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Age Estimation through Dental Measurements Using Cone-Beam Computerized Tomography Images in a Sample of Upper Egyptian Population

Hala Mohamed Ahmed[1], Ashraf Abd Alazim Ewiss[2], Nagwa Mohamed Khattab[3], and Maha Eshak Amer[4]

[1] Forensic Medicine and Toxicology Department, Faculty of Medicine
[2] Community Department, Faculty of Medicine
[3] Pedodontics Public Health Department, Faculty of Dentistry
[4] Oral Radiology Department, Faculty of Dentistry

Minia University, Minia, Egypt

Abstract The role of forensic odontology has increased in recent years. Age estimation of living or deceased individuals is an important aspect of this science .Dental age estimation methods are of particular value because teeth are highly resistant to mechanical, chemical, or physical impacts and time. So the aim of this study was to investigate the possible estimation of age by using dental age through some dental measurements using cone beam computerized tomography (CBCT). The study was done on forty eight cases (24 males and 24 females). Multiple measurements were done on the right upper central incisor, right upper lateral incisors, right upper canine and right first premolar teeth and their pulp at different levels (maximum width of the crown, cervical area, mid-root and apex) by many views: sagittal (bucco-lingual dimension), coronal (mesiodistal dimension), and axial (bucco- lingual and mesiodistal dimensions). In addition the tooth and the pulp areas were measured .The study proved that the most accurate model for determination of age in upper first premolar tooth was measurement of pulp length + pulp width at the crown+ pulp width mid level of the pulp where R was 97%. Followed by upper central incisor pulp width at mid-level of the pulp in Bucco-lingual view with R 96%. While measurement of tooth length for upper canine at Bucco-lingual view was the least accurate method for this tooth with R 90%.

So the study concluded that using CBCT is useful in detection of age by obtaining linear teeth measurements. In addition, the use of the upper first premolar tooth measurements followed by upper central incisor followed by upper canine are useful in estimating the chronologic age of any person.

Keywords CBCT, radiography, Teeth, Age Determination

Introduction

Divers age estimation methods are developed integrating single or multiple age-related variables. The estimated age prediction outcomes can help advice legal authorities in their judgment on the chronological age of individuals with a questioned age and provide more accurate postmortem profiling of unidentified body remains (Sforza et al., 2009).

Forensic identification includes processing long bones and teeth in order to verify a person's age. Whereas bones and teeth can be both used postmortem, teeth can be inspected also to some degree during life (Frieda et al., 2004).

The role of forensic odontology has increased in recent years, where age estimation of living or deceased individuals is an important aspect of this science .Dental age estimation methods are of particular value because teeth are highly resistant to mechanical, chemical, or physical impacts and time (Liang et al., 2009). Devers of dental age estimation methods were reported in literature. The dental age-related parameters are subdivided whether they indicate developmental, morphological, or bio-chemical tooth changes. Secondary dentine apposition is a significant morphological dental age predictor (Singaraju and Sharada , 2009).

Tooth is the hardest structure in the human body, and contains enamel and dentin. Tooth enamel is harder than bone and consists of more or less dead material. It functions as a protective layer around the tooth. Dentin on the other hand, lies beneath the enamel surface and constitutes the entire tooth root. It has a consistency similar to cartilage. Enamel does not show age-related changes except for a loss in permeability, an increase in brittleness and a small amount of wear. Also pathological conditions and behavioral habits such as caries, erosion, attrition and abrasion, may lead to loss of enamel. However, the remaining structures, the pulpdentinal complex (PDC), which includes dentin, cementum and the dental pulp, show age-related physiological and pathological changes (Liang et al., 2009).

The principal changes of the PDC during life are an increased mineralization of the primary dentin, an accelerated formation of secondary dentin, and decreased circulation and innervations of the dental pulp characterized by a marked reduction in cells, a relative increase in fibers, fat infiltration and calcification (Morse ,1991) . Therefore, the volume of the pulp canal system considerably reduces over time. Based on these age-related changes a variety of methods for dental age estimation were proposed (Bosmans et al., 2005).

Secondary dentine apposition is a significant morphological dental age predictor. It is defined as the formation of dentine after the completion of the primary dentine and starts at the moment the related tooth root is completed. The formation of secondary dentine may be caused by attrition, abrasion, erosion, caries, changes in osmotic pressure throughout the pulp chamber, or aging and decreases the volume of the dental pulp chamber. Therefore, the volume changes of the pulp chamber in intact teeth are considered as a dental age predictor (Yekkala et al., 2007).

Since 1982 dental radiography has been employed in methods of age estimation, Initial attempts were based on direct and indirect measurements of secondary dentin deposits at the pulp (Kvaal et al. 1995), refined this technique by measuring directly the pulp size and root size from radiographs of several teeth in the same dentition, and calculate the ratios of both. They concluded after multiple regression analysis that measurements on dental radiographs are a non-invasive technique for estimating the age of adults.

Vandevoort et al., 2004 conducted a study to correlate the volume ratio of pulp versus tooth with the chronological age of an individual using X-ray microfocus computed tomography unit (μCT). They concluded that this technique showed promising results for dental age estimation in a non-destructive manner. (Yang et al., 2006) developed a custom-made voxel counting software for calculating the ratio between pulp canals versus tooth volume based on cone-beam CT tooth images. The results of the analysis showed a moderate correlation between the pulp/tooth volume ratio and biological age; however most of these works were limited to a pilot study or applied to certain tooth (Star et al., 2010).

