±0.30 ^{A}	14.205	**<0.001****
	Range	1.29-2.21	1.5-3	1.13-2.14	1.38-2.63		
MD dimensions	Mean ± SD	7.39±0.44 ^{A}	6.76±0.50 ^{C}	7.29±0.47 ^{AB}	7.14±0.47 ^{B}	17.149	**<0.001****
	Range	6.5-8	5.5-7.5	6.5-8.25	6.25-8		
BL dimensions	Mean ± SD	9.45±0.55 ^{A}	9.25±0.62 ^{A}	8.14±0.63 ^{B}	8.07±0.59 ^{B}	73.694	**<0.001****
	Range	8.5-10.5	8-11	7-9.5	7-9		
BL/MD ratio	Mean ± SD	1.28±0.06 ^{B}	1.37±0.09 ^{A}	1.12±0.07 ^{C}	1.13±0.07 ^{C}	145.501	**<0.001****
	Range	1.13-1.43	1.2-1.64	1-1.36	1-1.28		
Inter-cuspal distance	Mean ± SD	5.75±0.65 ^{A}	5.84±0.53 ^{A}	3.88±0.55 ^{B}	4.12±0.77 ^{B}	135.611	**<0.001****
	Range	4.5-7.5	5-7	2.5-5	2.5-6		

Using: F- One Way analysis of variance, p-value >0.05 (Insignificant); *p-value <0.05 (Significant); **p-value <0.001 (Highly significant). Mean values in the same row which have different superscripts are significantly different at (p<0.05) using Tukey's Post Hoc test.

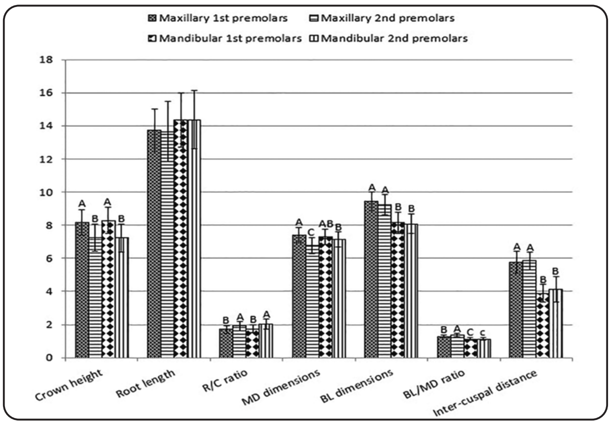

Fig. (1) Bar charts representing the comparisons between the four premolars groups according to metric parameters. Different letters indicate significant difference at ($p<0.05$).

As to BL/MD ratio, it was revealed that means of BL were higher than that of MD dimensions and there was a highly statistically significant difference between the four premolars. UP2 showed the significantly highest value, followed by UP1 with significantly lower value. There was an insignificant difference between LP2 and LP1, both showed the significantly lowest values **(Table 2 & Fig. 1)**.

1.3. Inter-cuspal distance

There was a highly statistically significant difference between the four groups. Groups UP2 and UP1 represented the highest mean values with no significant difference between them, followed by LP2 and LP1 with no significant difference between their means **(Table 2 & Fig. 1)**.

2. Non-Metric dental traits

2.1. Crown traits

- ***Premolars mesial/distal accessory ridges***

In maxillary 1st premolars, according to the frequency of mesial accessory ridges occurrence, 90% for absence of ridges (Grade 0) and 10% occurrence of ridges (sum of frequencies from Grades 1 to 4). 2% for truncated accessory ridge (Grade T). According to accessory ridges size, the most common grade was Grade 1 (6%), followed by Grades 3 & 4 (2% each) with no evidence of Grade 2. According to the frequency of distal accessory ridges occurrence, Grade 0 was 58% and 42% occurrence of distal ridges which was more common than mesial ones. 18% for Grade T. According to the size, Grades 2 & 4 (14% each) were the most common grades, followed by Grade 1 (8%) then the least common percentage was Grade 3 (6%) **(Fig. 2I. a-e & Table 3)**.

In maxillary 2nd premolars, concerning the mesial accessory ridges, 84% for Grade 0, 16% ridges occurrence with 6% Grade T. According to size, Grade 3 & 4 (6% each) were followed by Grades 1 & 2 (2% each). About distal accessory ridges, 80% for Grade 0, 20% occurrence that was more common than mesial accessory ridges and 6% for Grade T. Regarding the size, Grade 2 (8%) was the most common, then Grade 4 (6%), then Grade 3 (4%) and the least common was Grade 1 (2%) **(Fig. 2I. f-i & Table 3)**.

In mandibular 1st premolars, according to mesial accessory ridges, 90% for Grade 0, 10% occurrence with 6% Grade T. According to the size, Grade 1 (4%), followed by Grades 2, 3 & 4 (2% each). Regarding to distal accessory ridges, 60% for grade 0 and 40 % occurrence which was more common than mesial ridges with 6% Grade T. About the size, Grade 3 (18%) then Grade 2 (16%), followed by Grade 1 (6%) with no prevalence of grade 4 **(Fig. 2II. a-d & Table 3)**.

In mandibular 2nd premolars, regards the mesial accessory ridges, 94 % for Grade 0, 6% occurrence with 2% Grade T. Grade 3 (4%) was the most common, after that, Grade 4 (2%) with no evidence for both Grades 1 & 2. While distal accessory ridges, 94% for Grade 0 and 6% occurrence which both were equivalent to that of the mesial ridges with no prevalence of Grade T. Grades 1, 2 & 4 were only observed with frequencies 2% for each **(Fig. 2II. e-h & Table 3)**.

By comparing the different grades of mesial accessory ridges between the four premolars groups, there were insignificant differences between their values. Meanwhile, the comparisons of distal accessory ridges between the different groups revealed the following; In Grade 0, there was a highly statistically significant difference between the four premolars. There was an insignificant difference between LP2 and UP2, which represented significantly higher frequencies, followed by LP1 and UP1 which showed insignificant difference between their values. In Grade T, there was a statistically significant difference between the four premolars. There was an insignificant difference between UP1, UP2 and LP1. LP2 showed insignificant difference from UP2 and LP1 while showed significant difference to UP1. In Grades 1 & 2, there were insignificant differences between the different groups. In Grade 3, there was a statistically significant difference between all groups. There was an insignificant difference between LP1 and UP1, followed by UP2 and LP2 that showed insignificant difference between them, as well as, insignificant difference to UP1 and significant difference to LP1. Finally, in Grade 4, there was a statistically significant difference between the four premolars. There was an insignificant difference between UP1, UP2 and LP2, followed by LP1 that showed insignificant difference to UP2 and LP2 and significant difference from UP1 (**Table 3 & Fig. 3a**).

