EGYPTIAN
DENTAL JOURNAL
www.eda-egypt.org

Vol. 69, 1087:1098, April, 2023

Print ISSN 0070-9484 • Online ISSN 2090-2360

Oral Medicine, X-Ray, Oral Biology and Oral Pathology

Submit Date : 11-12-2022 • Accept Date : 19-01-2023 • Available online: 01-04-2023 • DOI : 10.21608/edj.2023.177672.2363

VARIATIONS IN CROWN SIZE AND ROOT CANAL CONFIGURATION IN A SAMPLE OF HUMAN PERMANENT MAXILLARY AND MANDIBULAR MOLARS IN EGYPTIAN POPULATION

Marwa M. Abd ElHameed* , Fatma M. Badawy** *and* Dina Abdelkhalik***

ABSTRACT

Structural variations in teeth are a part of dental anthropological system and should be addressed in different populations or races.

Aim: This study aimed to assess buccolingual thickness, mesiodistal width, cusp height, and root canal configurations using measurement, CBCT, and statistical analysis in a sample of permanent maxillary and mandibular molars in Egyptian population.

Materials and Methods: 42 extracted human permanent molars were collected from archives of Oral Biology Department, Faculty of Dentistry, Ain Shams university. Dimensions were measured using a digital caliper and root canal configuration was assessed using CBCT.

Results: Maxillary first molars (M1), showed statistically significant higher mean value than the maxillary second molars (M2) as regards MD width, ML DB diameter and DB Cusp height. While the mandibular first molars showed statistically significant higher mean value compared to mandibular second molars as regards BL dimension and MD width. For maxillary molars: Regarding CBCT, MB roots 39.0% showed type I canal configuration, 26.8% showed type II & IV canal configuration and 7.3% showed type VI canal configuration. All DB and palatal roots showed type I canal configuration. For mandibular molars: The mesial roots showed 2.9% type I canal configuration, 65.7% type II, and 31.4% type IV. All distal roots showed type I canal configuration.

Conclusions: Crowns of maxillary and mandibular first molars are significantly larger in all dimensions than maxillary and mandibular second molars respectively, CBCT is useful in determining variation in root canal configuration.

KEYWORDS: CBCT- Root canal morphology- crown dimensions

* Head of Department of Oral Biology, Faculty of Oral and Dental Medicine, Egyptian Russian University-Associate Professor in Department of Oral Biology, Faculty of Dentistry, Ain Shams University, 11566, Cairo, Egypt
** Department of oral and maxillofacial radiology, Ain Shams University, 11566, Cairo, Egypt
*** Department of Oral Biology, Faculty of Dentistry, Ain Shams University, 11566, Cairo, Egypt

INTRODUCTION

The number of cusps and morphologic dissimilarities in teeth have always been a researcher's point of interest. Structural variations in teeth are a part of dental anthropological system and should be addressed in different population or races. Variations in tooth morphology may be correlated to genetic alterations between different populations [1]. Morphological variations in cusps represent clinical challenges including; difficulty in band placement, plaque accumulation due to deep fissures, prevalence of caries due to presence of occlusal pits, malocclusion and difficulties in different dental procedures. Each cusp either in maxillary or mandibular molars has a unique growth pattern and different evolutionary background [2,3]. Also, many studies have reported that the mesiodistal width and buccolingual width are gender specific and the difference was statistically significant [4].

Cusps of maxillary molars are named Mesio-buccal-Paracone, Distobuccal-Metacone, Mesio-lingual-Protocone and distolingual-Hypocone **Fig (1A).** Axes representing the different dimensions of upper molars were represented in **Fig. (1B)** [5].

Meanwhile, the morphology of the occlusal surface of mandibular molars was described and categorized by **Gregory** [6] **and Hellman** [7] as shown in **Fig (2)** [8]**.**

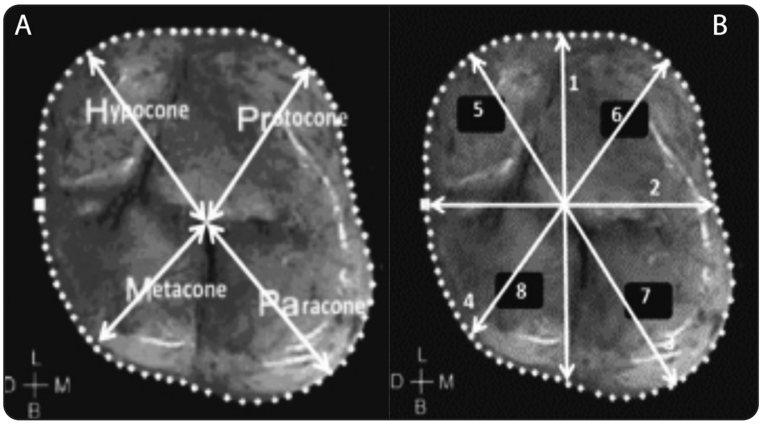

Fig. (1) **A:** Primary cusps for maxillary first molar. **B:** Schematic representation of different axes in maxillary first molar 1. Buccolingual thickness 2. Mesiodistal width 3. Mesiobuccal-Distolingual 4. Distobuccal-Mesiolingual 5. Hypocone 6. Protocone 7. Paracone 8. Metacone [5].

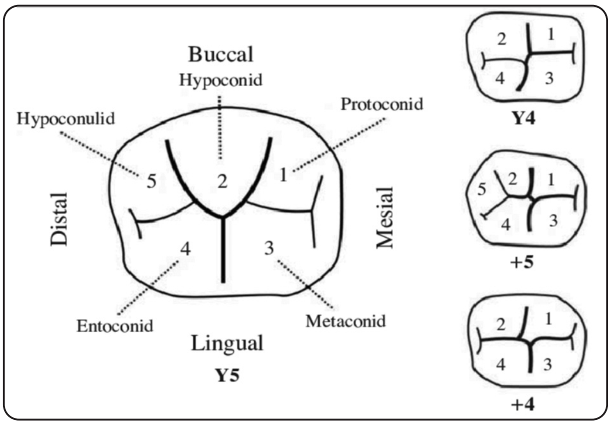

Fig. (2): Morphology of the occlusal surface using the morphological categories of **Gregory and Hellman** [6,7], Firstly, occlusal surfaces were divided into the five-cusp group and the four-cusp groups. Then, each group was subdivided into 'Y' pattern if there was contact between the metaconid and hypoconid, and '+ +'pattern if there was no contact between the metaconid and hypoconid. Therefore, there were a total of 4 categories: Y5, + +5, Y4, and + +4[3]. [8].