The aim of the current study was to correlate dental age with an individual's chronological age based on the calculated pulp, tooth and root measurements on cone beam computed tomography images.

Subjects and methods

Forty eight cone beam computerized tomography images were examined for cases already coming for doing orodental examination included 24 males and 24 females with a chronological age ranged between 14-45 years. They were selected from Oral Radiology department, Faculty of Dentistry, Minia University. The birth date of all subjects was checked with their identity card and written consent was taken during the dental record setup. They were free from caries or advanced periodontal diseases. Also, the CBCT image quality (allowed for each subject) the separation and segmentation of at least one intact and fully developed single rooted tooth (right upper central incisor (tooth number 1) , right upper lateral incisor (tooth number 2) , right upper canine (tooth number 3) and right upper 1st premolar(tooth number 4).

CBCT examination was performed with Scanora machine (Scanora® 3D with Auto Switch TM, Soredex, Helsinki, Finland), with 85 kVp, 15 mA.

The following measurements were performed using distances and areas measurement tools of the software (Cyber med Inc., Korea). On Demand 3 D application software, was used to manipulate images of the CBCT in multiplaner slices with three dimensional views to examine the slices at different plans of the tooth. The program automatically calculated the required measurements.

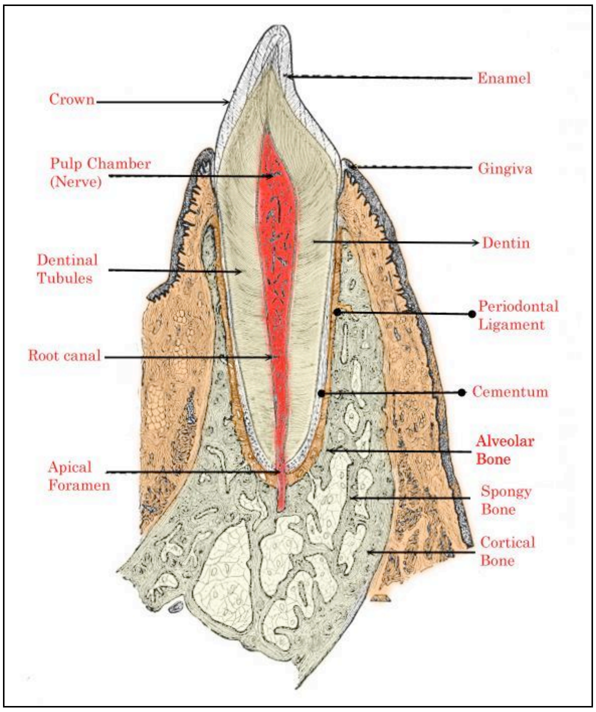

Figure 1: longitudinal section through single rooted tooth (Satish et al., 2007).

Teeth Measurements

For each tooth several measurements of the pulp and canal system was a carried out in different plans. These measurements included the followings:

1. Pulp length: measured from the highest point of the pulp horn to the apical foramen, in sagittal and coronal plans.
2. The pulp width was measured at the maximum width of the pulp chamber (pulp width 1), while at the pulp canal it was estimated by three measurements at different levels including cervical, middle and apical one third of the root) (pulp width 2, pulp width 3, pulp width 4 respectively). It was measured in bucco- lingual (BL), mesio-distal (MD), and axial (A) dimensions.
3. The pulp areas were drawn and calculated at the different planes; mesio-distal, bucco-lingua land axial planes.
4. The tooth length and the maximum width at different levels, maximum width at the crown, maximum width at the cervical area, middle root and apex of the root was done.

Statistical analysis

The data were collected and statically analyzed using SPSS for windows (version 17.0).). Values were expressed as mean ± standard deviation (SD). The significance of differences was calculated by using Pearson correlation test and predictive analysis of collected measurements. $P<0.05$ was considered significant.

Results

The present study was carried out on 48 cases, their chronological age ranged between 14-45 years. Right upper single rooted teeth were examined in each case. Therefore a total samples consisted of (192 tooth) including upper central incisor, upper lateral incisor, upper canine, and upper first premolar.

Table (1) shows Descriptive statistical analysis of the different teeth measurements; it shows mean ± standard deviation with minimum and maximum range of each measurement used in each tooth.

Table (2) shows Pearson correlations coefficient between age and different measurements of each tooth at different views. As shown in (figures 2, 3) the measurements of right upper central incisor (Bucco -lingual view) showed strong negative correlation between age and pulp width at both crown and mid root levels. Also, negative correlation was observed with pulp length (figure 4). The correlation coefficients were -0.827, -0.964, and -0.650 respectively.

Moreover, at Mesio-distal view there was strong negative correlation with pulp width at the apex level (r = -0.716, p value 0.001) (figure 5) and mild negative correlation with pulp length (r = -0.686, p value 0.01) but mild positive correlation with tooth area (r = 0.693, p value 0.01) (figure 6). In contrast by the axial view; the pulp measurement at Bucco-lingual dimension was the only correlated value with age (r = -0.729, p value 0.001) (figure 7).

There was no significant correlation of age with any measurement of the upper lateral incisor (tooth number 2). The right upper canine at Bucco-lingual view measurements showed strong negative correlation of age with pulp length and tooth length (r = -0.733, -0.903; p value 0.001, 0.0001) (figures 8 and 9) respectively. But when compared with upper central incisor it showed mild correlation with age.

By Mesio-distal view the pulp width measurements at middle level of the root was the only measurement that showed mild negative correlation with age (r = -0.613, p value 0.01) (figure 10). In addition the axial view showed no significant correlation with any measurements.