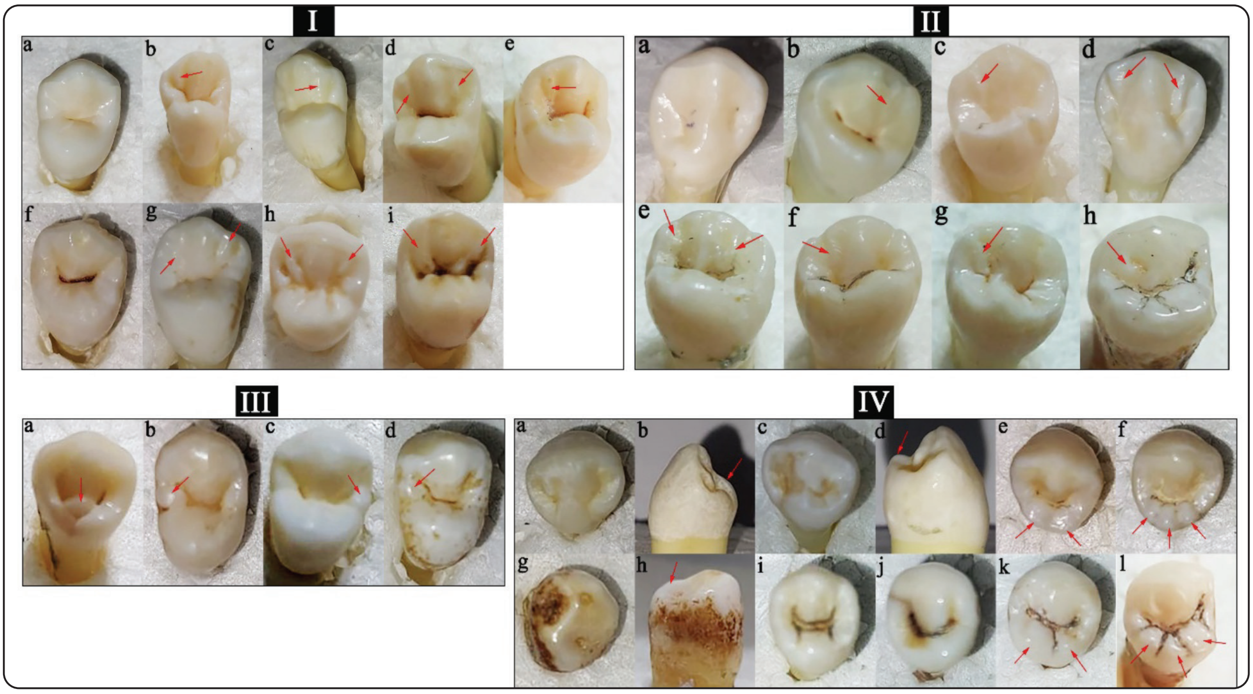

Fig. (2) Non-metric crown traits. I. Maxillary premolars mesial/distal accessory ridges: (a-e)- Maxillary 1st premolars; (a)- Mesial and Distal Grade 0, (b)- Mesial truncated ridge with size 4 (Grades T, 4) (arrow), (c)- Mesial Grade 1 (arrow), (d)- Distal Grade 2 (right arrow) and Mesial Grade 4 (left arrow), (e)- Distal Grade 3 (arrow). (f-i)- Maxillary 2nd premolars; (f)- Mesial and Distal Grade 0, (g)- Mesial Grades T, 4 (right arrow) and Distal Grade 1 (left arrow), (h)- Mesial Grades T, 2 (right arrow) and Distal Grade 3 (left arrow), (i)- Mesial Grade 3 (right arrow) and Distal Grade 4 (left arrow). II. Mandibular premolars mesial/distal accessory ridges: (a-d)- Mandibular 1st premolars: (a)- Mesial and Distal Grade 0, (b)- Distal Grade 1 (arrow), (c)- Distal Grade 2 (arrow), (d)- Distal Grade 3 (right arrow) and Mesial Grades T, 4 (left arrow). (e-h)- Mandibular 2nd premolars: (e)- Distal Grade 1 (right arrow) and Mesial Grades T, 4 (left arrow), (f)- Distal Grade 2 (arrow), (g)- Distal Grade 0 and Mesial Grade 3 (arrow), (h)- Distal Grade 4 (arrow). III. Odontomes and Maxillary premolars mesial/distal accessory cusps: (a)- Mandibular 1st premolar odontome (arrow). (b, c)- Maxillary 1st premolar mesial and distal accessory cusps respectively (arrows), (d)- Maxillary 2nd premolar mesial accessory cusp (arrow). IV. Mandibular premolars lingual cusp number: (a-f)- Mandibular 1st premolars; (a, b)- Grade 0 from occlusal and proximal aspects respectively, (c, d)- Grade 1 from occlusal and proximal aspects, (e)- Grade 2, (f)- Grade 3. (g-l)- Mandibular 2nd premolars; (g, h)- Grade 0 from occlusal and proximal aspects, (i, j)- Grade 1 with H-shaped and U-shaped central grooves. (k)- Grade 2, (l)- Grade 3.

- ***Premolars odontomes***

The odontome was only expressed on the occlusal surface of LP1 (2%) that showed insignificant difference from other premolars **(Fig. 2III. a, Fig. 3b & Table 3)**.

- ***Maxillary premolars mesial/distal accessory cusps***

In maxillary 1st premolars, the most common grade was Grade 0 (94%) with no accessory cusps. Only 4% for Grade 2 showed distal accessory cusps, followed by Grade 1 (2%) with mesial accessory cusp and no percentage for the presence of both accessory cusps (Grade 3) **(Fig. 2III. b, c & Table 3)**.

In maxillary 2nd premolars, 96% for Grade 0 and only 4% for Grade 1 with no prevalence of other grades **(Fig. 2III. d & Table 3)**.

By comparing the different grades of mesial/distal accessory cusps between the maxillary premolars, there were insignificant differences between their proportions **(Table 3 & Fig. 3)**.

TABLE (3) ***Comparison between premolars groups according to non-metric crown traits.***

			Maxillary 1st premolars (UP1) N=50		Maxillary 2nd premolars (UP2) N=50		Mandibular 1st premolars (LP1) N=50		Mandibular 2nd premolars (LP2) N=50		X^2	P-value
			n	%	n	%	n	%	n	%		
Premolars mesial/distal accessory ridges	Grade 0	Mesial	45	90%	42	84%	45	90%	47	94%	2.713	0.438
		Distal	29^{B}	58%	40^{A}	80%	30^{B}	60%	47^{A}	94%	22.425	**<0.001****
	Grade T	Mesial	1	2%	3	6%	3	6%	1	2%	2.083	0.555
		Distal	9^{A}	18%	3^{AB}	6%	3^{AB}	6%	0^{B}	0%	12.324	**0.006***
	Grade 1	Mesial	3	6%	1	2%	2	4%	0	0%	3.896	0.273
		Distal	4	8%	1	2%	3	6%	1	2%	3.141	0.370
	Grade 2	Mesial	0	0%	1	2%	1	2%	0	0%	2.020	0.568
		Distal	7	14%	4	8%	8	16%	1	2%	6.667	0.083
	Grade 3	Mesial	1	2%	3	6%	1	2%	2	4%	1.628	0.653
		Distal	3^{AB}	6%	2^{B}	4%	9^{A}	18%	0^{B}	0%	13.825	**0.003***
	Grade 4	Mesial	1	2%	3	6%	1	2%	1	2%	2.062	0.560
		Distal	7^{A}	14%	3^{AB}	6%	0^{B}	0%	1^{AB}	2%	11.063	**0.011***
Premolars odontome	Grade 0		50	100%	50	100%	49	98%	50	100%	3.015	0.389
	Grade 1		0	0%	0	0%	1	2%	0	0%	3.015	0.389
Maxillary premolars mesial/distal accessory cusps	Grade 0		47	94%	48	96%					0.157	0.692
	Grade 1		1	2%	2	4%					0.002	0.971
	Grade 2		2	4%	0	0%					0.510	0.475
	Grade 3		0	0%	0	0%					0.000	1.000
Mandibular premolars lingual cusp number	Grade 0						7	14%	3	6%	1.000	0.317
	Grade 1						27	54%	21	42%	1.002	0.317
	Grade 2						14	28%	25	50%	4.203	**0.040***
	Grade 3						2	4%	1	2%	0.002	0.971