The understanding of anatomy of root canals plays a prime role in the root canal treatment outcomes. Adequate biomechanical cleaning and shaping of the root canals, then, airtight seal of the entire canal space are necessary for a successful treatment. However, the unusual canal anatomy presents clinical challenges for clinicians [9].

Therefore, it is mandatory for clinicians to realize the variations in the root canal systems and their distinctive features in different populations when performing root canal treatment. First molars erupt at the age of 6–7 years and apical closure is completed by 8–9 years. The accomplishment of canal differentiation occurs about 3–6 years after root completion, therefore, any disruptions in this differentiation can result in variations in canal anatomy. Regarding mandibular molars, many classifications were suggested to enable a better understanding of the root canal anatomy of C-shaped canals. The earliest of which was proposed by **Manning** [10] and **Melton et al.** [11]. Various other classifications were then also proposed [12,13].

Melton et al. [11] classification of C-shaped canals was based on their cross-sectional shape. It was modified by **Fan et al.,** [14] as follows:

- **Category I (C1):** The canal shape was an disrupted "C" with no separation or division
- **Category II (C2):** The canal shape resembled a semicolon resulting from a discontinuation of the "C" outline
- **Category III (C3):** Two or three separate canals (greatest prevalence)
- **Category IV (C4):** One round or oval canal in that cross-section
- **Category V (C5):** No canal lumen clearly observed (which is usually noticed near the apex).

More commonly, types of root canals were sorted according to Vertucci's classification [15] **Fig. (3)**, this classification was used in the present study.

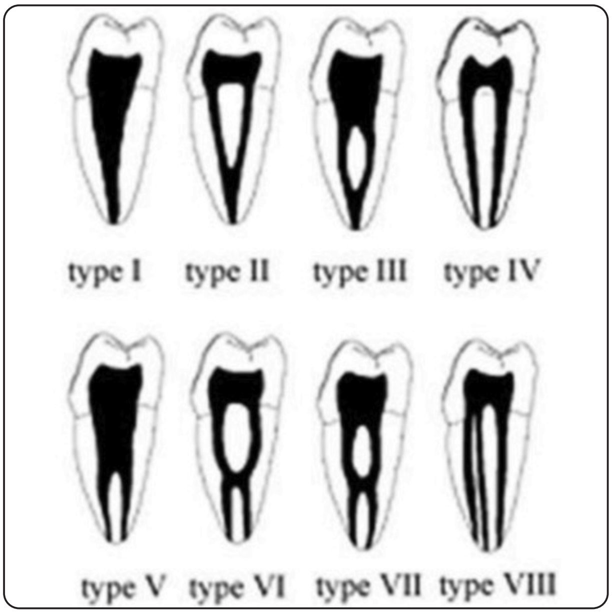

Fig. (3) Vertucci's classification of canal configuration

The use of standard radiographs to study the canal configuration of human teeth has the inadequacy of showing the subject in two-dimensional views (2D) instead of in three dimensions (3D), resulting in structures superimposition [16]. Cone beam computed topography (CBCT) and micro CTs represent a useful diagnostic non-invasive tool to resolve this issue and to explore dental and maxillofacial structures. [17]

CBCT images have been found to be useful and accurate in assessing root canal morphology and detecting periapical lesions. It has also been used to estimate the inter-orifice distances of root canals in three-rooted mandibular molars in Taiwanese individuals. Also, with its lower radiation and higher resolution than medical CT scans it produced valid root and canal details for diagnosis and prognosis in endodontic therapy. [18]

AIM OF THE STUDY

The study aimed to evaluate buccolingual crown thickness, mesiodistal crown width, cusp height for permanent maxillary and mandibular molars and also MLDB diameter of the permanent maxillary molars and finally root canal configurations in a sample of in Egyptian population. These recordings carried out using digital caliper measurements, CBCT, and statistical analysis.

MATERIALS AND METHODS

A total of 42 extracted human permanent molars (21 upper/ 21 lower) were collected from the archives of Oral Biology Department, Faculty of Dentistry, Ain Shams University. The collected teeth were assorted as (12 first molars and 9 second molars) for the maxillary and mandibular ones. The inclusion criteria-especially for those selected for crown dimension measurements- were absence of caries or severe attrition or abrasion. Teeth were washed and stored in distilled water. Afterwards, the teeth were properly washed under tap water and immersed in sodium hypochlorite solution. Calculus and stains were removed using a scaler.

Subsequent storage during the period of study was done in accordance with Gulabivala et al [19].

Buccolingual (BL) thickness, mesiodistal (MD) width and cusp height for maxillary and mandibular molars. MB-DL diameter were also measured for maxillary molars. All measurements were performed on extracted teeth by the aid of a digital caliper (0-150 millimeter (mm)/0-6") (INSIZE Company-made in Asia) (Mitutoyo, Japan) calibrated to 0.01mm. [20].

The BL measurement was defined as the greatest distance between the buccal and the lingual surfaces of the tooth crown, measured with the caliper beaks held at right angles to the MD dimension. The MD dimension was identified as the greatest distance between the contact points on the proximal surfaces of the tooth crown and was measured with the caliper beaks placed occlusally along the long axis of the tooth. The height of all cusps of both molars was also measured according to **Jensen et al.,** [21]. The diameter of the individual cusps in permanent maxillary molars was defined by measuring the oblique distance from the central pit to the most distant point located along the outer margin of the crown equivalent to its relevant cusp. The central pit located at the bottom of central fossa was defined as the point of junction of the primary occlusal fissures. Although the location of the central pit will be affected by the relative position of cusps, it is a main feature of all molars that is easily identified and provides a land mark for assessing the size of individual cusps [22].