As the upper first premolar at Bucco-lingual view showed mild negative correlation of age with pulp width at mid level of the pulp and pulp area (r = -0.0650, -0.626; p value 0.01, 0.01) (figures 11 and 12). It showed strong negative correlation with pulp length and tooth length (r = -0.737, -0.840; p = 0.001 and 0.001) (figures 13 and 14).

On the other hand the Mesio-distal view of measurement showed significant positive correlation of age with pulp width at mid-level of the pulp (r = 0.937, p value 0.001), and mild negative correlation of age with width of tooth at middle and cervical portion (r = -0.778, p value 0.01 in both).

Prediction analysis of the collected data were done as shown in table (3) where variable models were used to detect the most accurate method to identify age . This table showed that

The most accurate model for determination of age in upper first premolar was measurement of pulp length + pulp width at the crown+ pulp width at mid level of the pulp (R was 97%) (R = is the ability of this model to correspond identified age with known chronological age). But the ability to detect age by measurement of pulp width at mid level of the pulp by Mesio-distal view was (R 94%). Axial view was insignificant for identification of any tooth age.

Measurement of pulp width at mid level of the pulp at Bucco- lingual view of upper central incisor was follow the upper premolar tooth in accuracy of age detection with (R 96%) and followed by the measurement of tooth area + width cervical part of the tooth with accuracy (82%).

There were no models can be detected to identify age by use upper lateral incisor as this tooth was varied in different persons, so cannot depend on it in identification of unknown ages .

On the other hand measurement of tooth length for upper canine at Bucco-lingual view was the more accurate method for this tooth (R 90%) followed by measurement of pulp width at mid level of the pulp + pulp width of crown at Mesio-distal view (R 80 %).

So if a choice of tooth type is conceivable for age detection, 1st upper premolar, upper central incisor followed by upper canine should be selected respectively.

Table (1): Descriptive statistics for different measurements (B-bucoolingual , M-mesiodistal , A- axial) for tooth 1, 2, 3, and 4.

Measurements	Tooth 1 (Mean±SD) (Range)	Tooth 2 (Mean±SD) (Range)	Tooth 3 (Mean±SD) (Range)	Tooth 4 (Mean±SD) (Range)
B-pulp width 4	0.65±0.23 (0.2-0.9)	0.76±0.27 (0.2-1.6)	0.82±0.22 (0.5-1.2)	0.88± 0.44 (0.4-2)
B-pulp width 3	1.13±0.23 (0.8-1.5)	1.13±0.66 (0.5-2.6)	1.21±0.32 (0.8-1.7)	2.51±1.35 (0.8-4.7)
B-pulp width 2	1.62±0.27 (1.1-2.1)	1.71±0.35 (1.3-2.5)	2.2±0.52 (1.3-2.9)	3.51±0.93 (2.1-5.1)
B-pulp width 1	1.24±0.38(0.4-1.7)	1.29±0.42 (0.7-2.2)	1.93±0.53 (1.2-2.8)	13.99± 0.77 (12.9-15.4)
B-pulp length	17.59±1.86 (13.3-19.5)	14.1±1.68 (11.2-16.7)	18±1.41(15.7-19.5)	14.38±2.72 (9.5-17.9)
B-pulp area	16.1±3.52 (11.4-22.3)	15.07±2.67(11.06-19.8)	22.08±2.63 (15.9- 25)	24.63± 4.81 (19.6 -32.8)
B-tooth area	1.1±0.2 (0.3 -1.6)	81.5±7.05 (70.9 -92.08)	1.19±0.3 (0.88-2.1)	1.31±0.16 (0.7-1.8)
B-width apex	3.02±1.1 (0.9-3.8)	3.38±0.83 (2-4.4)	3.7±0.88 (2.2-4.9)	2.38±0.64 (1.5-3.8)
B-width mid	4.87±0.39 (4.2-5.4)	4.77±0.61(3.8-5.9)	4.7±1.67 (1.2-6.6)	6.73±1.76 (2.9-8.4)
B-width central	5.88±0.41 (5.2-6.3)	5.27±0.62 (4.5-6.3)	5.84±1.78 (1.9-7.2)	7.63±1.39 (5.4-9.8)
B-width ce	7.08 ±0.45 (6.3-7.8)	5.74 ± 0.45 (4-6.6)	6.5±2.12 (2-8.6)	8.98±0.88 (7.8-10.3)
B-tooth length	22.36±1.43 (19.5 -24.3)	19.46±1.1 (17.5-21)	23.3±1.5 (19.9-25.6)	19.15±2.50 (14.1-22.1)
M-pulpwidth4	0.95±0.31 (0.6 -1.5)	0.79±0.32 (0.4-1.4)	0.95±0.04 (0.4-1.07)	0.46 ± 0.1 (0.3-0.8)
M-pulpwith3	1.35 ±0.44 (0.8-2.3)	1.17 ±0.46 (0.6-2.1)	1.5±0.59 (0.80-2.5)	0.84±0.31 (0.5-1.3)
M-pulpwidt2	1.62±0.35 (1.1-2.3)	1.29±0.51 (0.5-2.1)	1.68±0.48 (1 -2.5)	1.7±0.9 (1-3.7)
M-pulpwidth1	1.38 ± 0.3 (0.7-1.7)	1.53±0.68 (0.7-2.7)	1.08±0.34 (0.60-1.6)	0.94±0.24 (0.6-1.3)
M-pulp length	15.49±2.63 (10.8-18.6)	14.63±2.12 (11.3-17.5)	15.25±4.5 (6.2 -2)	15.61±3.06 (10-19.5)
M-pulp area	10.27±2.1 (6.38-13.8)	11.48±2.5 (7.78-15.73)	14.5 ±1.2 (12.7-16.5)	9.92±2.4 (6.88-14.7)
M-tooth area	75.2±16 (48.05-94.37)	79.5±10.58 (55.2-92.2)	84.9±16.7 (55.8-108.5)	84.3±11.7 (72.3-111.02)
M-width apex	3.19±0.5 (2.5-3.8)	2.6±0.77 (0.8-3.6)	2.7±0.57(1.9-3.7)	2.01±0.54 (1.5-3.1)
M-width mid	3.85±0.71(2.7-4.9)	3.38±0.85(1.2-4.4)	4.25±0.8 (2.9 -5.3)	4.34±0.33(3.8-4.8)
M-width cer	4.36±0.57 (3.5-5.2)	3.92±0.7 (2.6-4.8)	4.58±0.44 (3.7 -5.2)	4.34±0.33(3.8-4.8)
M-width ce	6.08±0.6 (5.3-7.2)	5.64±0.78 (4.6-7.1)	6.12±0.56 (5.3-7)	6.46±0.47 (5.6-6.9)
M-tooth length	18.02±2.23 (12.7-2)	18.36±2.25 (14.7-21.6)	18.8±4.68 (11.4 -25.4)	20.5±2.79 (15.9-23.8)
A-pulp MD	2.27±0.25 (1.9-2.8)	1.96±0.33 (1.1-2.8)	1.86±0.38 (1.2-2.4)	1.7±0.38 (0.9-3.6)
A-pulp BL	2.11 ±0.45 (1.2-2.9)	2.37±0.62 (1.6-3.7)	3.38±0.74 (2.2-4.5)	4.98±0.78 (3.5-5.9)
A-pulp area	5.33 ± 1.31 (3.4-7.05)	4.42 ± 1.15 (2.58-6.21)	5.6±1.92(3.2- 6.2)	6.81±1.29 (5.03-8.83)
A-tooth area	34.93±4.82 (24-40.1)	28.35±7.32 (16.21-40.9)	36.97±5.61 (24.4-43.4)	33.93±5.95 (24.65-44.66)
A-tooth MD	5.04±0.65 (4.1-5.9)	4.66±0.56 (3.7-5.6)	5.09±0.43 (4.5-5.8)	3±0.31 (2.5-3.5)
A-tooth BL	6.98±7.7 (5.40-7.9)	6.08±1.01(4.3 - 8)	7.76±0.82 (6.4-8.7)	8.57±0.67 (7.4-9.4)

