Original Article

Morphometric Analysis Comparing Human Mandibular Deciduous Molars using Cone Beam Computed Tomography

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Abstract

Background: The presence of variations in crown and root measurements in deciduous teeth usually leads to complications during and after treatment. Hence, in order to improve the success rate in pediatric treatment, there must be proper knowledge of dental morphological and morphometric characteristics of deciduous teeth among different populations. **Objective:** The aim of the present study was to assess length of the crowns, length of the roots, roots to crown (R/C) ratio, and distance between the floor of pulp chamber to furcation using cone beam computed tomography (CBCT). **Materials and Methods:** Extracted deciduous molar teeth were collected and divided into: group I: Deciduous mandibular first molars (lower D) (n = 16) and Group II: Deciduous mandibular second molars (lower E) (n = 21). The length of the crowns, length of the roots, R/C ratio and distance between the floor of pulp chamber and furcation were measured using CBCT. Data were statistically analyzed. **Results:** Lower D showed smaller crown length with a mean of 4.87 mm, longer mesial root length with a mean of 9.68 mm and greater R/C ratio with a mean of 2 mm when compared to lower E. As for the distal root length and the distance between the floor of the pulp chamber and the furcation area, both molars closely resembled each other. There was a statistical significant difference between both molars regarding mesial root length, crown length, and R/C ratio. **Conclusion:** The current study concluded that dental morphological characteristics are important in research as they provide valuable information about diversities within a population.

Keywords: *Cone beam computed tomography, deciduous teeth, pulp chamber to furcation distance, root to crown ratio*

Introduction

Deciduous teeth show many morphological variations when compared to permanent teeth in size, external and internal morphology. Hence, successful pulp therapy in pediatric dentistry treatment demands proper understanding of dental morphology within each population.[1]

Studying the root morphometry and morphology of different populations are very important for a pedodontist as well as general dental practitioners. Direct observation using a microscope or a digital caliper is considered the most commonly used method in analyzing the root morphology. Teeth have two general sections; the crown which is covered by enamel and the root which is covered by cementum, the cement-enamel junction (CEJ) is the line at which these two sections meet. In healthy gingival conditions, the roots of teeth are found entirely embedded in the alveolar bone. The crown is normally found above the level of the alveolar bone, but somewhat obscured at the apical millimeter or so. Therefore, crown and root are the main anatomical terms defining the actual parts of any tooth.[2]

Root to crown (R/C) ratio defines the root length in relation to the crown length. Root length is considerably longer than crown length and this is important for proper support and anchorage of the teeth within the alveolar bone during normal function. The normal R/C ratio is called the favorable R/C ratio.[3] Therefore, R/C ratio is an important tool in the diagnosis of a tooth that is required to be an abutment for the construction of various types of prosthetic restorations.[4]

Invention of the three-dimensional imaging has facilitated the insight into tooth morphology and allowed interactive image manipulation as well as improved visualization of the area of interest as a three

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dimensional image. More advancement has been achieved in the field of radiology on the advent of the computed tomography (CT) for teeth imaging. CT has been improved rapidly and cone-beam computed tomography (CBCT) is the latest system which has been introduced in dentistry for imaging of maxillofacial region tissues.[5]

Since there is a lack of literature regarding the crown and root measurements in deciduous dentition so, the purpose of this study was to assess length of the crowns, length of the roots, R/C ratio and distance between the floor of pulp chamber to furcation using a CBCT.

Materials and Methods

A total of 16 deciduous mandibular first molar (lower D) and 21 deciduous mandibular second molar (lower E) were collected from the Department of Pedodontics and Preventive Dentistry, Ain Shams and Future Universities in Egypt. Molars with full root length without any evidence of root fracture or resorption were included in the current study. Molars that were badly decayed, severely attrited, endodontically treated, or restored with glass ionomer cement or stainless steel crown were excluded from the study.

These samples were then divided into two groups:
- Group I: Lower D (n = 16)
- Group II: Lower E (n = 21).