All measurements were made by one observer, and were repeated by the same observer after one month then the process was repeated by another observer. Measurement errors were calculated by comparing the first and second measurement values . The measurement errors calculated for the measurements were 0.50~0.77 mm. The average reliability obtained by using the 100(1-Error2/ s2) formula was 99%, demonstrating that there were few measurement errors in this study. Since the paired t-test for first and second measurements showed no significant differences, measurement errors due to photography and graphic analysis looks insignificant.

For CBCT examination, thick rectangular molds were made using pink wax to hold our samples. Samples were embedded in the wax mold by aligning them in rows leaving 0.5 cm space between them. Molds with samples were submitted for CBCT scan and images were acquired at Oral Radiology Department Ain Shams University. CBCT images were produced using i-CAT next generation device. The machine was operating with a tube voltage of 120 kilo Voltage peak, 37.07 milli amperes and voxel size of 0.2 mm for 26.9 s with field of view of 8 cm height and 8 cm diameter. Data were exported, transferred into an i-CAT format and then downloaded through a compact disk to a personal computer for observation.

Axial, coronal, and sagittal sections, as well as multiplanar reconstructed (MPR) sections of the molars, were displayed on a 32-inch HP LCD monitor at a resolution of 1280 × 1024 pixels.

The interpretation of the CBCT images was done in a dark room. The image magnification, contrast, and window size were manipulated to ensure optimum vision. Then, careful examination was performed by rolling the mouse wheel forward and backward (to scroll through the sections) to exclude any lateral canal that may have intervened with the reading. After examination, the roots and canals were characterized by a series of clicks on the scroll tool, from the canal orifice to the root apex in axial planes **(Fig. 4)**. Cross-sectional and MPR sections along the root axes were used for root and canal identification. The recording criteria for canal identification were as follows: (1) The pulp floor was identified when last faint radiolucent line connected two orifices; (2) the canal orifice was recognized as a radiolucent spot at which canal evaluations began; (3) the main canal was identified as a long connecting line that started from the orifice and ended in the apical foramen; (4) the apical foramen was located in the apical third of the root; and (5) the root end represented the most apical radiopacity of

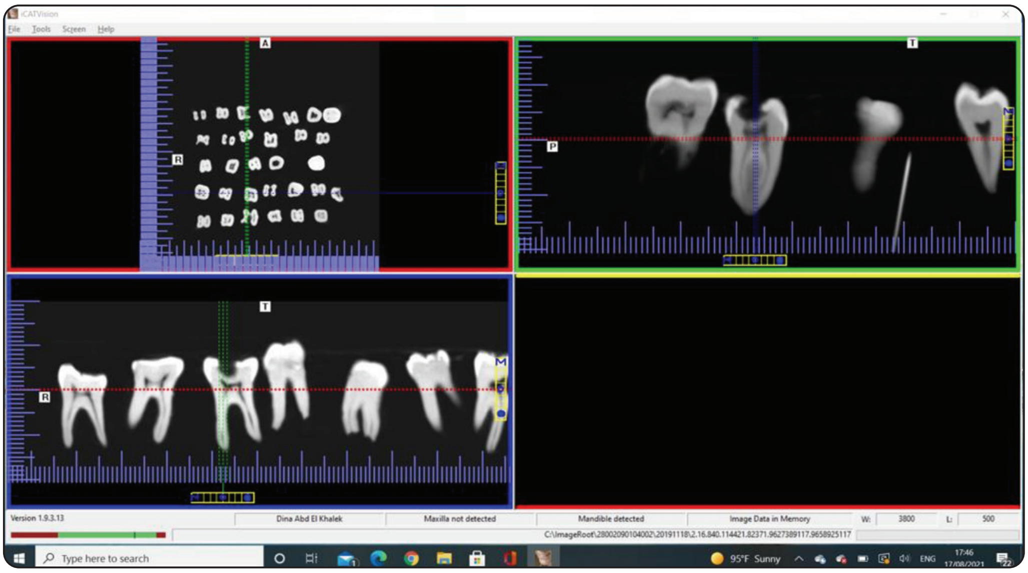

Fig (4) Cone beam computed tomography (CBCT) showing root canals configuration in a group of samples.

the root structure. A secondary canal was confirmed as a second radiolucent spot located off-center from the main canal. [23]

Data was analyzed using the statistical package for social sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA) and were exhibited as mean± standard deviation and ranges when their allocation was parametric (normal) . Also, qualitative variables were expressed as numbers and percentages.

Distribution of variables was performed with PASW Statistics 18.0 program (IBM-SPSS Corporation, Armonk, NY, USA). Differences between first molars and second molars, and correlation between groups were analyzed by paired t-test.

RESULTS

A) Regarding the measurements of the maxillary first molars (M1), they showed statistically significant higher mean value than the maxillary second molars (M2) as regards MD width, ML DB diameter and DB Cusp height **(table 1, fig. 5)**. While the mandibular first molars showed statistically significant higher mean value compared to mandibular second molars as regards BL dimension and MD width **(table 2, fig. 6)**.