B-Bucoo lingual; M- Mesio distal; A-Axial

Table (2): Correlation of ages with different methods of measurements of teeth 1, 2, 3, and 4.

Measurements	Tooth 1 r (p-value)	Tooth 2 r (p-value)	Tooth 3 r (p-value)	Tooth 4 r (p-value)
B pulpwidth4	-0.156 (0.628)	-0.458 (0.135)	0.037(0.910)	-0.069 (0.830)
B.L pulpwidth3	-0.964** (0.0001)	-0.517(0.085)	0.308(0.330)	-0.650* (0.01)
B.L pulpwidth2	-0.351(.264)	-0.537(.072)	-0.003(0.992)	-0.313 (0.32)
B.L pulpwidth1	-0.827**(.001)	-0.302(.340)	0.073(.822)	-0.343 (0.27)
B.L pulp length	-0.650* (.01)	-0.085(.792)	-0.733**(.001)	-0.737** (0.001)
B.L pulp area	-0.404(.193)	-0.340(.279)	-0.513(.088)	-0.626* (0.01)
B.L tooth area	-0.19(.554)	.017(.959)	-0.185(.565)	-0.138 (0.669)
B.L tooth width apex	-0.13(0.684)	-0.216(0.501)	-0.101(0.755)	-0.234 (0.465)
B.L tooth width mid	.178(0.580)	-0.288(0.365)	.541(0.069)	-0.036 (0.911)
B.L tooth width central	.067 (0.837)	-0.384(0.218)	.373(0.233)	-0.137 (0.672)
B.L tooth width ce	.419 (0.175)	.286(0.367)	.367(0.240)	-0.469 (0.124)
B.L tooth length	-0.448(0.144)	-0.376(0.229)	-0.903**(0.0001)	-0.840** (0.001)
M.D pulp width 4	-0.716**(0.001)	-0.277(0.384)	-0.445 (0.147)	.585 (0.127)
M.D pulp with 3	-0.469(0.124)	-0.407(0.190)	-0.613* (0.01)	.937** (0.001)
M.D pulpwidt2	-0.239 (0.455)	-0.162(0.615)	-0.310 (0.327)	.439 (0.277)
M.D pulpwidth1	-0.495(0.102)	.019(0.954)	.404 (0.193)	.509 (0.198)
M.D pulp length	-0.686*(0.01)	-0.364(0.244)	.415 (0.179)	-0.661 (0.074)
M.D pulp area	-0.275 (0.387)	.047(0.885)	.275 (0.386)	-0.473 (0.236)
M.D tooth area	.693*(0.01)	.026(0.937)	.397 (0.201)	-0.538 (0.169)
M.D tooth width apex	-0.371(0.235)	-0.432(0.161)	-0.464 (0.129)	.062 (0.883)
M.D tooth width mid	.408 (0.187)	-0.354(0.260)	.124 (0.700)	-0.778* (0.01)
M.D tooth width cer	.551 (0.064)	.540(0.070)	.118 (0.716)	-0.778* (0.01)
M.D tooth width ce	.295(0.352)	.417(0.177)	.311 (0.326)	-0.473 (0.237)
M.D tooth length	.156(0.628)	.126(0.696)	.535 (0.073)	-0.549 (0.159)
A pulp M-D	-0.165(0.609)	.037(0.910)	-0.186 (0.563)	.327(0.390)
A pulp B-L	-0.729**(0.001)	-0.198(0.537)	.010 (0.974)	-0.351(0.355)
A pulp area	-0.395 (0.204)	.125(0.700)	.141 (0.662)	-0.010(0.979)
A tooth area	.073(0.821)	-0.399(0.199)	.095 (0.770)	-0.275(0.474)
A tooth M-D	-0.211 (0.509)	-0.358(0.253)	-0.280 (0.378)	-0.597(0.090)
A tooth B-L	.343(0.276)	-0.114(0.724)	.100 (0.757)	-0.240(0.535)

