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ROOT-CROWN RATIO AND ROOT CANAL CONFIGURATION OF EGYPTIAN PRIMARY MOLARS SAMPLE USING CBCT AND CLEARING TECHNIQUE: AN INVITRO STUDY

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ABSTRACT

Background*:* The study of dental morphological characteristics is essential in research as it can provide information about diversities within a population and can also aid in clinical practice.

Aim*:* This work aimed to study the size and root canal morphology of primary molars in a sample of the Egyptian population.

Materials and Methods*:* Eighty primary molars were randomly selected from extracted teeth in children seeking dental treatment. The following measurements were performed: the crown height, root length, root trunk length from the buccal aspect, R/C ratio and mesiodistal dimension of the crown at the contacts. Whereas, the root canal morphology was studied using cone beam computed tomography and clearing technique. Statistical analysis of the previous data was tabulated.

Results: The mean mesiodistal crown width of deciduous mandibular first molar was 7.64mm, while that of the maxillary was 6.76mm respectively. It was found that the mean R/C ratio for the deciduous mandibular first molar was 1.45, while that of the maxillary was 1.58. As for the mean mesiodistal crown width of deciduous mandibular second molar was 9.71mm, while that of the maxillary the mean was 8.36mm respectively. Regarding R/C ratio, the mean R/C in the mandibular second molar was 1.79, while for the maxillary the mean was 1.74. The most common canal configuration for deciduous mandibular first molar is type IV in the mesial root and type I in the distal. Type II was the most relevant in the MB root of a deciduous maxillary first molar. Meanwhile, type I was the most common in the DB and type I in the palatal. Deciduous mandibular second molar showed type II and IV as the most common canal configurations in the mesial root and type IV in the distal. As for the maxillary deciduous second molar, type IV was the most common in the MB and DB roots and type I and IV in the palatal roots.

Conclusions: Morphological characteristics of primary molars in a sample of Egyptian population were consistent with those of other studies performed in different communities using a similar methodology.

Keywords: primary molars-root canal morphology-CBCT-Clearing technique

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INTRODUCTION

Dentition of humans appears to be undergoing evolutionary changes that vary between races and between individuals of the same race (Dahlberg, 1945). The final tooth form is known to represent an interaction between its developmental process, genetic and environmental factors. "Dental structures useful for identification purposes include cusp size, number and location of cusps, occlusal pattern, root configuration, number and arrangement of teeth, and individual tooth measurements" (Sharma, 1983; Loh, 1991).

In a study conducted by Gouse and Lee, (1971), they reported that dental characteristics, such as shape, size, presence, number of cusps are also genetically determined. In another study done by ***Smith et al., (1981)*** on the tooth size and morphology in Australian Population, the researchers have found that local adaptations to differences in environmental conditions, rather than gene flow, may account for differences in tooth size within Australian population.

Also, numerous variations in dental anatomy and morphology of each tooth can help in performing many dental procedures such as restorative, endodontic and orthodontic treatments. ***(Jordon et al., 1992; Ash and Nelson, 2003)***.

Tooth size is a determinant of normal occlusion because the mesiodistal crown width of maxillary and mandibular teeth must harmonise closely to allow proper interdigitation. Also, tooth size must be in harmony with dental arch size to allow adequate alignment ***(Moorrees and Reed, 1954).*** Mesiodistal width of teeth is a basic fundamental to which an orthodontist has to deal with in the clinical ***(Bolton, 1958).***

The mesiodistal widths of teeth were first formally investigated by G.V. Black in 1902 ***(Koora et al., 2010)***. ***Santoro et al., (2000)*** stated that: "One of the most critical factors in dental arch development and the relation of the arches to one another is the mesiodistal width of the tooth"**.** Thus, the size of individual tooth and groups of teeth is essential for the clinician to make an adequate diagnosis and treatment plan ***(Singh and Goyal, 2006).***

All teeth have two general sections, the crown and the root. While the crown is covered with enamel, the root is covered with cementum. The line at which these two sections join is called the cement-enamel junction. In a healthy gingival condition, the roots of teeth are entirely embedded in the alveolar bone which is covered by the soft tissue. The crown which exists solely outside of the surrounding bone is somewhat obscured at the apical millimetre or so by marginal gingiva. Therefore, crown and root can be used as anatomical terms, defining the actual parts of a tooth**.**

Root to crown (R/C) ratio determines the root length in relation to the crown length. Root length is considerably longer than crown length, and this allows for proper support of the teeth during normal function. ***(Newman et al., 2002).*** Short rooted teeth with low R/C ratios are effective in the prognosis and treatment planning of many dental procedures ***(Hölttä et al., 2004).***

Regarding the pulp cavity; it is divided into the pulp chamber and the radicular canals located into the dental root. The radicular canal which is a continuation of the pulp chamber opens to the periodontal membrane space by an apical foramen and occasionally accessory foramina ***(Perlich et al., 1981).***

An in vitro study of root and canal morphology of human deciduous molars was done in an Iranian population. This study revealed that deciduous molars showed variability in the number of roots and root canals, and differed in mean root length and angulation ***(Bagherian et al., 2010)***.