TABLE (1) Comparison in measurements between maxillary first and second molar

Upper	First molar (n=14)	Second molar (n=7)	t-test	p-value
1- BL dimension				
Mean±SD	10.56±0.34	10.71±0.17	-1.096	0.287
Range	9.9-11	10.5-11		
2- MD Width				
Mean±SD	10.16±0.46	9.69±0.55	2.097	0.050*
Range	9.5-10.7	9-10.5		
3- MB-DL diameter				
Mean±SD	10.81±0.11	10.71±0.20	1.422	0.171
Range	10.6-11	10.3-10.9		
4- ML- DB diameter				
Mean±SD	10.29±0.39	9.49±0.46	4.250	<0.001**
Range	9.6-10.7	8.7-9.9		
5- Cusp height				
MB				
Mean±SD	4.43±0.29	4.26±0.34	1.201	0.244
Range	3.7-5	3.7-4.8		
DB				
Mean±SD	4.09±0.31	3.66±0.13	3.484	0.002*
Range	3.5-4.8	3.5-3.9		
ML				
Mean±SD	4.01±0.28	4.17±0.53	-0.899	0.380
Range	3.5-4.4	3.4-4.7		
DL				
Mean±SD	3.16±0.13	2.97±0.45	1.463	0.160
Range	3-3.4	2.2-3.7		

Using: t-Independent Sample t-test;
p-value >0.05 NS; *p-value <0.05 S; **p-value <0.001 HS.

This table shows statistically significant higher mean value in first molar compared to second molar regarding MD Width, ML DB diameter and Cusp height "DB", with p-value ($p<0.05$).

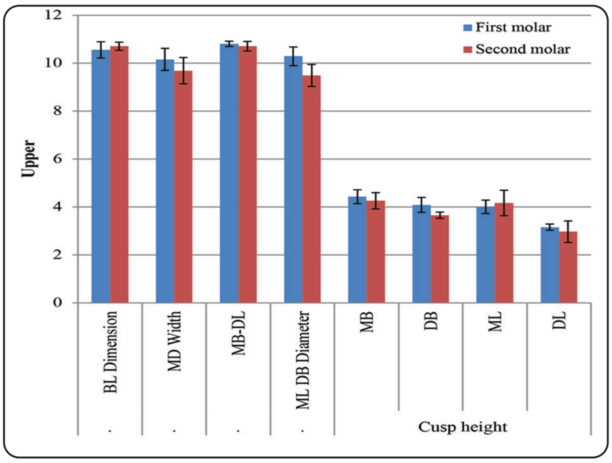

Fig. (5): Comparison in measurements between maxillary first and second molar

TABLE (2) Comparison in measurements between mandibular first and second molar

Lower	First molar (n=14)	Second molar (n=7)	t-test	p-value
1- BL dimension				
Mean±SD	10.19±0.38	9.69±0.53	2.909	0.007*
Range	9.5-10.8	8.6-10.6		
2- MD Width				
Mean±SD	10.70±0.43	10.32±0.42	2.424	0.022*
Range	10.2-12	9.5-10.9		
3- Cusp height				
MB				
Mean±SD	4.44±0.50	4.41±0.28	0.199	0.844
Range	3.7-5.2	3.9-4.8		
DB				
Mean±SD	4.02±0.71	3.96±0.42	0.287	0.777
Range	2.6-5	3.1-4.6		
D				
Mean±SD	3.61±0.51	--	--	--
Range	3-4.8	--		
ML				
Mean±SD	4.31±0.67	4.18±0.38	0.635	0.531
Range	3.5-6	3.2-4.7		
DL				
Mean±SD	3.91±0.62	3.71±0.33	1.138	0.265
Range	2.6-5	3.1-4.3		

Using: t-Independent Sample t-test;
p-value >0.05 NS; *p-value <0.05 S; **p-value <0.001 HS

This table shows statistically significant higher mean value in first molar in comparison to second molar regarding BL dimension and MD width, with p-value ($p<0.05$).

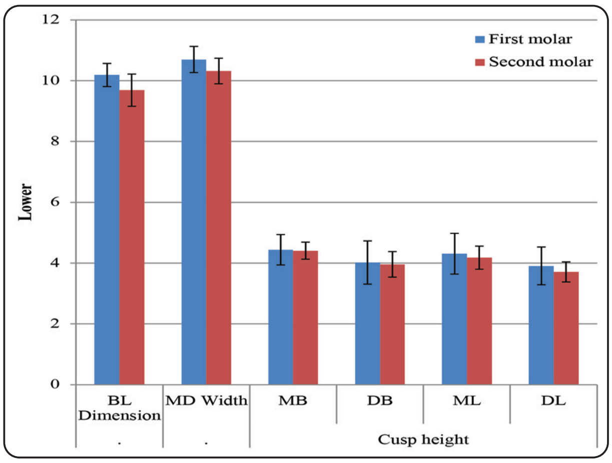

Fig. (6): Comparison in measurements between mandibular first and second molar

B) Regarding CBCT, the following configurations, according to Vertucci's classification **for maxillary molars** revealed:

For MB roots 39.0% showed type I canal configuration, 26.8% showed type II canal configuration, 26.8% type IV canal configuration and 7.3% showed type VI canal configuration. All DB and palatal roots showed type I canal configuration (**fig. 7, table 3**).

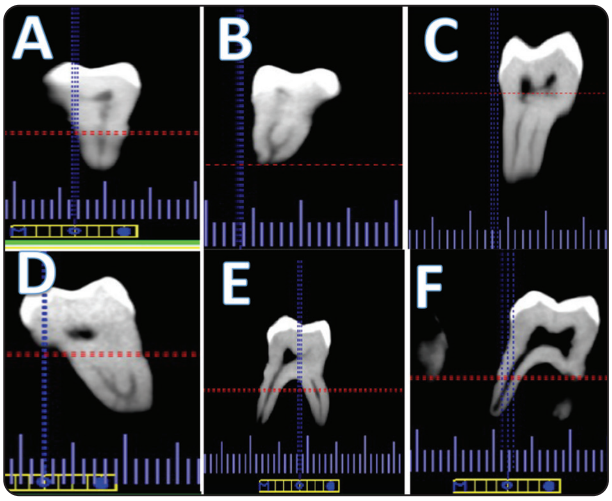

Fig. (7): A) Mesiobuccal canal type I , B) Mesiobuccal canal type II, C) Mesiobuccal canal type IV , D) Mesiobuccal canal type VI , E) Distobuccal canal type I , F) Palatal canal type I

TABLE (3) Types of root canals in upper molars among study groups.