Teeth were cleaned and washed to remove any debris. Calculus was removed using hand scalers then the teeth were stored in glass containers containing 10% formalin solution until experimentation. The teeth were the mounted in straight line on the modeling pink wax in rows leaving 0.5 cm space between them after determining the various aspects of the tooth which are buccal, lingual, mesial, and distal, in order to maintain uniformity of the samples.

Scanning technique

CBCT scanner was used to scan the mounted teeth and imported to the vision preview screen for three-dimensional construction of images in three planes, i.e., sagittal, axial, and coronal. An experienced radiologist acquired the images according to the manufacturer's instructions. The whole CBCT imaging was handled by a registered dental radiologist. Two examiners evaluated the CBCT images: an Oral Biology lecturer (Examiner1) and a Pedodontist lecturer (Examiner 2).

The molds with the samples in were submitted for CBCT scan 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 in an i-CAT format and then downloaded through a compact disk to a personal computer for linear measurement.

Images evaluation

Examination of the CBCT images was made after adjustment of the contrast and brightness of the images which was done using the image processing tool in the software in an attempt to ensure the optimal visualization. CBCT images were then evaluated by moving the toolbar.

CBCT images were used for measuring crown length, mesial and distal root length, R/C ratio and distance between the floor of pulp chamber to furcation.

The R/C ratio was measured according to Kim *et al*. 2013[6] and was done on CBCT images. The following definitions were used for the CBCT-based measurements as shown in Figure 1.

1. Crown length: which is the distance between the buccal cusp tip and the buccal CEJ
2. Root length: which is the distance between the buccal CEJ and the root apex for both mesial and distal roots
3. R/C ratio which was calculated by dividing the longest root length (mesial root) by crown length.

The measurement of distance between the floor of the pulp chamber to furcation was also done on CBCT images as shown in Figure 2.

Statistical analysis

The mean and standard deviation values were calculated for each group in each test. Data were explored for normality using Kolmogorov–Smirnov and Shapiro–Wilk tests, data showed parametric (normal) distribution. Independent sample t-test was used to compare between two groups in nonrelated samples. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics version 20 for Windows (USA).

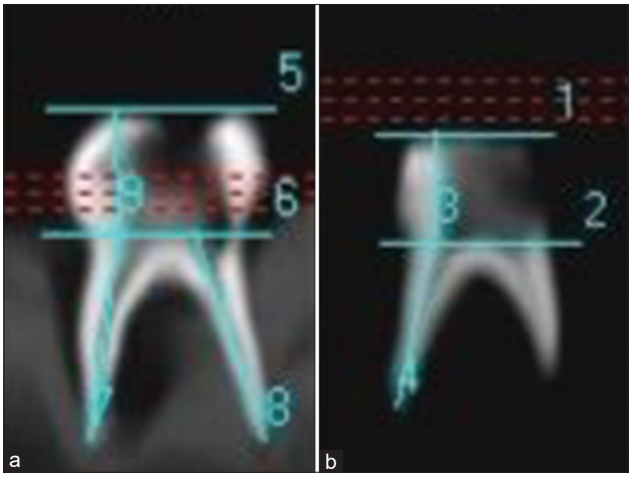

Figure 1: Cone beam computed tomography showing: (a) lower E sample's measurement of crown length and root length. (b) Showing lower D sample's measurement of crown length and root length

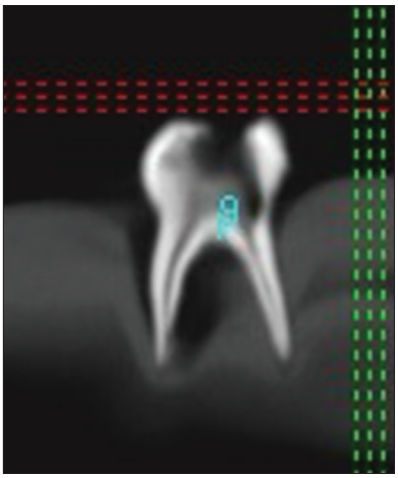

Figure 2: Cone beam computed tomography showing lower E sample's measurement between the floor of the pulp chamber to furcation

Results

Mesial root

There was a statistically significant difference between lower E and lower D groups. Lower D showed slightly higher mean value regarding mesial root length (9.68 mm) than that of lower E (8.88 mm) as shown in Table 1 and Figure 3.