Margarit and Andrei, (2011) stated that teeth do not always have the same anatomy. The anatomical variations in the number of roots, number of root canals, and even the shape of root canals are often encountered. Moreover, studying dental morphology implies the process of registration, analysis, and understanding of all information concerning the coronal and radicular morphology of teeth which appear among populations (***Marcovich, 2012***). The variations in the root anatomy are commonly reported than those in the crown morphology. So, it is essential to study the root and root canal anatomy due to its endodontic significance ***(Vertucci, 1984)***.

The number and type of root canals were categorised into eight classes according to Vertucci's classification as follows, ***Type I:*** A single canal is present from the pulp chamber to the apex. ***Type II:*** Two separate canals leave the pulp chamber, but join to form one canal to the site of exiting. ***Type III:*** One canal leaves the pulp chamber, divides into two within the root, and then merges to exit in one canal. ***Type IV:*** Two separate and distinct canals are present from the pulp chamber to the apex. ***Type V:*** Single canal leaving the pulp chamber but dividing into two separate canals with two separate apical foramina. ***Type VI:*** two separate canals leave the pulp chamber, merge within the body of the root and redivide short of the apex to exit as two distinct canals. ***Type VII:*** one canal leaves the pulp chamber, divides and then rejoins within the body of the root and finally redivides into two distinct canals short of the apex. ***Type VIII:*** three separate canals extend from the pulp chamber to the apex.

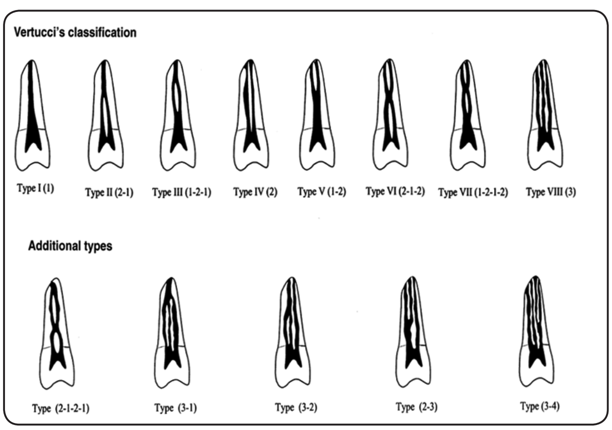

Fig. (1) Classification of root canal system types ***(Gulabivala et al., 2002)***.

CBCT is a well known diagnostic tool for evaluation of root canals, especially in curved roots. ***Zhang et al., 2011*** studied the root canal morphology of mandibular first and second permanent molars in a Chinese population using CBCT. While, ***Vijayakumar et al., 2013*** studied the root canal morphology of human primary maxillary molars in Indian population using spiral computed tomography. High-resolution computed tomography (μCT) was used to construct three-dimensional (3D) images for the morphology of root canal systems of primary molars ***(Wang et al., 2013)***. The photos showed the complexity of the root canals of the primary molars and also several capabilities of the CT Scan in advanced research ***(Zormchhing et al.,2005)***.

The clearing technique aids in better visualisation of the morphology of the root canals and is considered a simple and inexpensive method. In 1980 Don Robertson et al., (1980) used the clearing technique to study root canal systems in endodontically treated teeth. Hua et al.,2011 studied the root canal morphology in Chinese children, through a transparent specimen of a set of deciduous teeth, the shape of root canals was observed under a stereomicroscope.

However, the prevalence of dental characteristics regarding tooth size and the various configuration of root canals in Egyptian primary molars have not been sufficiently highlighted, that's why the present work aimed to record and evaluate these parameters in a sample of primary molars in Egyptian children.

Aim of the Study

The present work aimed to record variations in the tooth size and variations in root canal morphology in a sample of Egyptian primary molars using Cone Beam Computed Tomography (CBCT) and Clearing Technique respectively. The research question can be formulated in PICO format as:

Population: Maxillary and mandibular primary molars

Outcomes:

Mesiodistal crown width

Root/Crown ratio

Root canal configuration, according to Vertucci's classification

MATERIALS AND METHODS

Sample Collection

A total of 68 primary molars were randomly selected from extracted teeth in children seeking dental treatment in a private clinic; mandibular first primary molar (n=17), mandibular second primary molar (n=17), maxillary first primary molar (n=17) and maxillary second primary molar (n=17). Signed consent was obtained from their parents. The inclusion criteria of the selected teeth were intact roots with minimal signs of resorption, minimal occlusal decay and without fillings. Teeth were fixed in 10% formaldehyde and were then washed with 3% sodium hypochlorite to remove any remaining soft tissues. Then, teeth were dried to be ready for inspection.

Recording sizes of teeth

External morphological observations of the teeth were done, where each tooth was measured in the following dimensions:

a) *Crown height:* Distance between the mesiobuccal cusp tip and the cementoenamel junction (CEJ) on the buccal surface.

b) Root length: Distance between the CEJ on the buccal surface and the highest point on the root apex. Both crown height and root length were measured according to the methodology by (***Lind, 1972)***.

c) Root trunk length from the buccal aspect: This was measured from the CEJ in the middle of the buccal surface till the beginning of the bifurcation.

d) R/C ratio was calculated by dividing root length by crown length.

e) Mesiodistal dimension at the contact areas

Measurements were recorded manually by a single examiner using a digital calliper (Aragwal et al., 2015). These measurements were performed by holding each tooth vertically and placing the blades of the calliper on the molars' contact points with the blade's proximal sides parallel to the long axis of the tooth (Sonbol et al., 2011).