Data are expressed as n; number and (%). x^2: Chi-square test; p-value >0.05 (Insignificant); *p-value <0.05 (Significant); **p-value <0.001 (Highly significant). Values in the same row which have different superscripts are significantly different at (p<0.05) using Chi-square test.

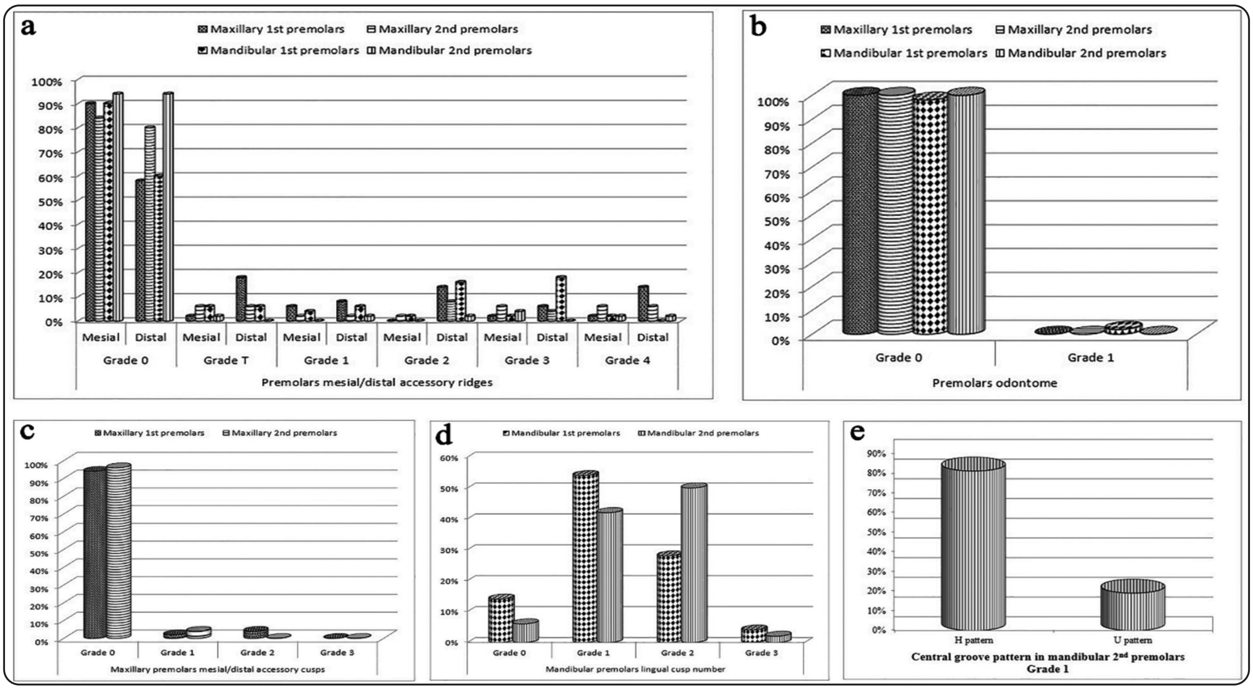

Fig. (3) Bar charts of non-metric crown traits representing; (a)- The comparisons between the four premolars groups according to mesial/distal accessory ridges. (b)- The comparisons between the four premolars groups according to odontomes. (c)- The comparisons between maxillary premolars according to mesial/distal accessory cusps. (d)- The comparisons between mandibular premolars according to lingual cusp number. (e)- the comparison between H-shaped and U-shaped central groove pattern in mandibular 2nd premolars Grade 1.

- ***Mandibular premolars lingual cusp number***

In mandibular 1st premolars, Grade 1 (54%) with one lingual cusp that had independent apex, was the most common pattern, then Grade 2 (28%) with two lingual cusps, followed by Grade 0 (14%), showed fused lingual cusp that lack the free apex. The least percentage was Grade 3 (4%) with three lingual cusps **(Fig. 2IV. a-f & Table 3)**.

In mandibular 2nd premolars, the most common pattern was Grade 2 (50%), followed by Grade 1 (42%), then Grade 0 (6%) and the least one was Grade 3 (2%). In Grade 1, 81% showed H-shaped pattern of central groove and only 19% showed U-shaped pattern with highly significant difference between them **(Fig. 2IV. g-l & Table 3)**.

By comparing the different grades of lingual cusp number between the mandibular premolars, there were insignificant differences between their percentages except for Grade 2, in which LP2 revealed a significant higher value than LP1 **(Table 3 & Fig. 3d, e)**.

2.2. ***Root traits***

- ***Maxillary premolars root number***

In maxillary 1st premolars, one-rooted premolars (52%) were the most common, followed by two-rooted premolars (48%) with no percentage for three-rooted premolars. In one-rooted premolars, 24% of samples showed single apex, 22% for bifid apex and only 6% for double apex. In two-rooted premolars, the bifurcation was seen most common at middle third (34%), then at coronal third (8%), then at apical third (6%) **(Fig. 4I. a-f & Table 4)**.

In maxillary 2nd premolars, 80% of samples showed one root and only 20% showed two roots with no prevalence for three rooted premolars.

In one-rooted premolars, 66% for single apex, 10% for double apex and 4% bifid apex. In two-rooted premolars, the bifurcation was only seen at middle third (12%) and apical third (8%) **(Fig. 4I. g-k & Table 4)**.

By comparing the root number between the maxillary premolars, there was a significant difference between them at one root (UP1 < UP2) and two roots (UP1 > UP2). In one-rooted maxillary premolars concerning the apex, there was a highly significant difference between their values at single apex (UP1 < UP2) and significant difference at bifid apex (UP1 > UP2) with no significant difference at double apex. In two-rooted maxillary premolars according to the level of bifurcation, only the bifurcation at middle third showed significant difference in their percentages (UP1 > UP2) **(Table 4 & Fig. 5a)**.