Distal root

There was no statistically significant difference between lower E and lower D groups. Lower E showed slightly higher mean value regarding distal root length (7.70 mm) than that of lower D (7.29 mm) as shown in Table 1 and Figure 3.

Crown length

There was a statistically significant difference between Lower E and Lower D groups. Lower E showed higher mean value regarding crown length (5.49 mm) than that of lower D (4.87 mm) as shown in Table 1 and Figure 3.

Root to crown ratio

There was a statistically significant difference between lower E and lower D groups ($P < 0.001$). Lower D showed higher mean value (2 mm) than that of lower E (1.18 mm) regarding R/C ratio as shown in Table 2 and Figure 4.

Floor to furcation

There was no statistically significant difference between lower E and lower D groups. Lower E showed slightly higher mean value (1.78 mm) than that of lower D (1.74 mm) as shown in Table 2 and Figure 4.

Discussion

Tooth morphometric analysis is considered valuable data in dentistry. These data are valuable in restoring the crowns of deciduous teeth and understanding the occlusion of deciduous dentition in pediatric dentistry.[7]

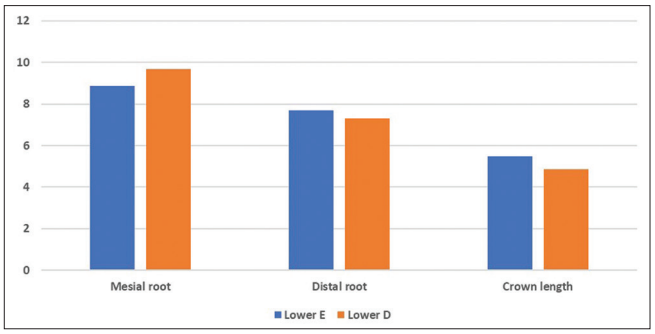

Figure 3: Bar chart representing mesial root, distal root and crown length

Table 1: The mean, standard deviation values of mesial root, distal root and crown length of different groups

Variables	Mesial root		Distal root		Crown length	
	Mean	SD	Mean	SD	Mean	SD
Lower E	8.88	1.27	7.70	1.56	5.49	0.51
Lower D	9.68	0.86	7.29	1.01	4.87	0.47
P	0.037*		0.373 (NS)		0.001*	

Lower D (n=16) and lower E (n=21). *Significant (P<0.05).
NS: Nonsignificant (P>0.05); SD: Standard deviation

Table 2: The mean, standard deviation values of roots to crown ratio and floor to furcation of different groups

Variables	R/C ratio		Floor to furcation	
	Mean	SD	Mean	SD
Lower E	1.18	0.21	1.78	0.22
Lower D	2.00	0.23	1.74	0.16
P	<0.001*		0.582 (NS)	

Lower D (n=16) and lower E (n=21). *Significant (P<0.05).
NS: Nonsignificant (P>0.05); R/C: Roots to crown; SD: Standard deviation

It is very important to be aware of the normal and usual morphology of roots regarding number, shape and length which should be known among every population. Racial differences regarding crown measurements have long been recognized, however, morphometric analysis of roots and pulp chambers have not received the same attention among different populations. The majority of text books of dental anatomy fail to cover detailed information regarding root morphology and morphometry that is unique to African populations.[8,9]

Knowing about the teeth morphology and morphometry is also very important for maintaining pediatric dental integrity. This can be achieved by ensuring correct tooth spacing, esthetics, phonation, mastication as well as prevention of psychological effects which can occur as a result of tooth loss. Root canal therapy in deciduous teeth aims to clean the pulp chambers and root canals from the infected tissues; so, detailed knowledge of pulp chamber and root lengths of deciduous teeth within each population can greatly improve the effectiveness and success of treatment.[10,11]