Each molar was measured three separate times, and then the mean value of the measurements was used. Different recording sheets were used at each time to ensure no access to the previous measurements ***(Huang et al., 2012)***. If there was a discrepancy greater than 0.2 millimetres (mm) between the recordings, the measurements were discarded, and a new set was done (***Sridhar et al., 2011***). These recordings were also confirmed using cone beam computed tomography (CBCT).

Fig. (2): A digital calliper with the blades on the proximal sides parallel to the long axis of the tooth

Morphology of the root canals

This was done using CBCT and canal clearing and staining technique.

CBCT: Molds into which the samples were placed, were submitted for CBCT scan using an i-Cat Scanner at the Faculty of Dentistry, Ain Shams University. The teeth were aligned in rows leaving arbitrary 0.5 cm in between. The machine was supplied with amorphous silicon flat panel sensor with cesium iodide scintillator. A focal spot size 0.5mm, a 14-bit gray scale resolution and a 120 Kv peak were used with a field of 8 cm height and 8 cm diameter. A line was drawn following the curvature of each root, then the images of canal configuration were determined. For images evaluation, the brightness and contrat were adjusted using the image processing tool in the software to ensure optimal visualisation.

CBCT images were evaluated continuously by moving the toolbar from the floor of the pulp chamber to the apex to determine the number of root canals as shown in figure (3).

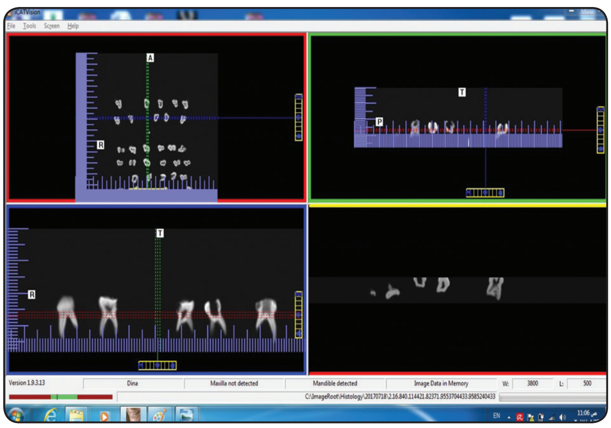

Fig. (3): CBCT images are showing how the root canals were evaluated.

b) Clearing Technique (Fig. 4): Access cavities were prepared, and the pulp tissue was extirpated using 5.25% sodium hypochlorite solution. Teeth were stored in 5% nitric acid for decalcification. They were then washed under running water and placed in increasing concentrations of ethyl alcohol. Teeth were rendered evident by immersing them in methyl salicylate solution for three days until they were completely transparent. Following this procedure, India Ink was injected into the root canals, and the number of root canals in each root was recorded. ***(Don Robertson et al.,1980)***.

Statistical analysis

Data were statistically analysed using Fisher exact test, pairwise comparison and t-test.

RESULTS

1- Recording the sizes of teeth

The mean mesiodistal crown width of deciduous mandibular first molar was 7.64mm, while that of the maxillary was 6.76mm respectively. It was found that the mean R/C ratio for the deciduous mandibular first molar was 1.45, while that of the maxillary was 1.58.

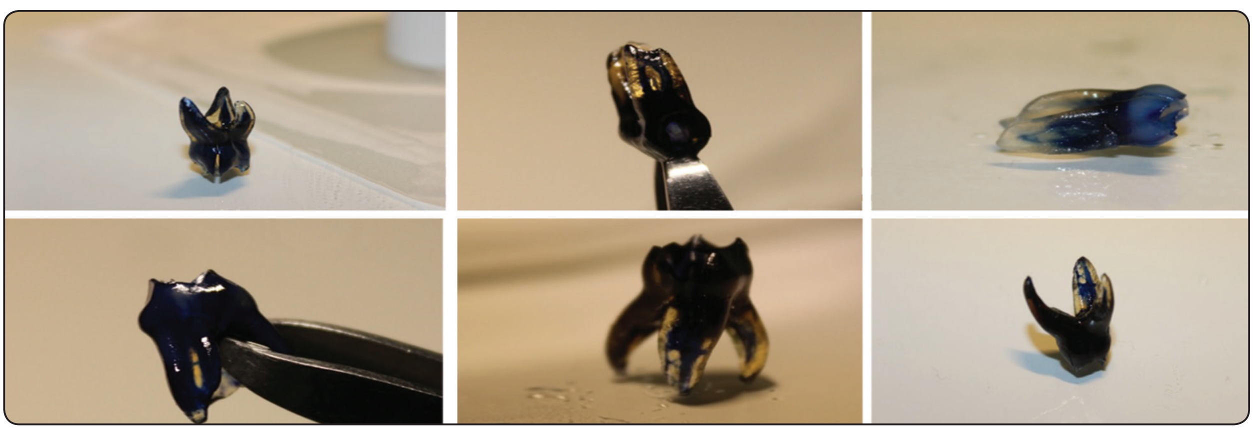

Fig. (4): Showing clearing in different deciduous molars

TABLE (1): The mean and standard deviations of different measurements of deciduous lower first molar