Table (3): Predictive analysis study of age estimation by different models of measurements.

Model of measurement	Upper 1		Tooth 2		Tooth 3		Tooth 4	
	Accuracy R	Sign.	Accuracy R	Sign.	Accuracy R	Sign.	Accuracy R	Sign.
B.L pulp width 3	%96	0.0001						
Pulp width 4 M.D	%72	0.001						
Tooth area M.D	%69	0.01						
Tooth area + width cer M.D	%62	0.001						
Pulp BLA.	%73	0.001						
Pulp length LB					%73	0.001		
Tooth length B.L					%90	0.0001		
Pulp width 3 M.D					%61	0.01		
M.D Pulp width 3and pulp width 1					%80	0.01		
B.L Pulp length							74%	0.001
B.L Pulp length and pulp width 3							90%	0.0001
B.L Pulp length and pulp width 3 and pulp width 1							97%	0.0001
Tooth length B.L							84%	0.001
Pulp width 3 M.D							94%	0.001
Width 2 Pulp M.D							78%	0.01

Correlation of ages with different measurements of upper central incisor

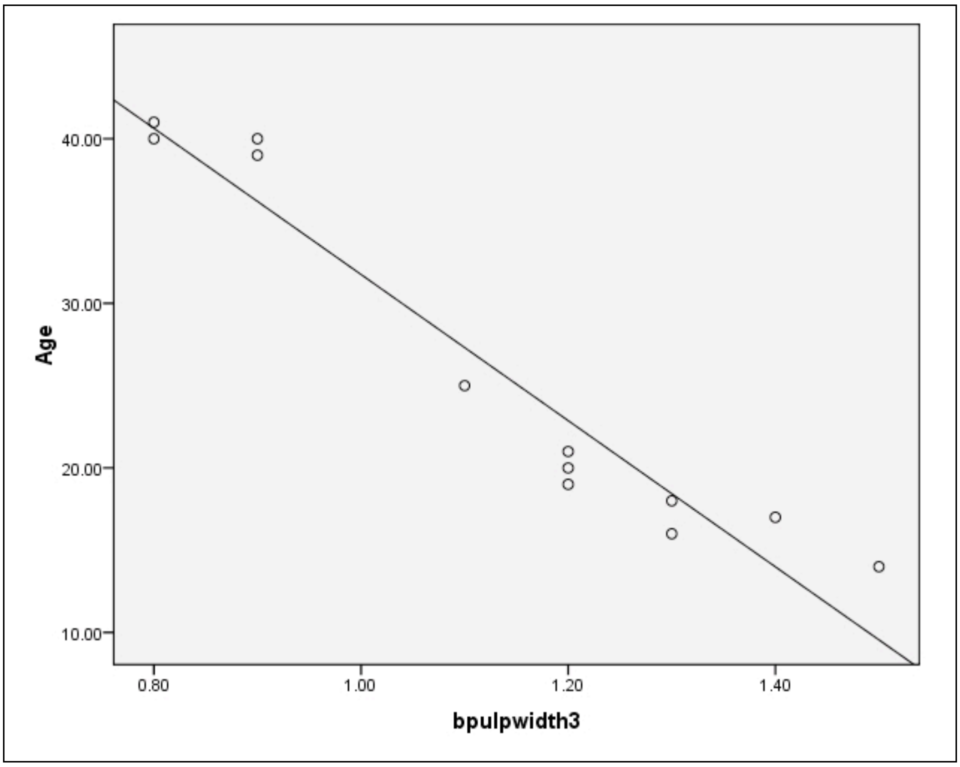

Figure (2): Pulp width mid-level of the root by Bucco-lingual view.