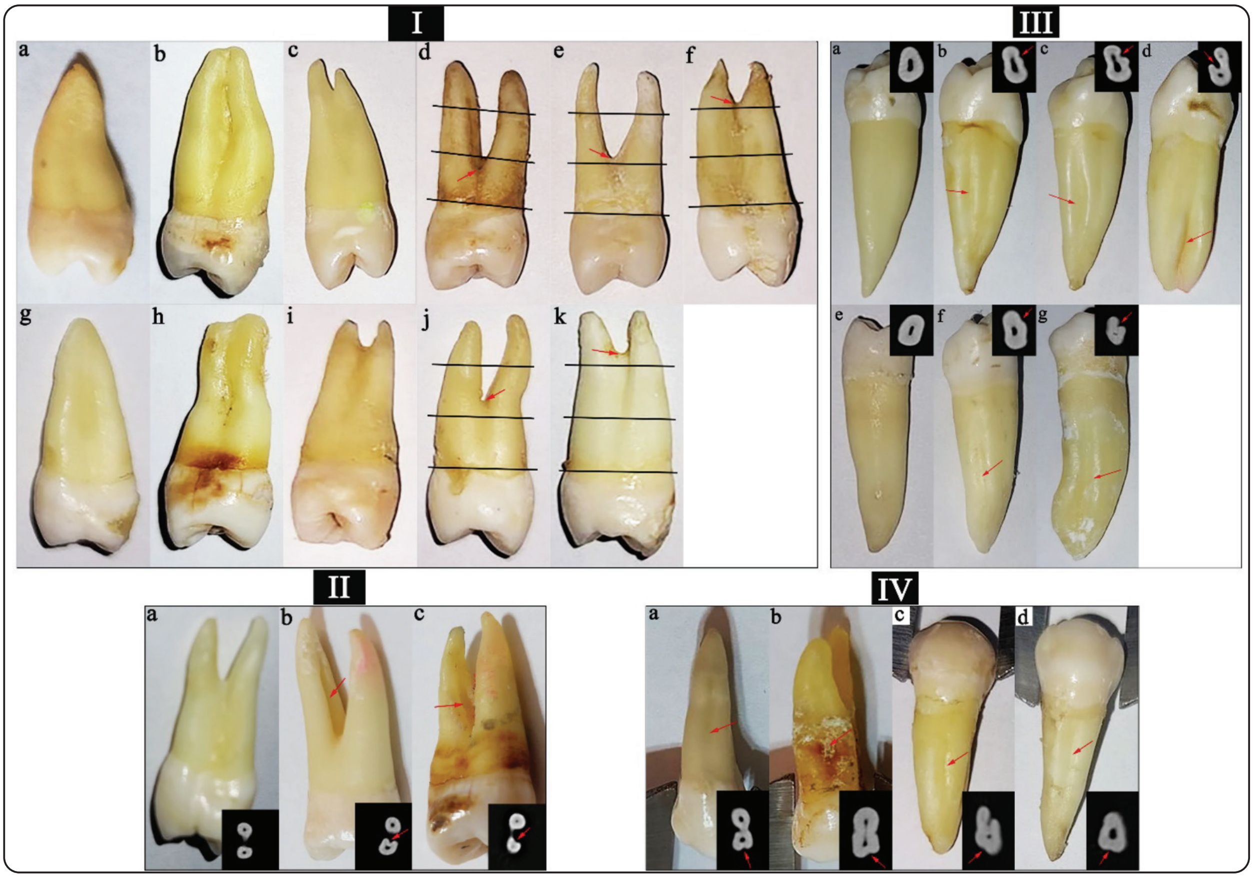

Fig. (4) Non-metric root traits. I. Maxillary premolars root number: (a-f)- Maxillary 1st premolars; (a)- One root with single apex, (b)- One root with double apex, (c)- One root with bifid apex, (d)- Two roots with bifurcation at coronal third (arrow), (e)- Two roots with bifurcation at middle third (arrow), (f)- Two roots with bifurcation at apical third (arrow). (g-k)- Maxillary 2nd premolars; (g)- One root with single apex, (h)- One root with double apex, (i)- One root with bifid apex, (j)- Two roots with bifurcation at middle third (arrow), (k)- Two roots with bifurcation at apical third (arrow). II. Furcation groove of bifurcated maxillary premolars: (a, b)- Maxillary 1st premolars; (a)- No furcation groove, (b)- Furcation groove at palatal aspect of the buccal root (arrow), (c)- Maxillary 2nd premolar furcation groove (arrow). III. Mandibular premolars root groove pattern (arrows): (a-d)- Mandibular 1st premolars; (a)- Grade 0, (b)- Grade 1, (c)- Grade 2, (d) Grade 3. (e-g)- Mandibular 2nd premolars; (e)- Grade 0, (f)- Grade 1, (g)- Grade 2. IV. Buccal grooves on premolars roots (arrows): (a)- Maxillary 1st premolar, (b)- Maxillary 2nd premolar, (c)- mandibular 1st premolar, (d)- Mandibular 2nd premolar. The small boxes in II, III, IV showing CBCT cross sections at root level.

TABLE (4) Comparison between premolars groups according to non-metric root traits.

			Maxillary 1st premolars (UP1) N=50		Maxillary 2nd premolars (UP2) N=50		Mandibular 1st premolars (LP1) N=50		Mandibular 2nd premolars (LP2) N=50		X^2	P-value
			n	%	n	%	n	%	n	%		
Maxillary premolars root number	One root	Single apex	12	24%	33	66%					16.162	**<0.001****
		Double apex	3	6%	5	10%					0.136	0.712
		Bifid apex	11	22%	2	4%					5.659	**0.017***
		Total	26	52%	40	80%					7.531	**0.006***
	Two roots	Bifurcated at coronal third	4	8%	0	0%					2.344	0.126
		Bifurcated at middle third	17	34%	6	12%					5.647	**0.018***
		Bifurcated at apical third	3	6%	4	8%					0.006	0.936
		Total	24	48%	10	20%					7.531	**0.006***
	Three roots		0	0%	0	0%					0.000	1.000
Mandibular premolars groove pattern and number	Grade 0						22	44%	43	86%	17.582	**<0.001****
	Grade 1						13	26%	6	12%	2.339	0.126
	Grade 2						4	8%	1	2%	0.842	0.359
	Grade 3						11	22%	0	0%	10.215	**0.002***
	Grade 4						0	0%	0	0%	0.000	1.000
	Grade 5						0	0%	0	0%	0.000	1.000
Groove on the buccal aspect of premolars roots	Absence		49	98%	49	98%	47	94%	47	94%	2.083	0.555
	Presence		1	2%	1	2%	3	6%	3	6%	2.083	0.555

Data are expressed as n; number and (%). x^2: Chi-square test; p-value >0.05 (Insignificant); *p-value <0.05 (Significant); **p-value <0.001 (Highly significant). Values in the same row which have different superscripts are significantly different at (p<0.05) using Chi-square test.