	Min	**Max.**	**Mean**	**±SD**	**SE**
Lower D crown height	4.88	7.10	6.18	0.56	0.15
Root Length	7.08	9.97	8.91	0.88	0.24
R/C	1.19	1.75	1.45	0.17	0.05
Trunk height	0.83	2.80	1.57	0.53	0.14
MD dimension	6.75	8.11	7.46	0.42	0.11

TABLE (2): The mean and standard deviation of various measures of deciduous upper first molar

	Min	**Max.**	**Mean**	**±SD**	**SE**
Upper D crown height	3.42	6.05	5.33	0.67	0.18
Root Length	7.20	10.60	8.22	0.79	0.21
C/R	1.29	2.20	1.58	0.25	0.07
Trunk height	0.96	2.40	1.69	0.33	0.09
MD dimension	6.24	7.79	6.76	0.48	0.13

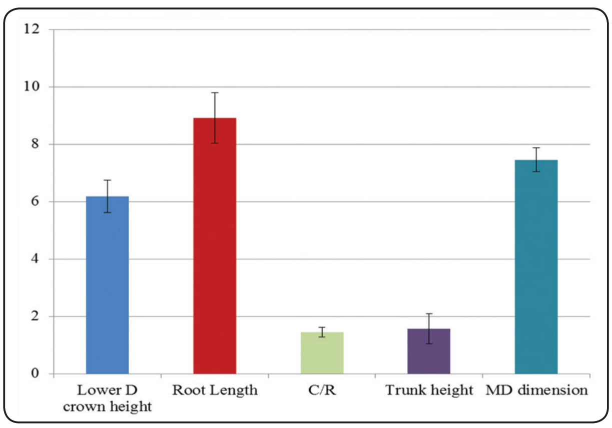

Fig. (5): Bar chart showing different measurements of deciduous lower first molar

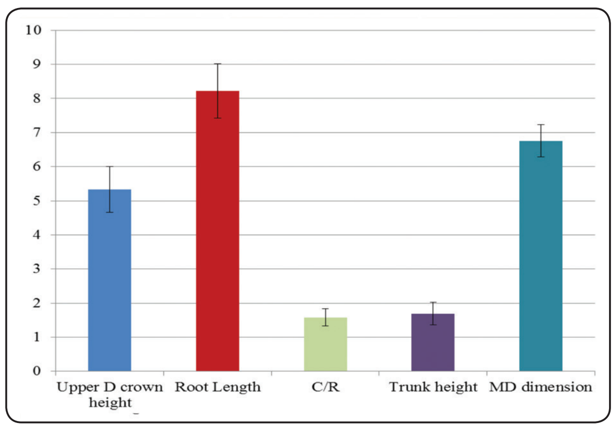

Fig. (6): Bar chart showing different measurements of deciduous upper first molar

As for the mean mesiodistal crown width of deciduous mandibular second molar was 9.71mm, while that of the maxillary the mean was 8.36mm respectively. Regarding R/C ratio, the mean R/C in the mandibular second molar was 1.79, while for the maxillary the mean was 1.74.

TABLE (3): The mean and standard deviation of different measurements of deciduous lower second molar

	Min	**Max.**	**Mean**	**±SD**	**SE**
Lower E crown height	5.25	6.47	5.81	0.38	0.10
Root Length	8.14	11.64	10.42	0.96	0.25
C/R	1.42	2.10	1.79	0.22	0.06
Trunk height	0.56	3.04	1.94	0.70	0.18
MD dimension	8.94	10.68	9.71	0.65	0.17

TABLE (4): The mean and standard deviation of various measurements of deciduous upper second molar

	Min	**.Max**	**Mean**	**SD±**	**SE**
Crown height upper E	5.03	6.96	5.84	0.50	0.13
Root length	8.11	12.65	10.08	1.31	0.35
C/R	1.25	2.24	1.74	0.27	0.07
Trunk height	1.25	2.50	1.85	0.41	0.11
MD dimension	7.08	9.79	8.36	0.66	0.18

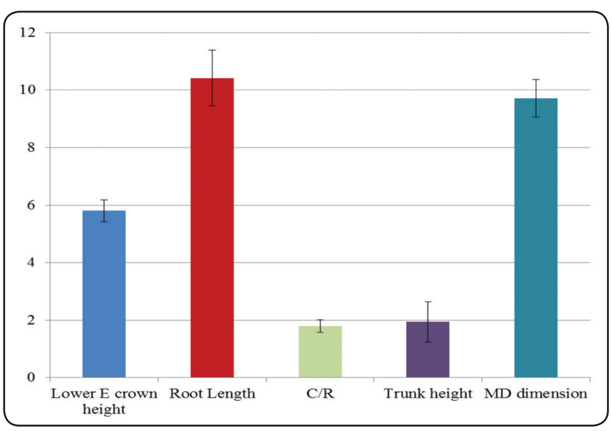

Fig. (7): Bar chart showing different measurements of deciduous lower second molar