Upper molars	No.	%
MB canals		
I	16	39.0%
II	11	26.8%
IV	11	26.8%
VI	3	7.3%
DB	One root canal	
Palatal roots	One root canal	

For Mandibular molars:

The mesial roots showed 2.9% type I canal configuration, 65.7% type II, and 31.4% type IV. All distal roots showed type I canal configuration **(fig. 8, table 4)**.

TABLE (4) Types of root canals in lower molars among study groups.

Lower molars	No.	%
Mesial root		
Type I	1	2.9%
Type II	23	65.7%
Type IV	11	31.4%
Distal root	One root canal	

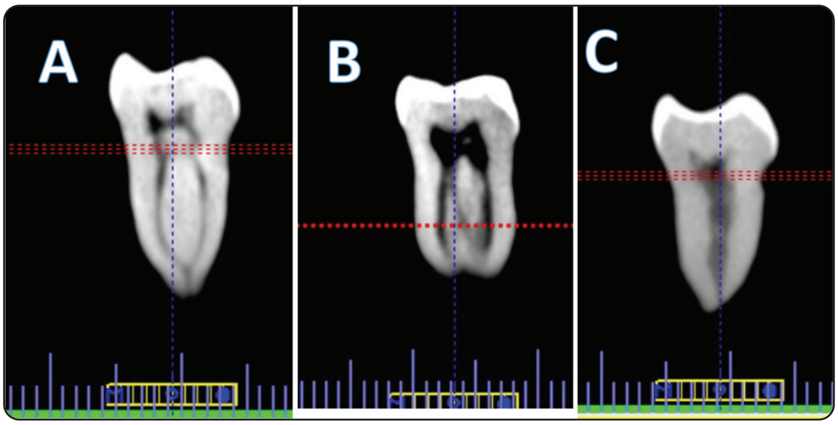

Fig. (8): A) Mesial root type II, B) Mesial root type IV, C) Distal root type I

DISCUSSION

There are different degrees of expression, frequency, and variations of teeth among different populations[24]. The buildup of data on the morphometric traits of the teeth led anthropologists to become more recruited to the evolutionary implication of these data and to consider the mode of inheritance and hereby came the objective of the present work.

In conservative dentistry, the morphology of crowns is crucial in the precise restoration of tooth morphology and function. While racial differences in crown morphology are recognized, the various aspects of root form and canal anatomy of human teeth have not had the same attention in different populations. Books of dental anatomy do not provide thorough information of root canal morphology that may be distinctive to African populations [20,25].

Morphology of the occlusal surface of the mandibular molars has been a matter of interest for dental anthropologists for a long time [26]. Variations in sizes have been observed in mandibular molars of different populations. Mandibular molars are more variable than the maxillary molars [27].

A digital caliper was used for measurement of mesio-distal crown width because of its accuracy. It eliminates measurement transfer and calculations errors[28]. Accordingly, within limitations of the present study, it was found that:

Regarding the mesiodistal width of the maxillary molars:

Our study on a sample of Egyptian population revealed that the mean mesio-distal crown width of M1was higher than that of. M1 was 9.5-10.7 mm, M^2 was 9-10.5 mm.

A study was carried out by **Richardson and Malhotra,** [29] to analyze the mesiodistal crown dimension of 162 American Negros permanent dentition, the mean mesio-distal crown width of M1 was 10.31mm and was higher than that of M2 which is compatible with our results.

Unlike **Brook AH et al.,** [30], who have studied the mesio-distal crown width of the permanent dentition of the North American sample. The investigators stated that "the mean mesio-distal crown width of M1 was 10.81 mm while that of M2 was 10.23 mm".

Meanwhile, **Khan et al.,** [31] who have studied the mesio-distal crown width of maxillary molars between different populations showed that Bangladeshis have measurements close to those of North Indians, Icelanders and Jordanians but larger than those of North American Whites. The investigators revealed that the mean mesio-distal crown width of M1 in Bangladeshis was 10.68 mm which is different from our readings, while that of the Americans whites was 10.25 mm.

Recently, **Jaiswal et al.,** [32] have studied the mesio-distal crown width of maxillary molars among adolescent population of Province, Nepal and found that there is significant difference between mesiodistal width of maxillary molars (P value is <0.001) which is compatible with our results.

Regarding root canal morphology of maxillary molars:

Dentists should be acquainted with common root canal configurations and anatomic variations due to their clinical importance [33]. Since root canal morphology differs between different populations, separate studies for different populations must be done to render reliable results.

Using CBCT providing a detailed 3D image from axial, sagittal and transverse planes and gives detailed assessment of the morphology of the root and root canal configuration in different dimensions without anatomical superposition [34]. That's why we studied root canal morphology using CBCT.

Then we recorded our results according to vertucci classification, It was previously employed in similar studies [35,36]**.**

In our study, CBCT showed (39 %) of M1 mesiobuccal roots (MB) type I followed by type II & IV (6.8%).

In a study done by **Pécora et al.,1992** [37]**,** the internal anatomy of maxillary molars in Brazilian subpopulation, the investigators found that the most common MB2 canal configuration of M1 was type I (48%), and 100% of DB &P canals were type I and this prevalence of configuration was in accordance with our study.

Al-Nazhan et al., [38] made a survey on the root canal morphology of M1 in among a Saudi Arabian subpopulation reported a high frequency of type I (76.7%) MB2 canal configuration which was unlike our results.

Another inconsistency with our results was **Rwenyonyi et al.,** [39]**.** The investigators studied the root canal configuration of M1&M2 in Ugandan population, they found that most of the MB2 canal configuration was type I (75%), and (98.5%) of DB &P canals were also type I canal configuration.

Our findings were also comparable with **Pattanshetti et al.,** [40] who investigated the root and canal morphology of M1 in Kuwait population using the staining and clearing technique. The investigators have concluded that the most common prevalence of MB2 canal configuration was type I (75.1%), and (99.3%) of DB &P canals were type I canal configuration.