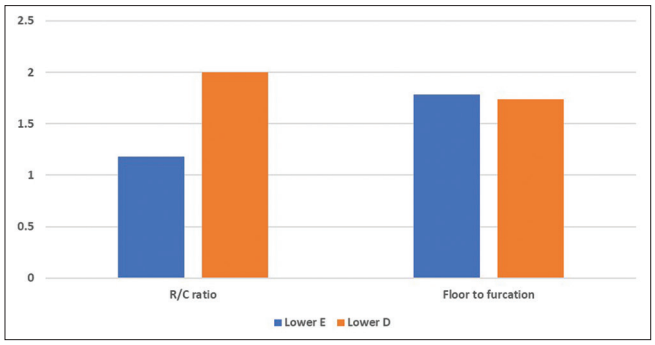

Figure 4: Bar chart representing roots to crown ratio and floor to furcation

In such treatments, the root length should be accurately determined to minimize the risk of periapical injury and possible damage to the permanent successor. Therefore, root length measurement is a crucial factor for a successful treatment as it allows complete disinfection of the root canal with no risk periapical tissue injury. Moreover, proper knowledge of exact root length provides the working length that prevents over or under instrumentation while in debris removal it might be hampered.[12,13]

Unfavorable R/C ratios of the deciduous dentition might affect the prognosis of various dental treatments. Periapical or panoramic radiography is the most commonly used methods measurements of crown, root lengths, and normal R/C ratios. However, previous investigations have found that panoramic radiographs have the lowest reliability among assessments of all tooth types.[14] Moreover, the identification of the CEJ on periapical radiographs using the paralleling technique might be affected by the angular differences between the concerned tooth and the film.[15] CBCT has overcome these withdraws in the field of dentistry, because distortion-free slice images of single roots are excellent for measuring the crown and root lengths of teeth and hence accurate R/C ratio.[16]

Understanding the accurate depth of the pulp chamber as well as the size of the furcation area will be a first step for precise access cavity preparation in deciduous multirooted teeth also minimizes the risk of perforations and protects the permanent successors. This attempt was made to understand the pulpal chamber better to reduce these common errors that might occur during deciduous molars pulpotomy.

Our results have shown that lower D has shown smaller crown length with a mean of 4.87 mm, longer mesial root length with a mean of 9.68 mm and greater R/C ratio with a mean of 2 mm with compared to lower E. As for the distal root length and the distance between the floor of the pulp chamber and the furcation area, both molars closely resembled each other.

Our results were found in agreement with Ash and Nelson 2010[17] who stated that lower D and lower E crown lengths were 6 mm and 5.5 mm, respectively. As for the root length of lower D is was 9.8 mm which was coinciding with our results, while that of lower E was 11.3 mm which was not in agreement with our results.

In another study made by Kalhori and Sadeghi 2010[18] on the Iranian population, the researchers have found that the mean value for lower D mesial root length was 9.66 mm while that of the distal root was 7.22 mm. As for the lower E, the mean value for the mesial root length was 9.40 mm and that of the distal root was 8.27 mm which reveals that the lower D showed higher mean value of the mesial root length and lower mean value of the distal root length when compared to the lower E. This shows strong agreement with our results.

In another study done by Gaurav *et al*. 2013[19] on the mandibular deciduous molars of Indian population, the investigators have found that the mean value for the mesial and distal root lengths of mandibular molars was 8.28 mm and 7.18 mm, respectively. The researchers stated that in mandibular molars, the mesial root was longer than distal root. These results closely resembled our results.

Short rooted teeth are mainly due to disturbances occurring during development or may be as a result of resorption of the original roots. Developmentally, short-rooted teeth may be genetic and this condition is termed short root anomaly[20,21] or exogenous, which might be encountered during chemotherapy or radiotherapy.[22]

Conclusion

When a large collection of dentitions from one species is studied; it showed surprisingly large degree of variations in size and form. These variations might be affected by the environment where growth took place. These variations might be affected by the environment where growth took place and can be recognized within a group of individuals and termed developmental defects. Variations are found among individuals within the same population so, a feature may take different forms or its measurable size may vary.[23]

Information regarding deciduous teeth morphology and morphometry is important for anthropological and forensic significance as well as for clinical practice in pediatric dentistry. Therefore, better knowledge of root length will definitely help to achieve better outcomes of pulpectomy in deciduous teeth among different populations.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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