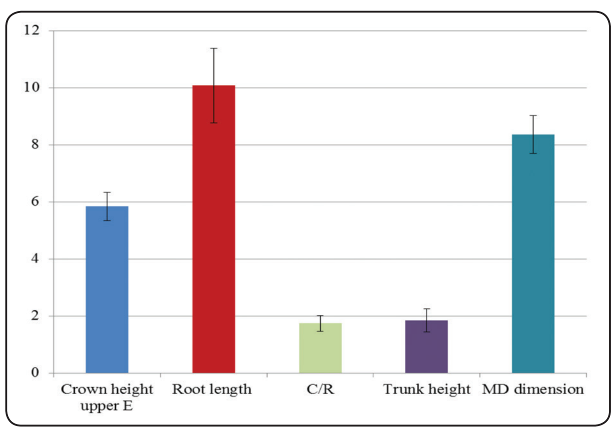

Fig. (8): Bar chart showing different measurements of deciduous upper second molar

2- Morphology of root canals

Cone Beam Computed Tomography

Cone beam computed tomography revealed the following root canal configurations, according to Vertucci's classification. Regarding the mesial roots of lower deciduous first molars, type IV showed the most common canal configuration with a percentage of 64.7%. As for the distal roots of lower deciduous first molars, type I showed the most common canal configuration with a percentage of 41.2 %. Regarding the mesiobuccal roots of upper deciduous first molars, type II revealed the most common canal configuration with a percentage of 70.6%.

While regarding the distobuccal roots of upper deciduous first molars, type I showed the most common canal configuration with a percentage of 52.9%. As for the palatal roots of upper deciduous first molars, type I showed the most common canal configuration with a percentage of 58.8%. The previous results are shown in the table (5).

TABLE (5): Prevalence and percentages of root canals configurations in lower and upper deciduous first molars using CBCT

	I	II	IV	V	VIII
Lower D					
Mesial root	4 (23.5%)	2 (11.8%)	11 (64.7%)	0 (0.0%)	0 (0.0%)
Distal root	7 (41.2%)	4 (23.5%)	5 (29.4%)	1 (5.9%)	0 (0.0%)
Upper D					
MB root	4 (23.5%)	12 (70.6%)	0 (0.0%)	0 (0.0%)	1 (5.9%)
DB root	9 (52.9%)	0 (0.0%)	8 (47.1%)	0 (0.0%)	0 (0.0%)
Palatal root	10 (58.8%)	0 (0.0%)	7 (41.2%)	0 (0.0%)	0 (0.0%)

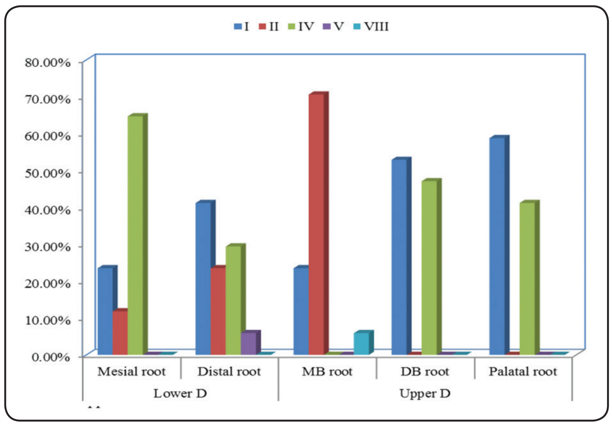

Fig (9): Bar chart is representing percentages of root canal types in lower and upper deciduous first molars.

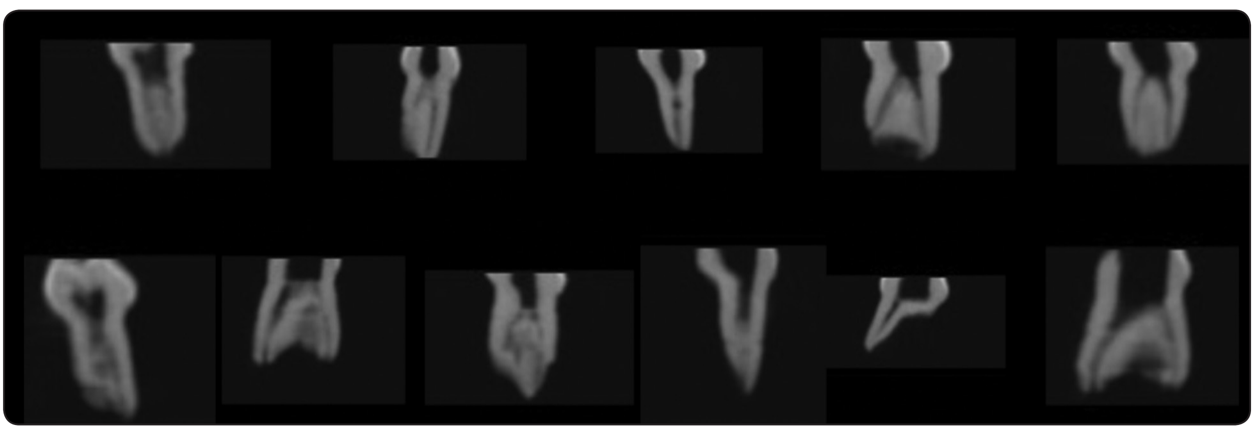

Fig.(10): CBCT showing: type II mesial root lower D, type IV medial root lower, type I distal root lower D, type IV distal root lower D, type V distal root lower D, type IV mesiobuccal upper D, type VIII MB upper D, type I DB upper D, type I and type IV palatal upper D