Moreover, a study done by **Zheng et al.,** [41] who investigated the root canal morphology in a Chinese population using CBCT. The investigators found that the MB2, type I configuration was most prevalent (58.2%), and (100%) of DB &P canals were type I canal configuration.

In a study done by **Lee et al.,** [42] on the incidence of MB2 canal in Korean maxillary molars using CBCT. They found that the frequency of MB2 was 71.8% in M1 which support our results, while types III and II canal configurations were the most prevalent in the MB2 which disagreed with our results.

In another study done by **Al -Fouzan et al.** [43] on the internal anatomy of upper molars, they revealed that type II (33.1%) followed by type IV (18.2%) was the most prevalent canal configuration of MB2 which was encountered in our results.

Recently, **Al-Shehri, et al.** [23] studied the root and root canal configuration of M1 in a selected sample of Saudi population using CBCT ,the researchers showed that 55.6% of MB2 was type IV ,while single canal MB was type I (35.1%) followed by type IV(33.3%) which disagree with our results ,and 100% of DB &P canals were type I and this prevalence of configuration agree with our study.

In a study done by **Neelakantan et al.,** [44] on root canal configuration of maxillary molars of selected sample in Indian population teeth using CBCT. The investigators revealed that MB root had one canal in (62%) with type I (87.8%) and two canals in (44.1%) with type IV (50%) and type II (13%), while DB &P roots had type I configuration which wasn't encountered with our results.

In another study done by **Nayak et al.,** [45] on root canal morphology of South Indian maxillary molar teeth using the staining and clearing technique, they found that 9.4% of M2 had MB2 where type I (96%) was the most prevalent canal, type I (92%) for DB and also type I (99%) for P canals. This is in agreement with our results, while single canaled MB with type I (46%), type II (25%) and type VI (10%) configuration which disagree with our results.

Regarding mandibular buccolingual and mesio-distal crown dimensions and. cusp height:

Mesio-distal crown width was measured in our study because it is important in clinical dentistry as well as anthropology and anatomy. In orthodontics, the diagnosis and treatment of malocclusions require thorough knowledge of tooth mesio-distal crown width as the ideal occlusion is reliant on the correct intercuspation of the teeth [46]. Also, **Anderson,** [47] used both techniques (direct on extracted teeth and indirect on study casts) in his odontometric study and he demonstrated that there were no statistically significant differences between the two methods. Our study on a sample of mandibular molars in Egyptian population revealed that there was statistically significant higher mean value in the mandibular first molar compared to mandibular second molar in MD and BL dimensions, with a mean of 10.19mm and 10.70mm respectively. **Smith et al.,** [48], have studied the mesio-distal crown width of mandibular molars in Australia. The researchers found that the mean mesio-distal crown width of mandibular first molar was 12 mm. Meanwhile, **Bishara et al.,** [49] who have studied the mesio-distal crown width of mandibular first molars in Egypt, Mexico and United states. The investigators revealed that the mean mesio-distal crown width of mandibular first molars in Egyptians was 11 mm which is approximatly similar to our readings, Mexicans 10.7 mm while that of the Americans was 10.4 mm. Also, according to **Ash and Nelson, (2002)** [50] the mesio-distal crown width of mandibular first molars is 11 mm which is comparable to our results. Another study done by **Singh et al.,** [51] on the mesio-distal crown width of the permanent dentition in North Indian children, the mean mesio-distal crown width of mandibular first molar was 10.81 mm. Recently, **Agrawal et al.,** [20] have studied the mesio-distal crown width of mandibular first molar and found that the mean was 10.34 mm which is comparable to our results.

Regarding root canal configuration of mandibular molars:

In the current study, CBCT revealed that the most prevalent mesial root canal frequency in mandibular first and second molars was type II (65.7%) followed by type IV (31.4%) then type I the least (2.9%), while distal root canal morphology was type I in all study samples. However, a study done by **Gulabivala et al.,** [19] on the root canal morphology of Burmese mandibular molars by the staining and clearing technique, the investigators found that the most common mesial canal configuration was type IV (41.4%), while distal root canal showed prevalence of type I in all study samples.

Other data was recorded by **Ahmed et al.,**[25]. They studied the root canal morphology of mandibular molars in Sudanese population using the clearing and staining method. The investigators have concluded that the mesial root canal configuration was type IV (73%) and type II (14%), while the distal root canal was type I (38%) and type II (28%).

Regarding the cusp heights:

In our study we found that the heights of the mesiobuccal cusps of maxillary and mandibular first molars had the highest mean values. Similarly, in Japanese population, permanent molars, the height of the hypoconid in permanent molars had a mean value equivalent to that of the upper trigonal cusps, indicating that upper and lower functional cusps of the same height articulate with each other [52].

It's worth mentioning that many studies have been recently focusing on Egyptian population regarding morphological and structural variation through different perspectives using CBCT. **Hend El-Messiry et al.,**[53] conducted a study on the presence of variations in crown and root measurements in deciduous teeth. On the same way **Mohammed E. Rokaya et.al,** [54] detected the middle mesial canals (MMCs) prevalence in mandibular 1st molars, its configuration type and its percentage of incidence with age. They founded that, the MMCs prevalence in mandibular 1st molars among some Egyptian population was 10.79 %, and CBCT scan is helpful way to detect the presence of MMCs.

CONCLUSIONS

Crowns of both maxillary and mandibular first molars are significantly larger in all dimensions than maxillary and mandibular second molars respectively, CBCT is useful in determining variation in root canal configuration. The most prevalent root canal configuration of MB root of maxillary molars is type I. Meanwhile, the most prevalent configuration for the mesial root of mandibular molars is type II. The closest prevalence to our study was Nepal and North American population regarding crown dimensions and the south Indian population regarding root canal configurations.

RECOMMENDATIONS

Further studies are recommended to include larger sample size from different regions throughout Egypt for comparative purposes.