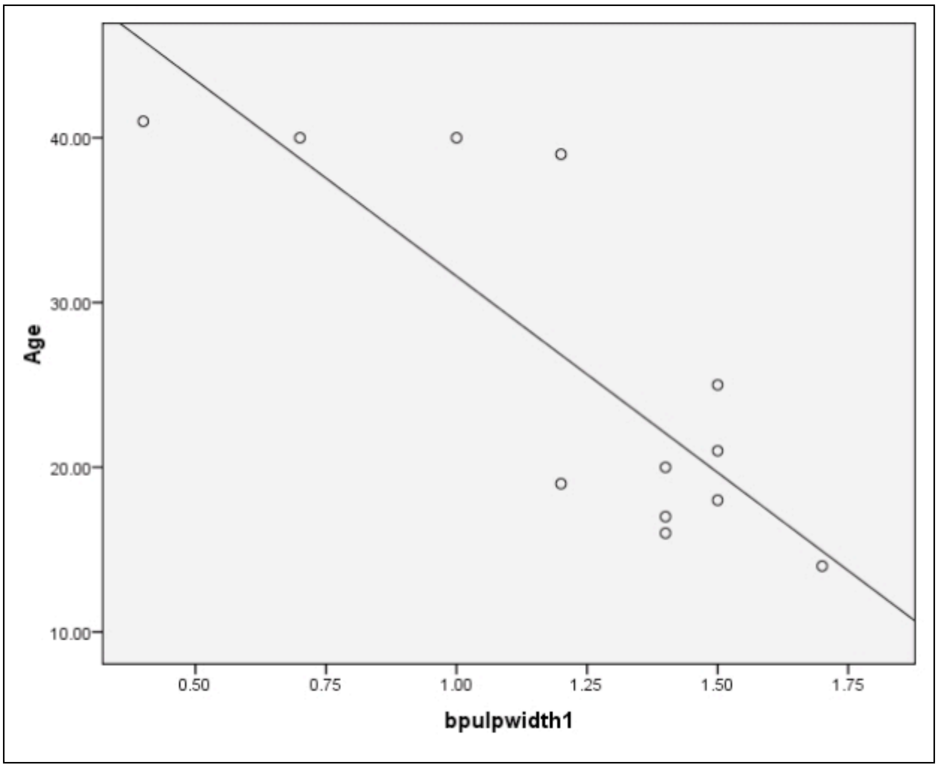

Figure (3): Pulp width at the crown by Bucco-lingual view.

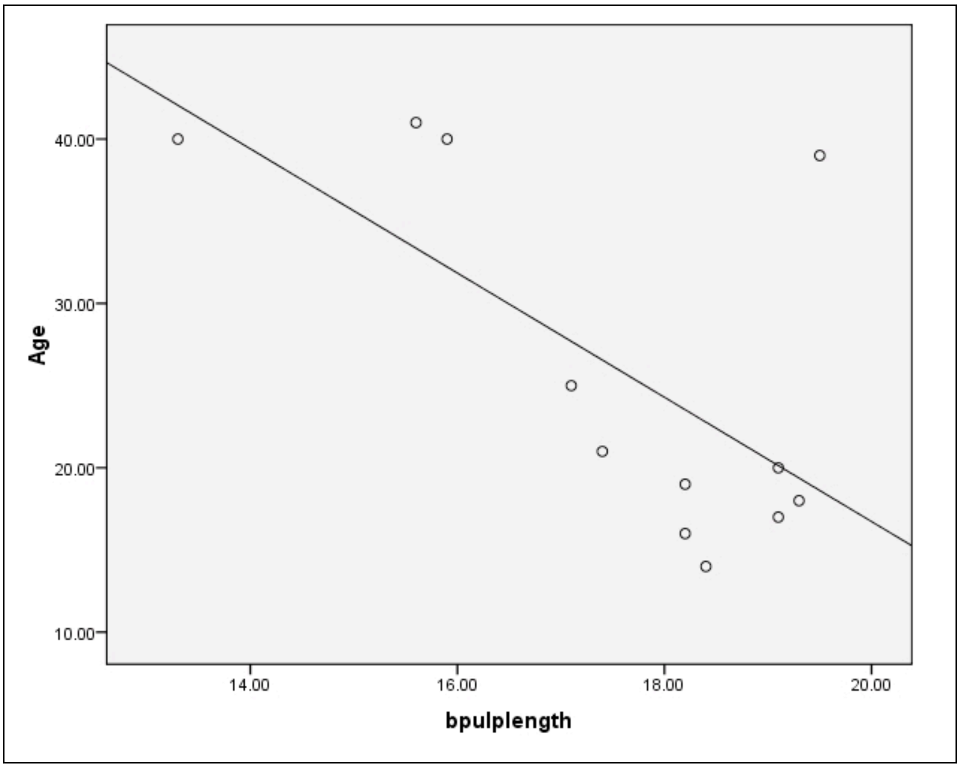

Figure (4): Pulp length at Bucco-Lingual view.