Regarding the mesial roots of lower deciduous second molars, type II & IV showed the most common canal configurations equally with a percentage of 41.2%. As for the distal roots of lower deciduous second molars, type IV was the most common canal configuration (52.9 %). The mesiobuccal roots of upper deciduous second molars showed type IV canal configuration with a percentage of 47.1%. Regarding the distobuccal roots of upper deciduous second molars, type IV revealed the most common canal configuration with a percentage of 47.1%. As for the palatal roots of upper deciduous second molars, type I & IV was the most common canal configurations (41.2 %). The previous results are shown in the table (6).

TABLE (6): Prevalence and percentages of root canals configurations in lower and upper deciduous second molars using CBCT

	I	II	IV	Non-VERTUCCI
Lower E				
Mesial root	2 (11.8%)	7 (41.2%)	7 (41.2%)	1 (5.9%)
Distal root	2 (11.8%)	6 (35.3%)	9 (52.9%)	0 (0.0%)
Upper E				
MB root	7 (41.2%)	2 (11.8%)	8 (47.1%)	0 (0.0%)
DB root	5 (29.4%)	4 (23.5%)	8 (47.1%)	0 (0.0%)
Palatal root	7 (41.2%)	3 (17.6%)	7 (41.2%)	0 (0.0%)

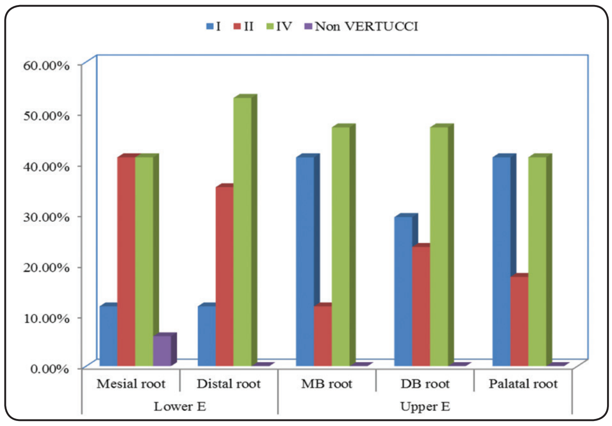

Fig (11): Bar chart is representing percentages of root canal types in lower and upper deciduous second molars.

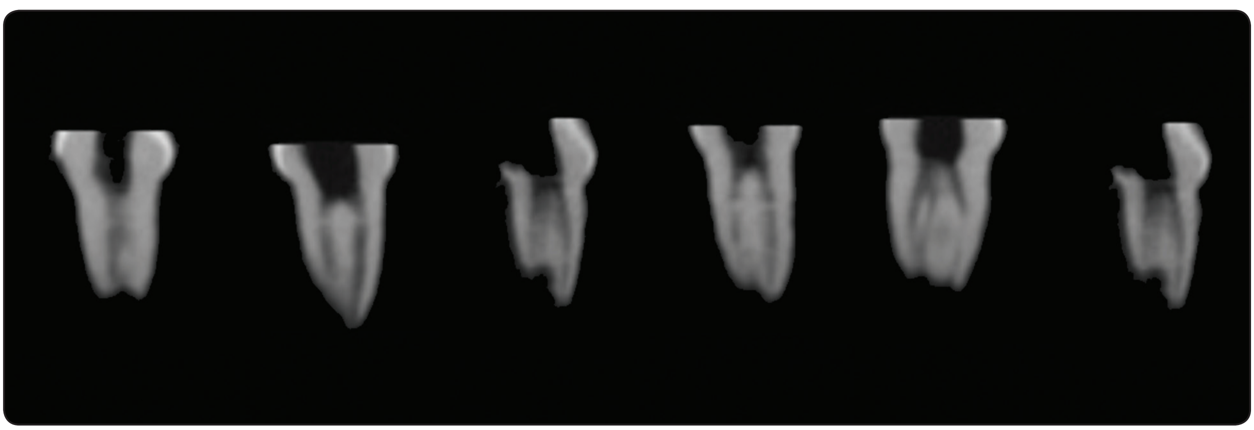

Fig (12): CBCT showing type I & type II mesial root lower E, type IV mesial root lower E, Non-Vertucci mesial root lower E & type II distal root lower E

TABLE (7): Comparison of percentages of root canal types in lower and upper deciduous first and second molars.