REFERENCES

1. Nayak R, Kotrashetti V, Nayak A, Patil V, Kulkarni M, Somannavar P,: Maxillary and mandibular first premolars showing three-cusp pattern: an unusual presentation. Case Reports in Dentistry; Article ID 734143: 4 Pages, 2013.
2. Kraus BS, Jordan RE. The human dentition before birth. Philadelphia: Lea and Febiger; 1965.
3. Osborn HF. Trituberculy in relation to the human molar teeth and primates. Evolution of mammalian molar teeth to and from the triangular type. New York: Macmillan;. p-48-65,1907.
4. Agnihotri, G. and Sikri, V. Crown and cusp dimensions of the maxillary first molar: a study of sexual dimorphism in Indian Jat Sikhs. Dental Anthropology Journal, 23(1), pp.1-6, 2010.
5. Sharma, P., Singh, T., Kumar, P., Chandra, P.K. and Sharma, R., Sex determination potential of permanent maxillary molar widths and cusp diameters in a North Indian population. journal of orthodontic science, 2(2), p.55-60. 2013.

6. Gregory WK. Studies on the evolution of the primates-part i the cope-osborn "theory of trituberculy" and the ancestral molar patterns of the primates. Bulletin of the American Museum of Natural History, 35:239-55, 1916.

7. Hellman M. Racial characters of human dentition. Proceedings of the American Phylosophical Society.; 67:15774, 1928.

8. Nayef H. Felemban and Bhari S. Manjunatha: Prevalence of the number of cusps and occlusal groove patterns of the mandibular molars in Saudi Arabian population. J Forensic Leg Med. (49): 54-58, 2017.

9. de Pablo OV, Estevez R, Péix Sánchez M, Heilborn C, Cohenca N. Root anatomy and canal configuration of the permanent mandibular first molar: A systematic review. J Endod;36:1919-31, 2010.

10. Manning SA. Root canal anatomy of mandibular second molars. Part II. C-shaped canals. Int Endod J;23:40-5, 1990.

11. Melton DC, Krell KV, Fuller MW. Anatomical and histological features of C-shaped canals in mandibular second molars. J Endod;17:384-8,1991.

12. Al-Fouzan KS. C-shaped root canals in mandibular second molars in a Saudi Arabian population. Int Endod J;35:499-504,2002.

13. Fernandes M, de Ataide I, Wagle R. C-shaped root canal configuration: A review of literature. J Conserv Dent;17:312-9, 2014.

14. Fan B, Chen WX, Fan MW. Configuration of C-shaped canals in mandibular molars in Chinese population. J Dent Res;80:704,2001.

15. Vertucci, F.J.: Root canal anatomy of the human permenant teeth. Oral Surgery Oral medicine and Oral Pathology. 58: 589–99, 1984.

16. Patel S, Dawood A, Ford TP, Whaites E. The potential applications of cone beam computed tomography in the management of endodontic problems. Int Endod J;40:818-30, 2007.

17. Zitong Lin, Qingang Hu, Tieme Wang, Jiuyu Ge, Shu Liu, Min Zhu, Shanhui Wen. Use of CBCT to investigate the root canal morphology of mandibular incisors. Surgical and Radiologic Anatomy,36,877-882,2014.

18. Zhang R, Wang H, Tian YY, Yu X, Hu T, Dummer PM. Use of cone-beam computed tomography to evaluate root and canal morphology of mandibular molars in Chinese individuals. Int Endod J. 2011;44:990–9.

19. Gulabivala, K., Opasanon, A., Ng, Y.-L. and Alavi, A.: Root and canal morphology of Thai mandibular molars International Endodontic Journal. 56–62, 2002.

20. Agrawal, A., Manjunatha, B.S., B Dholia, B. and Yousef Althomali, Y.: Comparison of sexual dimorphism of permanent mandibular canine with mandibular first molar by odontometrics. Journal of Forensic Dental science. 7(3)238-243, 2015.

21. Jensen E, Kai-Jen Yen P, Moorrees CF, Thomsen SO. Mesiodistal crown diameters of the deciduous and permanent teeth in individuals. J Dent Res.;36:39–47, 1957.

22. Shintara Konodo, Grant C Townsend, and Hiroyuki Yamada : Sexual dimorphism of cusp dimensions in human maxillary molars, American Journal of Physical Anthropology 128(4),870-877,2005.

23. Al-Shehri S. A.-N. S., Shoukry S., Al-Shwaimi E., Al-Sadhan R. A.-S. B. Root and canal configuration of the maxillary first molar in a Saudi subpopulation: a cone-beam computed tomography study. Saudi Dental Journal ;7:69–76,2019.

24. Kieser, J.A. and Van Der Merwe C.A.: Classificatory reliability of the Carabelli trait in man. Arch. Oral. Biol. 29:795-801, 1984.

25. Ahmed H.A., Abu-bakr N.H., Yhia N.A. and Ibrahim Y.E.: Root and root canal morphology of permanent mandibular molars in a Sudanese population. International Endodontic Journal 40:766-712, 2007.

26. Hasund, A. and Bang, G.: Morphologic Characteristics of the Alaskan Eskimo Dentition: IV Cusp Number and Groove Patterns of Mandibular Molars. American Journal of Physical Anthropology. 67:65-69 1985.

27. Loh, H.S.: Mongoloid features of the permanent mandibular second molar in Singaporean Chinese. Aust. Dent. J. 36:442-4, 1991.

28. Hunter, W.S. and Priest, W.R.: Errors and discripancies in measurement of tooth size. J. Dent. Res. 39:405-14, 1960.

29. Richardson, E.R. and Malhotra, S.K. Mesiodistal crown dimension of the permanent dentition of American Negroes. American journal of orthodontics, 68(2), pp.157-164, 1975.

30. Brook, A.H., Griffin, R.C., Townsend, G., Levisianos, Y., Russell, J. and Smith, R.N. Variability and patterning in permanent tooth size of four human ethnic groups. Archives of oral biology, 54, pp.S79-S85, 2009.