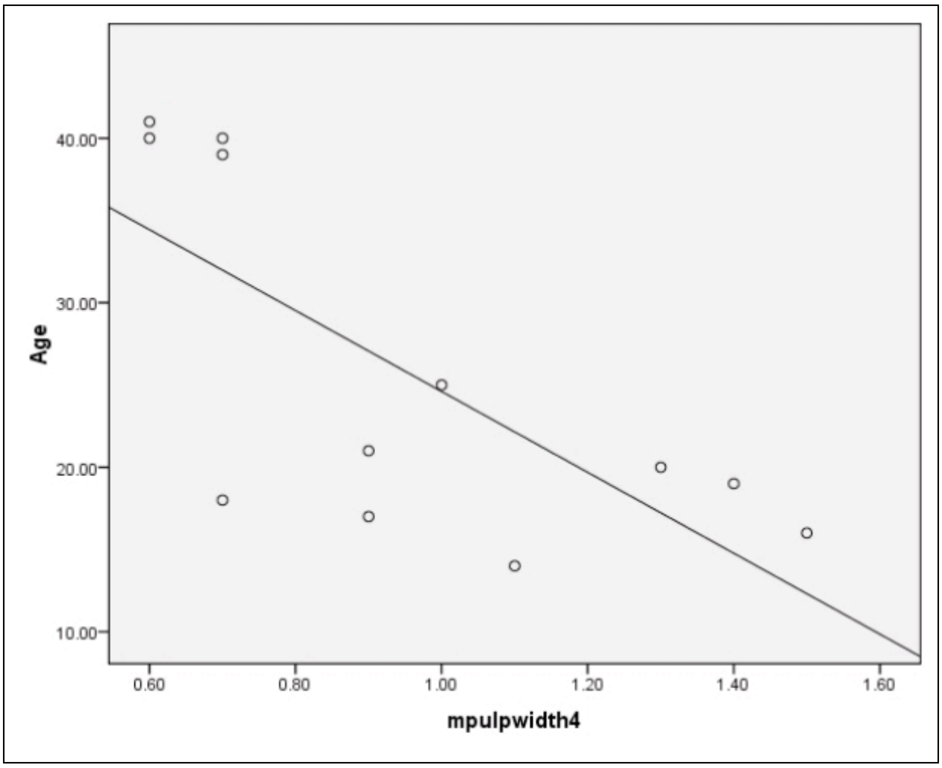

Figure (5): Pulp width first premolar at mesio-distal view.

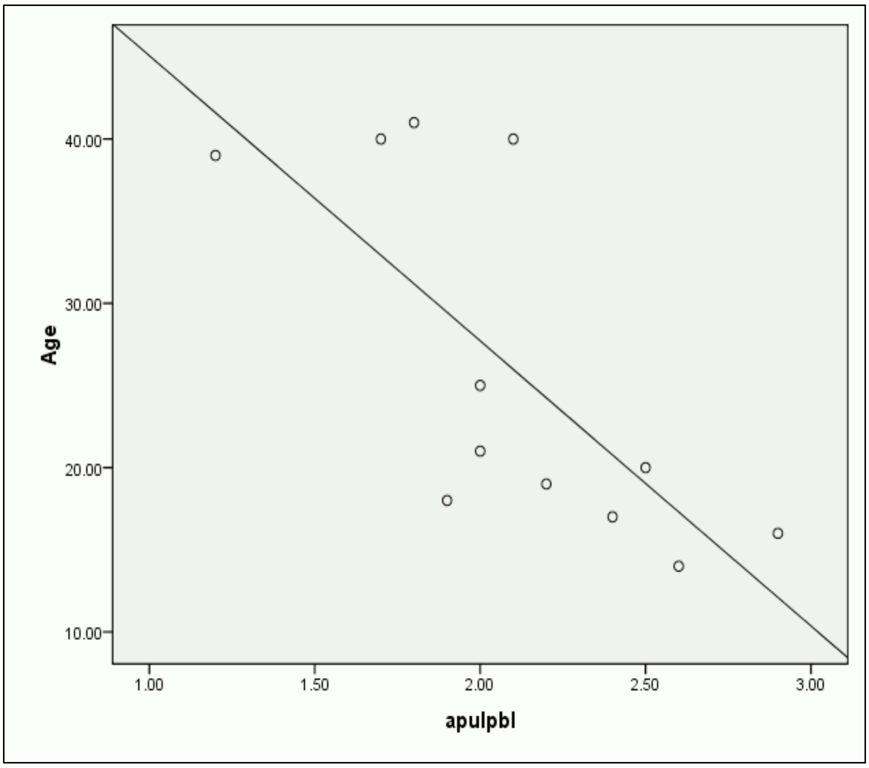

Figure (6): Tooth area at mesio-distal view.

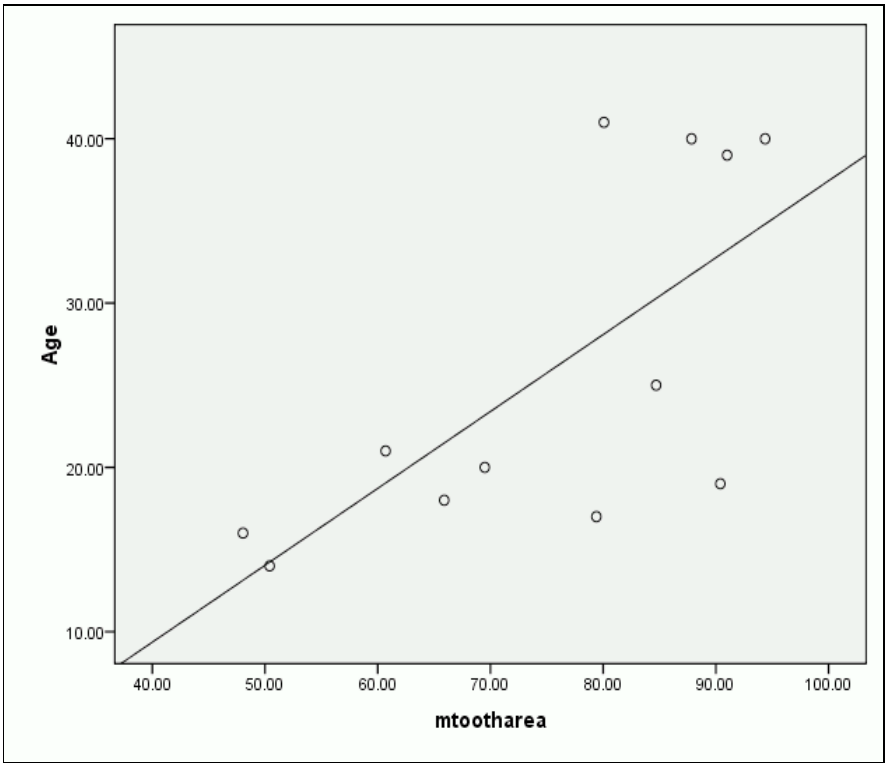

Figure (7): Pulp bucco-lingual at axial view.