	I	II	IV	V	VIII	Non VER-TUCCI	x2	p-value
Mesial root								
Lower D	4(23.5%)	2(11.8%)	11(64.7%)	0(0.0%)	0(0.0%)	0(0.0%)	5.333	0.149
Lower E	2(11.8%)	7(41.2%)	7(41.2%)	0(0.0%)	0(0.0%)	1(5.9%)		
Distal root								
Lower D	7(41.2%)	4(23.5%)	5(29.4%)	1(5.9%)	0(0.0%)	0(0.0%)	5.321	0.150
Lower E	2(11.8%)	6(35.3%)	9(52.9%)	0(0.0%)	0(0.0%)	0(0.0%)		
MB root								
Upper D	4(23.5%)	12(70.6%)	0(0.0%)	0(0.0%)	1(5.9%)	0(0.0%)	16.961	<0.001
Upper E	7(41.2%)	2(11.8%)	8(47.1%)	0(0.0%)	0(0.0%)	0(0.0%)		
DB root								
Upper D	9(52.9%)	0(0.0%)	8(47.1%)	0(0.0%)	0(0.0%)	0(0.0%)	5.143	0.076
Upper E	5(29.4%)	4(23.5%)	8(47.1%)	0(0.0%)	0(0.0%)	0(0.0%)		
Palatal root								
Upper D	10(58.8%)	0(0.0%)	7(41.2%)	0(0.0%)	0(0.0%)	0(0.0%)	3.529	0.171
Upper E	7(41.2%)	3(17.6%)	7(41.2%)	0(0.0%)	0(0.0%)	0(0.0%)		

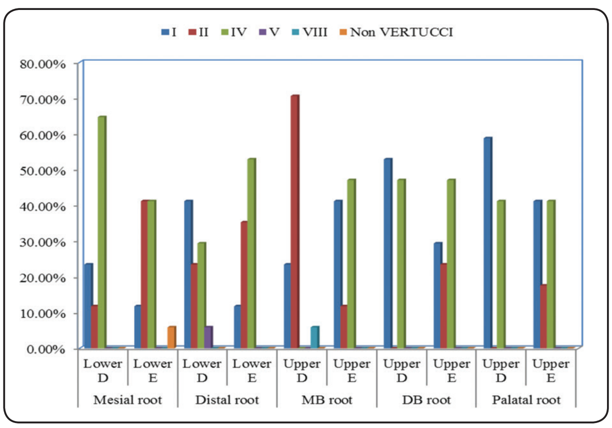

Fig (13): Bar chart is representing comparison of percentages of root canal types in lower and upper deciduous first and second molars.

DISCUSSION

There are different degrees of expression, frequency and variation of teeth in dentitions among different populations ***(Kieser and Van der Merwe, 1984)***. The majority of dental anatomy books fail to supply enough information for the features of root and root canal morphology that may be unique to African populations **(Gulabivala *et al., 2002; Ahmed et al., 2007*)**. The final tooth form represents the sum of its genetic endowment and long-term environmental influences ***(Mosharraf et al., 2010)***

Intimate knowledge of the internal and external morphology of each primary tooth is required would be helpful in the success of endodontic treatment. Thorough understanding of the dental anatomy of primary dentition is essential for all treatment aspects. The primary cause of failure of pulpectomy is an inability to recognise and therefore adequately treat all the canals of the root canal system ***(Ozcan et al., 2016)***

Regarding Mesio-distal crown width:

It is essential to measure the mesiodistal crown width in human populations as it is crucial in clinical dentistry, anthropology and anatomy. In orthodontics, the diagnosis and treatment of malocclusions require accurate knowledge of tooth mesiodistal crown width as the stable occlusion is reliant on the correct intercuspation of the teeth ***(Andrews, 1972)***. A digital calliper was used for measurement of mesiodistal width because of its accuracy. It eliminates measurement transfer and calculations errors ***(Hunter and Priest, 1960).***

Our study on a sample of Egyptian primary molars revealed that the mean mesiodistal crown width of deciduous mandibular first molar was 7.64mm, while that of the maxillary was 6.76mm respectively. As for the mean mesiodistal crown width of deciduous mandibular second molar was 9.71mm, while that of the maxillary the mean was 8.36mm respectively.

Root to Crown ratio:

In the present study, according to ***(Brook and Holt, 1978),*** R/C ratio was done instead of tooth length linear measurement because, in the radiographic examination, alterations in tooth angulations are known to affect the radiographic tooth length, but does not change the R/C ratio. It was found that the mean R/C ratio for the deciduous mandibular first molar was 1.45, while that of the maxillary was 1.58. As for the deciduous mandibular second molar, the mean R/C ratio was 1.79, while for the maxillary the mean was 1.74.

Cone beams computed tomography (CBCT), allow the identification of anatomic features (Mukhaimer***, 2014)***. Two-dimensional images such as periapical radiographs do not allow accurate measurement and may become distorted depending on the angle between the film and the tooth. Panoramic radiographs show vertical magnification, and they are also sensitive to patient positioning, even under optimal conditions ***(Lund et al., 2010).***

Root canal morphology:

One of the reasons why root canal morphology is of clinical importance is the challenges facing clinicians when performing endodontic treatment in molars is the complexity of the root canal systems. Since root canal morphology differs between different populations, separate studies for diverse communities must be done to render reliable results.