31. Khan, S.H., Gazi, S.H., Tanzila, R., Hasan, N. and Russell, S.H.: Mesiodistal crown dimension of permanent teeth in Bangladeshi population. Bangabandhu Sheikh Mujib Medical University Journal. 4(2)81-87, 2011.

32. Jaiswal, A.K., Parajuli, U., Bajracharya, M. and Singh, B., 2020. Mesio-distal crown width in permanent dentition amongst adolescent population of Province II of Nepal. Journal of Gandaki Medical College-Nepal, 13(1), pp.51-55, 2020.
33. Kalender, A., Celikten, B., Tufenkci, P., Aksoy, U., Basmacı, F., Kelahmet, U. and Orhan, K., 2016. Cone beam computed tomography evaluation of maxillary molar root canal morphology in a Turkish Cypriot population. Biotechnology & Biotechnological Equipment, 30(1), pp.145-150, 2016.
34. Betancourt, P., Navarro, P., Cantín, M. and Fuentes, R. Cone-beam computed tomography study of prevalence and location of MB2 canal in the mesiobuccal root of the maxillary second molar. International journal of clinical and experimental medicine, 8(6), p.9128, 2015.
35. Al-Qudah A.A., Awawdeh L. A. Root and canal morphology of mandibular first and second molar teeth in a Jordanian population. Int. Endod. J. 42: 775- 784, 2009.
36. Wang, Y., Zheng, Q., Zhou, X., Tang, L., Wang, Q., Zheng, G.and Huang, D.: Evaluation of the Root and Canal Morphology of Mandibular First Permanent Molars in a Western Chinese Population by Cone-Beam Computed Tomography. J Endod. 36:1786-1789, 2010.
37. Pécora, JB Woelfel MD Sousa Neto, and EP Issa:Morphologic study of the maxillary molars. Part II internal anatomy.Braz Dent J.; 3(1): 53-7, 1992.
38. Al-Nazhan, S. The prevalence of two canals in mesial root of endodontically treated maxillary first molars among a Saudi Arabian sub-population. Saudi Dental Journal.; 17: 15-21, 2005.
39. Rwenyonyi, C.M., Kutesa, A.M., Muwazi, L.M. and Buwembo, W., 2007. Root and canal morphology of maxillary first and second permanent molar teeth in a Ugandan population. International Endodontic Journal, 40(9), pp.679-683, 2007.
40. Pattanshetti, N., Gaidhane, M. and Al Kandari, A.M., 2008. Root and canal morphology of the mesiobuccal and distal roots of permanent first molars in a Kuwait population–a clinical study. International Endodontic Journal, 41(9), pp.755-762, 2008.
41. Zheng, Q.H., Wang, Y., Zhou, X.D., Wang, Q., Zheng, G.N. and Huang, D.M. A cone-beam computed tomography study of maxillary first permanent molar root and canal morphology in a Chinese population. Journal of endodontics, 36(9), pp.1480-1484, 2010.
42. Lee, J.H., Kim, K.D., Lee, J.K., Park, W., Jeong, J.S., Lee, Y., Gu, Y., Chang, S.W., Son, W.J., Lee, W.C. and Baek, S.H. Mesiobuccal root canal anatomy of Korean maxillary first and second molars by cone-beam computed tomography. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology, 111(6), pp.785-791, 2011.
43. Al-Fouzan, K.S., Ounis, H.F., Merdad, K. and Al-Hezaimi, K. Incidence of canal systems in the mesio-buccal roots of maxillary first and second molars in Saudi Arabian population. Australian Endodontic Journal, 39(3), pp.98-101, 2013.
44. Neelakantan P., Subbarao C., Ahuja R., Subbarao C. V. Root and canal morphology of Indian maxillary premolars by a modified root canal staining technique. Odontology ;99(1):18–21, 2011.
45. Nayak G, Singh KK, Shekhar R. Endodontic management of a maxillary first molar with three roots and seven root canals with the aid of cone-beam computed tomography. Restor Dent Endod;40:241–8, 2015.
46. Andrews L. F.: The six keys to normal occlusion. American Journal of Orthodontics. 62: 296-309, 1972.
47. Anderson, A.A.: Dentition and occlusion development in African American children: Mesiodistal crown diameters and tooth size ratios of primary teeth. Pediatr. Dent. 27(2):121-128, 2005.
48. Smith, P., Brown, T. AND Wood, W.B.: Tooth Size and Morphology in a Recent Australian Aboriginal Population From Broadbeach, South East Queensland. American Journal of Physical Anthropology. 55:423 -432, 1981.
49. Bishara, S.E., Jakobsen, J.R., Abdallah, E.M. and Garcia, A.F.: Comparisons of mesio-distal and bucco-lingual crown dimensions of the permanent teeth in three populations from Egypt, Mexico and the United States. Am. J. Orthod. & Dentofac. Orthoped.96:416-22, 1989.
50. Ash M.M. and Nelson S.J.: Wheeler's dental anatomy, physiology and occlusion p.32,45,53, Philadelphia, PA: A.B. Saunders (2010).
51. Singh, S.P. and Goyal, A.: Mesiodistal crown dimensions of the permanent dentition in North Indian children. J. Indian Soc. Pedod. Prev. Dent. 24 (4):192-6, 2006.
52. Sekikawa, M., Kanazawa, E. and Ozaki, T. Cusp height relationships between the upper and lower molars in Japanese subjects. Journal of Dental Research, 67(12), pp.1515-1517, 1988.
53. Hend El-Messiry and Iman Alaa. Morphometric Analysis Comparing Human Mandibular Deciduous Molars using Cone Beam Computed Tomography. Contemporary Clinical Dentistry 12(2):133-137, 2021
54. Mohammed E. Rokaya, Wael Hussein Kamel, Khalid S Hassan. Middle Mesial Canals Prevalence percentage and Its Configuration type Among Some Egyptian Population by CBCT, 05 May 2022, PREPRINT (Version 1) available at Research Square [https://doi.org/10.21203/rs.3.rs-1455902/v1]