The percentage of furcation groove occurrence on the palatal aspect of the two-rooted maxillary premolars buccal root was 79.2% (19 out of 24 teeth) in UP1 and 40% (4 out of 10 teeth) in UP2 with insignificant difference between them (**Fig. 4II & Fig. 5b**).

- ***Mandibular premolars root groove pattern and number***

In mandibular 1st premolars, Absence or rounded developmental groove (Grade 0) by percentage (44%) was the most common pattern, followed by Grade 1(26%), demonstrated shallow V-shaped groove, then 22% for Grade 3 (deep V-shaped groove), then 8% Grade 2 (moderately deep V-shaped groove) and no percentages for both Grades 4 & 5 with no evidence of two-rooted premolars (**Fig. 4III. a-d & Table 4**).

In mandibular 2nd premolars, only Grade 0 (86%), Grade 1 (12%) and Grade 2 (2%) were detected (**Fig. 4III. e-g & Table 4**).

By comparing the different grades of root groove pattern between the mandibular premolars, there were insignificant differences between their values except for Grade 0 and Grade 3 that revealed a highly significant and significant differences between the mandibular premolars, (LP1 < LP2) and (LP1 > LP2) respectively (**Table 4 & Fig. 5c**).

Root buccal grooves were observed in 2% of both maxillary premolars and 6% in both mandibular premolars with insignificant difference between the four groups (**Fig. 4IV, Table 4 & Fig. 5d**).

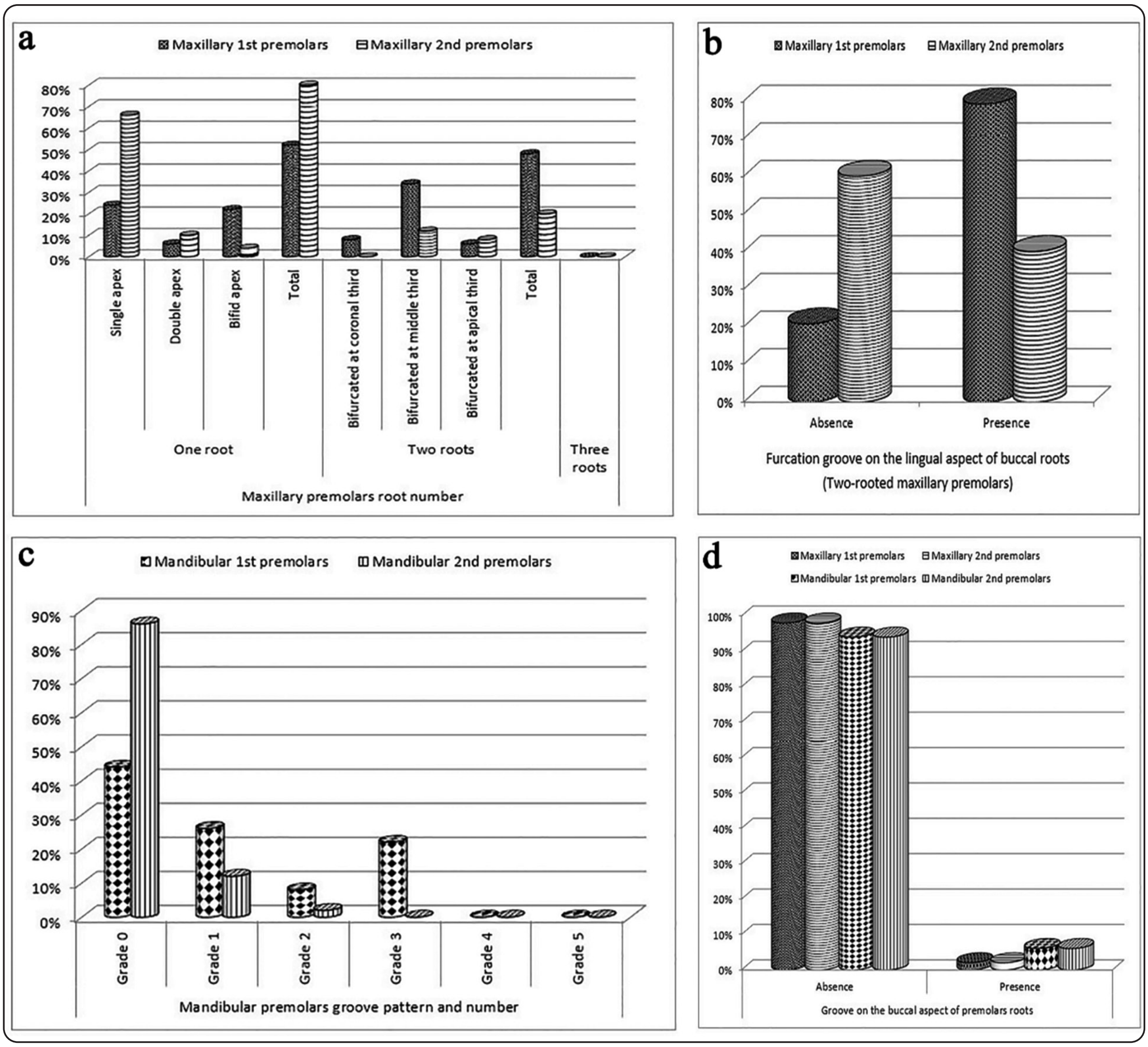

Fig. (5) Bar charts of non-metric root traits representing; (a): The comparisons between maxillary premolars according to root number. (b): The comparisons between two-rooted maxillary premolars according to furcation groove. (c): The comparisons between mandibular premolars according to root groove pattern. (d): The comparisons between the four premolars according to root buccal groove.

3. Root canals configuration

In maxillary 1st premolars, the most common root canals configuration was type IV (72%), followed by Type II (10%), then type V (8%) and type VI (6%) with the least common patterns were type I and VII (2% each). **(Fig. 6 a-f & Table 5)**.

In maxillary 2nd premolars, type IV (40%) was the most common pattern, then type II (18%) and type VI (14%), followed by type I (10%) and type III and V (6% each). This group showed equivalent percentages of type XIII, XVI and XIX (2% each) which were not revealed in any other premolars **(Fig. 6 g-o & Table 5)**.

In mandibular 1st premolars, the most common configuration was type I (62%), followed by type V (24%), then type III (8%) and type VI (2%). Only these premolars showed type IX and additional type

1-3-2 canals with percentage 2% each **(Fig. 6 p-u' & Table 5)**.

In mandibular 2nd premolars, the only root canals patterns detected were type I (92%) and type V (8%) with no evidence of any other configurations **(Fig. 6 v-w & Table 5)**.