Regarding the description of the root canal configuration, Vertucci's classification for a description of root canal morphology was used, also previously employed in similar studies on permanent teeth (***Al-Qudah and Awawdeh, 2009; Wang et al., 2010***). Various methods have been used for studying root canal anatomy; including replication techniques, ground sections, clearing techniques and radiography. Advanced modes of radiographic imaging and analysis have allowed in-depth knowledge about pulp space anatomy in three dimensions ***(Tian et al., 2012).***

For *in vivo* study, conventional radiography is the technique most frequently used. However, this technique has limitations because the images of the roots and root canals always overlap, so it is difficult to see the buccolingual aspect (***Pineda and Kutler., 1972).*** Although an angled view (vertically and horizontally) may be helpful (***Cooke and Cox,1979)*** this is often difficult to achieve, especially with children. Several studies have suggested that CBCT is a good option when studying the root and canal morphology of permanent teeth ***(Zhang et al., 2011; Tu et al., 2009)*** because it can provide information in three dimensions. It is relatively straightforward to determine the root and canal numbers in the horizontal image, so this study provides reliable information about of the occurrence and numbers of canals.

A study was carried by ***(Metska et al.,2014)*** to compare the precision of root canal length determination on cone-beam computed tomographic (CBCT) scans and periapical radiographs (PAs) with the actual root canal length. They found out that root canals of anterior teeth, there was no significant difference between the 2 methods. For root canals of posterior teeth, CBCT images gave results significantly closer to the actual root canal length in comparison with PAs. Root canal length measurements of posterior maxillary teeth were more accurate when assessed by CBCT images than PAs.

CBCT is a non-invasive method compared with the clearing technique. Conventional periapical radiographs provide only two-dimensional images, and in some cases, roots can be superimposed in these images; therefore, they are not beneficial in the evaluation of complex root canal anatomies due to their natural limitations ***(Purra et al., 2013).***

CBCT results of this study showed that type IV was the most relevant root canal configuration in the mesial root of deciduous mandibular first molar 64.7% and type I was the most common in the distal root 41.2%. While, for the maxillary deciduous first molar, type II was the most common in the MB root 70.6%, type I in the DB52.9% and type I in the palatal root 58.8%. These results come in accordance with ***(Bagherian et al.,2010)*** where the mandibular first molars showed Type IV root canal configuration in 81.5% of the mesial roots, while the distal roots showed type I in 77.8% of their sample. While, in our study, type II and IV were equally the most relevant root canal configurations in the mesial root of deciduous mandibular second molar 41.2% and type IV was the most common in the distal root 52.9%. While, for the maxillary deciduous second molar, type IV was the most common in the MB and DB roots 47.1% and type I and IV in the palatal root 41.2%. Unlike, ***Bagherian et al.,2010*** who found that all the maxillary second molars showed Type I root canal configuration in the three roots (MB, DB and Palatal) in 100% of their sample.

Using clearance technique, ***Long M. et al., 2011*** conducted a study on a sample of Chinese primary molars. They reported that maxillary primary molars had three canals and mandibular deciduous molar had four canals, lateral canals and anastomosis between the root canals were popular in deciduous molars which were not concomitant with our results and might be attributed to differences between populations and sample size collection. Also, Wang ***et al., 2013*** reported that in primary molars, numbers of roots and root canals varied from two to four. Maxillary molars exhibited more one-canal than two-canal roots, yet there were equal numbers in mandibular molars. Fusion between the distobuccal and palatal roots in maxillary molars was familiar with a higher prevalence in maxillary first molars.

We can conclude that the term "trait" has been defined as a distinguishing feature, or characteristic of an individual. The frequency of occurrence of a trait may be low in a specific population because that trait is becoming progressively more, or less well developed in that population. So, it is not right to consider this trait as an anomaly and should be considered a characteristic feature of that population. Thus, an anomaly which is regarded as in one population may be a trait in another (Dholia ***and*** Manjunatha***, 2015)***. Further studies are recommended to be done for human dentitions in different communities.

Clinical implications:

The manufacturers of readymade crowns for pediatric dentistry can use the mesiodistal and occlusogingival dimensions when fabricating crowns for Egyptian population.

Root crown ratio can be utilized in cases of pulpectomy. Since most pediatric dentists perform pulpectomy without taking a radiograph to determine the root canal length, it would be beneficial to estimate it by measuring the crown and apply the corresponding R/C ratio on it.

Pediatric dentists should utilise the information regarding the number and configuration of root canals to increase the success rate of pulpectomy cases.

CONCLUSIONS

Egyptian primary molars show diversity in size and configuration of their root canals.

CBCT is a valuable, reliable tool to study the size of teeth and to explore the morphology of root canal systems and can aid in the detection of collaterals or extra canals.

The clearing technique enables us to directly see the root canal morphology but still has a limitation concerning time consumption.

The most common canal configuration for deciduous mandibular first molar is type IV in the mesial root and type I in the distal. Type II was the most relevant in the MB root of a deciduous maxillary first molar. While type I was the most common in the DB and type I in the palatal. Deciduous mandibular second molar showed type II and IV as the most common canal configurations in the mesial root and type IV in the distal. As for the maxillary deciduous second molar, type IV was the most common in the MB and DB roots and type I and IV in the palatal roots.

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