By comparing the root canals configurations between the four premolars, there were highly significant differences between their values at types I, II and IV, in addition to significant difference at types V and VI. There were insignificant differences at other patterns. In type I, LP2 showed the significantly highest percentage, followed by LP1 with significantly lower value. There was insignificant difference between UP2 and UP1, showed the significantly lowest proportions. In type II, the multiple comparisons revealed that there was insignificant difference between UP2 and UP1, had the significantly highest values, followed by LP1 and LP2 that showed insignificant difference between their values and from UP1 but showed significant difference from UP2. In type IV, the UP1 showed the significantly highest value, then UP2 had a significantly lower percentage, followed by LP1 and LP2. In type V, there were insignificant difference between LP1, LP2 and UP1, then UP2 that showed insignificant difference to UP1 and LP2 with significant difference from LP1. At last, in type VI, there were insignificant difference between UP2, UP1and LP1, followed by LP2 which showed insignificant difference to UP1 and LP1, while showed significant difference from UP2 **(Table 5 & Fig. 7)**.

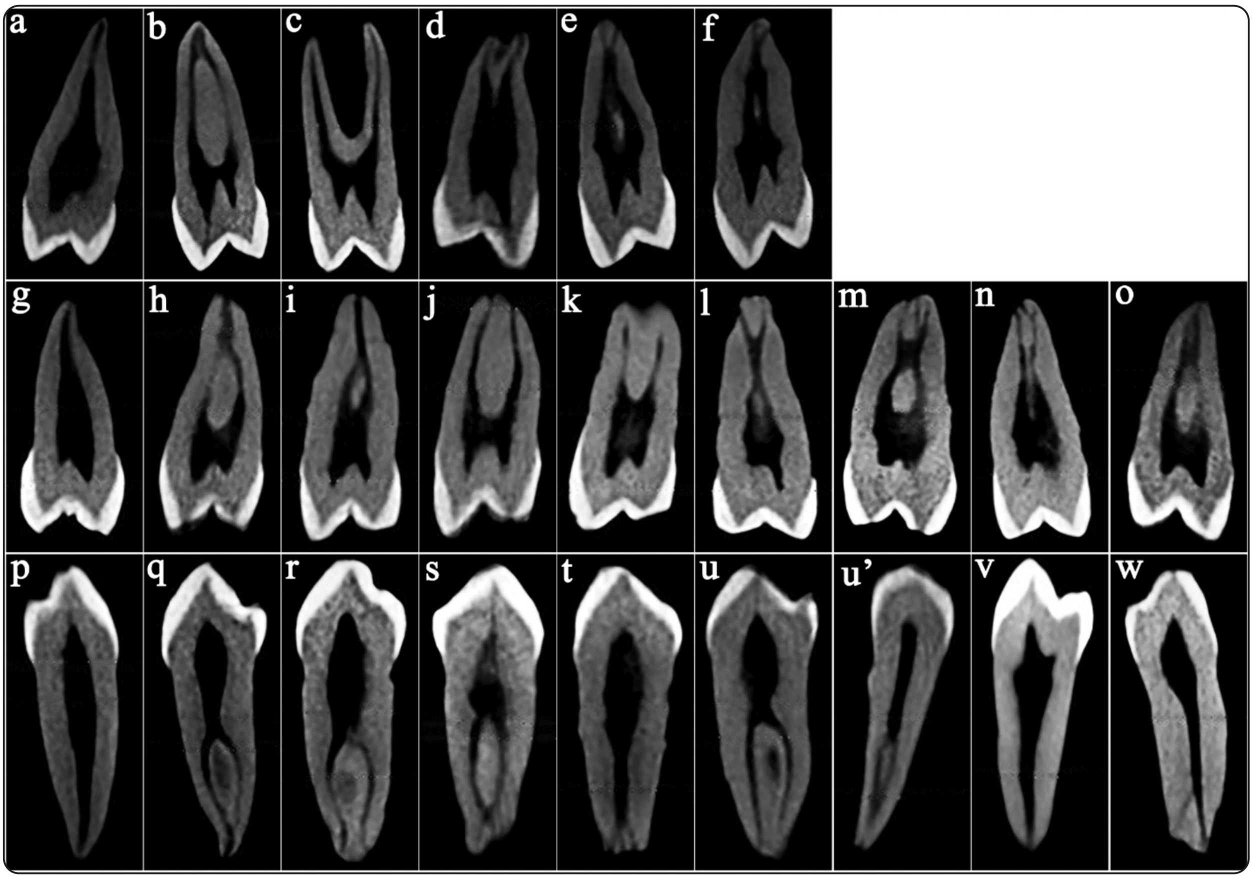

Fig. (6) CBCT showing root canals types regardless roots number. (a-f)- Maxillary 1st premolars; (a)- I, (b)- II, (c)- IV, (d)- V, (e)- VI, (f)- VII. (g-o)- Maxillary 2nd premolars; (g)- I, (h)- II, (i)- III, (j)- IV, (k)- V, (l)- VI, (m)- XIII. (n)- XVI, (o)- XIX. (p-u')- Mandibular 1st premolars; (p)- I, (q)- III, (r)- V, (s)- VI, (t)- IX, (u, u')- Additional type 1-3-2 canals in BL and MD sections respectively. (v, w)- Mandibular 2nd premolars; (v)- I, (w)- V.

TABLE (5) Comparison between premolars groups according to root canals configurations.

		Maxillary 1st premolars (UP1) N=50		Maxillary 2nd premolars (UP2) N=50		Mandibular 1st premolars (LP1) N=50		Mandibular 2nd premolars (LP2) N=50		x^2	P-value
		n	%	n	%	n	%	n	%		
Vertucci's classification	Type I	1 ^{C}	2%	5 ^{C}	10%	31 ^{B}	62%	46 ^{A}	92%	113.747	**<0.001****
	Type II	5 ^{AB}	10%	9 ^{A}	18%	0 ^{B}	0%	0 ^{B}	0%	17.512	**<0.001****
	Type III	0	0%	3	6%	4	8%	0	0%	7.550	0.056
	Type IV	36 ^{A}	72%	20 ^{B}	40%	0 ^{C}	0%	0 ^{C}	0%	90.476	**<0.001****
	Type V	4 ^{AB}	8%	3 ^{B}	6%	12 ^{A}	24%	4 ^{AB}	8%	10.366	**0.016***
	Type VI	3 ^{AB}	6%	7 ^{A}	14%	1 ^{AB}	2%	0 ^{B}	0%	11.063	**0.011***
	Type VII	1	2%	0	0%	0	0%	0	0%	3.015	0.389
Sert and Bayirli classification	Type IX	0	0%	0	0%	1	2%	0	0%	3.015	0.389
	Type XIII	0	0%	1	2%	0	0%	0	0%	3.015	0.389
	Type XVI	0	0%	1	2%	0	0%	0	0%	3.015	0.389
	Type XIX	0	0%	1	2%	0	0%	0	0%	3.015	0.389
Additional type	1-3-2 canals	0	0%	0	0%	1	2%	0	0%	3.015	0.389

Data are expressed as n; number and (%). x^2: Chi-square test; p-value >0.05 (Insignificant); *p-value <0.05 (Significant); **p-value <0.001 (Highly significant). Values in the same row which have different superscripts are significantly different at (p<0.05) using Chi-square test.

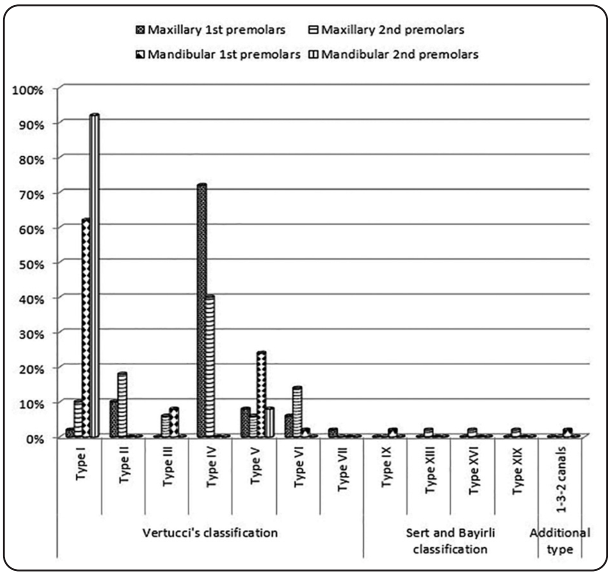

Fig. (7) Bar charts representing the comparisons between the four groups according to root canals configurations.

DISCUSSION

Human populations from various geographical regions differ in tooth size and morphology of crown and root. Dental morphology has been extensively considered and studied to address the diversity ranging from regional minor differentiation to global one. These discrepancies have been greatly attributed to racial/genetic factors, but also may be due to diversity in the design of the study, sample size and evaluation method **(Irish, 2015; Boschetti et al., 2017; Scott, 2018)**.

Very little investigations were performed by researchers concerning dental metrics. Assessment of the wide variation in the crown and root dimensions among populations is so crucial, since the practice worldwide goes along with a standardized table for these measurements (**Nagaş et al., 2018**). The present protocol was designed to use extracted teeth and anatomical crown dimensions instead of clinical measurements on patients or which include those done on dental casts. These measures can be highly precise especially for crown height that the whole anatomical crown was measured from cusp tip to cervical line, in addition to MD dimensions of the crown due to the proximal clearance with absence of adjacent teeth (**Magne et al., 2003**). The comparison between maxillary and mandibular tooth sizes represent a useful diagnostic tool which permitting an educated prediction of the dental treatment outcomes and limit the unnecessary complications. Taking into consideration the discrepancy of the tooth size ratios with the proper relationship of the total MD dimension of the maxillary to mandibular dentition will provide a rout for an optimal post treatment occlusion (**Santoro et al., 2000**).

The prognoses of teeth with short roots that result in unfavorable R/C ratios, may be affected and complicate treatment planning in many dental fields specially when considering the ability of these teeth to carry masticatory forces (**Hölttä et al., 2004**). The crown height mean of UP1 in this analysis seems to be smaller than that in **Magne at al. (2003)** that analyzed the anatomic crown of these teeth in white subjects. In this research, there was a non-significant difference of the root length means between the four premolars, being nearly comparable with that of **Kim et al. (2013)** and **Bernardi et al. (2019)** who investigated the premolars of the Korean and European populations respectively. In this investigation, the mean of R/C ratio was insignificantly higher in both mandibular than the corresponding maxillary premolars and significantly higher in LP2, UP2 than LP1, UP1 respectively. This is quite comparable to **Yun et al. (2014)** and **Sindi et al. (2022)**, who studied R/C ratio in Finnish, Korean and Saudi populations using panoramic radiographs, as the previous works indicated that the means of mandibular premolars were higher than that of maxillary premolars, however, they revealed nearly similar values between 1st and 2nd premolars.

In the current study, the MD mean of UP1 was the highest value, followed by both mandibular premolars with insignificant difference between them, then UP2. Records from researches done by **Hattab et al (1997)** and **Legovic et al. (2003)**, who determined the MD crown diameter of the four premolars in Jordanians and Croatians, indicated that mandibular premolars, of nearly equal means, showed the highest values followed by UP1 then UP2. **Litha et al. (2017)** and **Togoo et al. (2019)** in India and Southern Saudi Arabia showed that both mandibular premolars and UP1 showed more or less equivalent means while UP2 had the lowest value. Other studies that done by **Abdella at al. (2020)** on Egyptians and **Rakhshan et al. (2022)** on Iranian population, documented that LP2 had the highest value, then LP1, followed by UP1 then UP2. The present findings are quite different from that of the mentioned studies. The BL means of maxillary premolars in the study herein were larger than the mandibular premolars, in addition, UP1, LP1 were insignificantly larger than that of UP2, LP2 respectively. Furthermore, the means of BL/MD ratio were the highest in UP2, then UP1, followed by both mandibular premolars. **Legovic et al. (2003)**, **Litha et al. (2017)**, **Abdella at al. (2020)** and **Rakhshan et al. (2022)** values showed that maxillary premolars had higher BL means than mandibular premolars which approximate the results of the present work except that 2nd premolars were larger than that of the 1st premolars, as well as, closely matching the results of BL/MD ratio except that LP2 showed higher value than that of LP1.

The inter-cuspal distance means of maxillary premolars here were significantly higher than that of mandibular premolars, as well, 2nd premolars showed insignificantly higher means than that of the corresponding 1st premolars. These are quite similar to **Yoo et al. (2015)**, who studied both mandibular premolars in Koreans, except that they recorded a significantly difference between them. Furthermore, **Qamar et al. (2020)** estimated an equivalent inter-cuspal distance means between the maxillary premolars in Pakistan and Saudi Arabia.

Concerning mesial/distal accessory ridges in the present investigation which exhibited low to moderate frequencies. **Mihailidis et al. (2013)** who examined the maxillary premolars prevalence and patterning of the accessory ridges in six ethnic groups combined are in accordance with the results herein in that the distal accessory ridges exhibited higher occurrence rate than that of mesial ones, however differ in that the occurrence of mesial/distal accessory ridges and truncated ridges had higher frequencies in UP2 than UP1. Additionally, **Baby et al. (2017)** stated that the distal accessory ridge was more common feature on all premolar types with low expression of the mesial one and the occurrence of mesial/distal ridges had higher proportion in 1st than 2nd premolars in Kerala population as documented in the present work. There are frequencies differences between the degree of expression in several populations presented by **Burnett et al. (2010)** and **Mihailidis et al. (2013)** which are also not comparable to the existing work, suggesting this trait may be effective in distinguishing between populations.

The odontome is an uncommon dental anomaly that primarily occurs in people from Asian descent **(Levitan and Himel, 2006)**. In the study here, the odontome showed very low prevalence and only expressed in LP1. This is in accordance with **Rao et al. (2010)** who reviewed that odontomes has tendency toward mandibular premolars with comparatively infrequent in the maxillary ones. Aside from the declaration of the rare occurrence of the odontome in the study of **Baby et al. (2017)**, they detected this feature in UP1, as well as both mandibular premolars.

In this study, mesial/distal accessory cusps occurred in low frequencies in both maxillary premolars. **Adams et al. (2019)** studied the global distribution of mesial/distal accessory cusps of maxillary premolars. They outlined that most populations showed lower frequencies of this trait especially North Africa that was the only group, lacking either accessory cusps on any tooth. As well as, globally, the mesial accessory cusps occurred in higher percentages than that of distal cusps as the case of UP2 in this study but opposite to UP1. **Abdella et al. (2020)** stated that the occurrence of this feature was higher in 2nd than 1st premolars, however, in here, there was insignificant difference between them.

In this observation, roughly half the samples of LP1 were one lingual cusp and of LP2 were two lingual cusps in addition to lower values to other patterns. These findings are almost equivalent to those in **Khraisat et al. (2013)** and **Baby et al. (2017)**, who studied mandibular premolars in Jordanian and Kerala populations. **Yoo et al. (2015)** confirmed that the frequency of H-shaped central groove pattern in LP1 were considerably higher than U-shaped pattern in Koreans as detected in this work, and were opposite to the results of **Sunil and Gopakumar (2012)** and **Ali et al. (2019)** in Kerala and Pakistan populations.

In this study, the frequency of one-rooted maxillary premolars was higher than that of two-rooted premolars, that was significantly more manifested in 2nd premolars with no evidence of three-rooted ones. The finding of UP1 agrees with **Gupta et al. (2015)**, **Senan et al. (2018)**, **Wu et al. (2020)** and **Alenezi et al. (2022)** who evaluated their root morphology in North Indian, Yemeni, Shandong Chinese and Kuwaiti populations. However, **Loh (1998)**, **Abella et al. (2015)** and **Faraj et al. (2022)** showed that two-rooted UP1 were higher than that of one-rooted premolars in Singaporean, Spanish and Sulaimani populations. Moreover, **Bulut et al. (2015)** and **Alqedairi et al. (2018)** recorded that the majority of UP1 had two roots and UP2 usually had one root in Turkish and Saudi individuals. The above-mentioned studies recorded that the three-rooted maxillary premolars were absence or found in only few cases.

The discrepancy in the distribution of maxillary premolars root number between the current work and previous investigations may be explained not only by the causes mentioned earlier, but also due to the controversy of the definition of the single and double-rooted teeth. As **Loh (1998)** and **Bulut et al. (2015)** were considered the fused roots form (completely fused and apically separated roots) as an actually two-rooted premolars as the tooth was originally developed with two roots, along with the furcation of the two separated roots form started at a level about half of the two roots length. **Abella et al. (2015)** and **Faraj et al. (2022)** were considered the actually fused roots from one-rooted premolars, while the apically separated roots from two-rooted premolars.

In existing research, the maxillary premolars with single apex were more frequently than that with double apex, which is the case in **Senan et al. (2018)** and opposite to that revealed by **Faraj et al. (2022)**. The bifurcation of maxillary premolars in this study occurred most often in the middle third and least often in the apical third. While, **Saber et al. (2019)** detected that the bifurcation of maxillary premolars in Egyptian population was most common at the middle then apical and least common at coronal third. The UP1 bifurcation in Polish population of **Olczak et al. (2022)** study was most common at the coronal then middle then apical third.

It has been reported that dentin wall thickness at the furcation groove of un-instrumented natural root canals of maxillary premolars was less than one millimeter, rendering the buccal root not being suitable for post placement. Thus, recognition of the potential presence of such anatomical feature is of great importance in endodontic and subsequent restorative procedures, preventing excessive dentin wall thinning and strip perforation at this area which reducing the possibility of vertical root fracture **(Kfir et al., 2020)**. The furcation groove exhibited high occurrence percentage of the two-rooted UP1 in this study that is lower than **Tamse et al. (2000)** and **Awawdeh et al. (2008)**, nearly comparable to **Lammertyn et al. (2009)**, and higher than that reported by **Kfir et al. (2020)** and **Alenezi et al. (2022)**.

The presence of radicular grooves on the root surfaces of mandibular premolars has been demonstrated in several studies. Clinically, these grooves are relevant as their depth may act as dental plaque and calculus reservoir, complicating the management of periodontal diseases. Another point of view, their presence has been linked to root canal system complexities as C-shaped canal or canal bifurcation, increasing the failure rate in endodontic treatment of these teeth **(Cleghorn et al., 2008; Fan et al., 2008; Gu et al., 2013; Boschetti et al., 2017)**.

The results of this research are in accordance with **Arslan et al. (2015)** who confirmed that the frequency of the radicular groove presence was significantly higher in LP1 than LP2 in Turkish population. In addition, this work agrees with **Gu et al. (2013)** who estimated the root groove pattern on LP1 in Chinese population and reported that Grade 0 was the most common pattern, followed by Grade1, then Grade 3, then Grade 2 with low frequencies of Grades 4 & 5. The same outcomes were revealed by **Dou et al. (2017)** except for Grade 2 which was higher than Grade 3. Moreover, the present study showed rare occurrence of the groove on the buccal aspect of premolars roots. Its occurrence on mandibular premolars was insignificantly higher than on maxillary premolars. **Boschetti et al. (2017)** and **Dou et al. (2017)** revealed extremely low percentage of this feature on LP1.

Root canal systems have been characterized as complex anatomical structures with extensive implication on endodontic treatment. CBCT was used in the present work as it is a considerable technological advancement, offering a three-dimensional view without overlapping of the complex anatomical structures and providing a better understanding of root canal morphology in coronal, axial and sagittal sections **(Monsarrat et al., 2016)**.

This analysis indicated that the most common root canal anatomy was type IV in maxillary premolars and the second most prevalent was type II with low percentages of other Vertucci's types. Above that, UP2 showed equivalent low percentages of Sert and Bayirli's types. These results come in accordance with **Awawdeh et al. (2008)**, **Weng et al. (2009)**, **Saber et al. (2019)**, **Alenezi et al. (2022)** and **Olczak et al. (2022)**. Although **Alqedairi et al. (2018)** stated that type IV was the most common canal morphology in UP1, they declared that type I was the most prevalent in UP2. Furthermore, **Elnour et al. (2016)** identified the presence of types XIII, XVI and XIX in UP2 as the present work, however **Gupta et al. (2015)** and **Saber et al. (2019)** indicated their existence in UP1. Whilst, most of mandibular premolars in this research exhibited type I, followed by little values of type V. The current findings are more or less similar to **Liu et al. (2013)** and **Dou et al. (2017)**, studying LP1. However, **Boschetti et al. (2017)** pointed that type V was the most common configuration. **Mohamed and Abdallah (2021)** stated that type I was the most common in both mandibular premolars, while the second most prevalent was type II in LP1 and type V in LP2. **Liu et al. (2013)** and **Arslan et al. (2015)** figured out the presence of types IX and 1-3-2 canals in LP1 as shown in this research.

CONCLUSION

This study elucidated the discrepancies of metric and non-metric dental traits with root canals configuration between all types of Egyptian premolars, in addition to the difference in expression of these features from a population to another.

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Declaration of interest

The author has no competing interests to declare which are relevant to the content of this article.

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