Correlation of ages with different measurements of upper canine

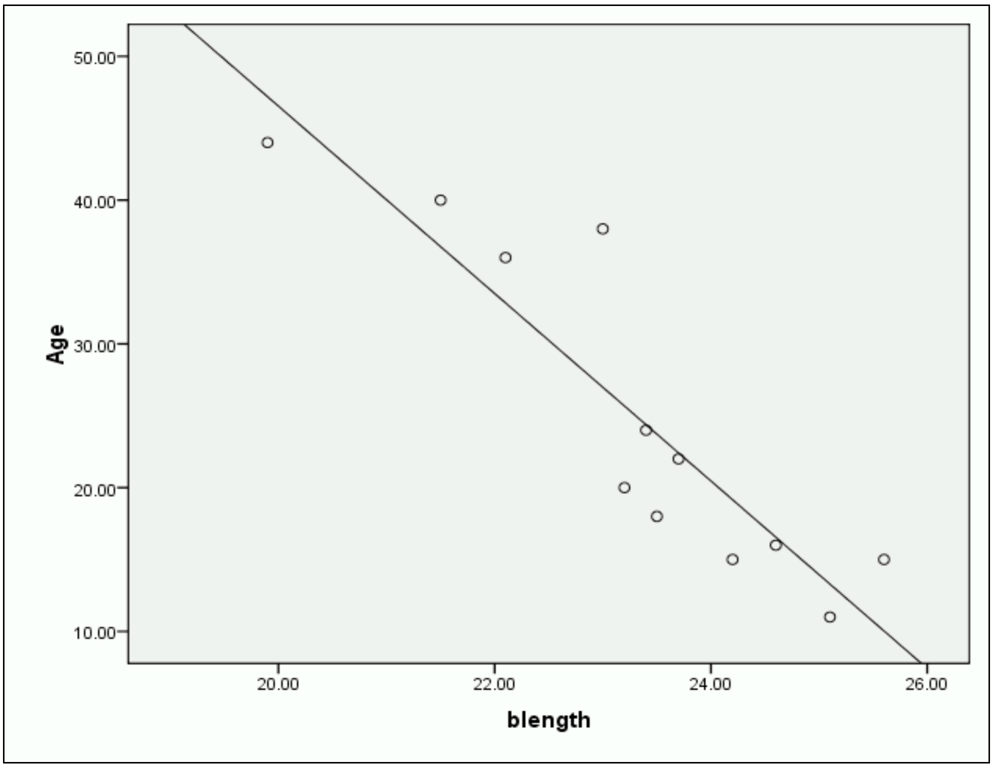

Figure (8): Pulp length at bucco-lingual view.

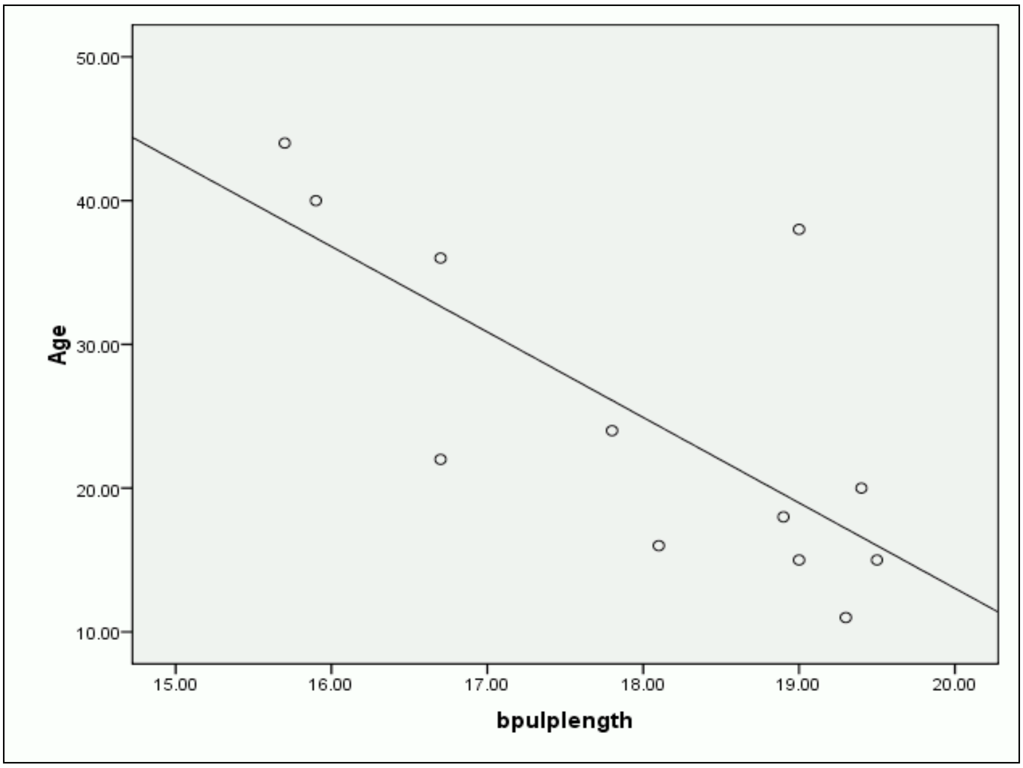

Figure (9): Tooth length at bucco-lingual view.

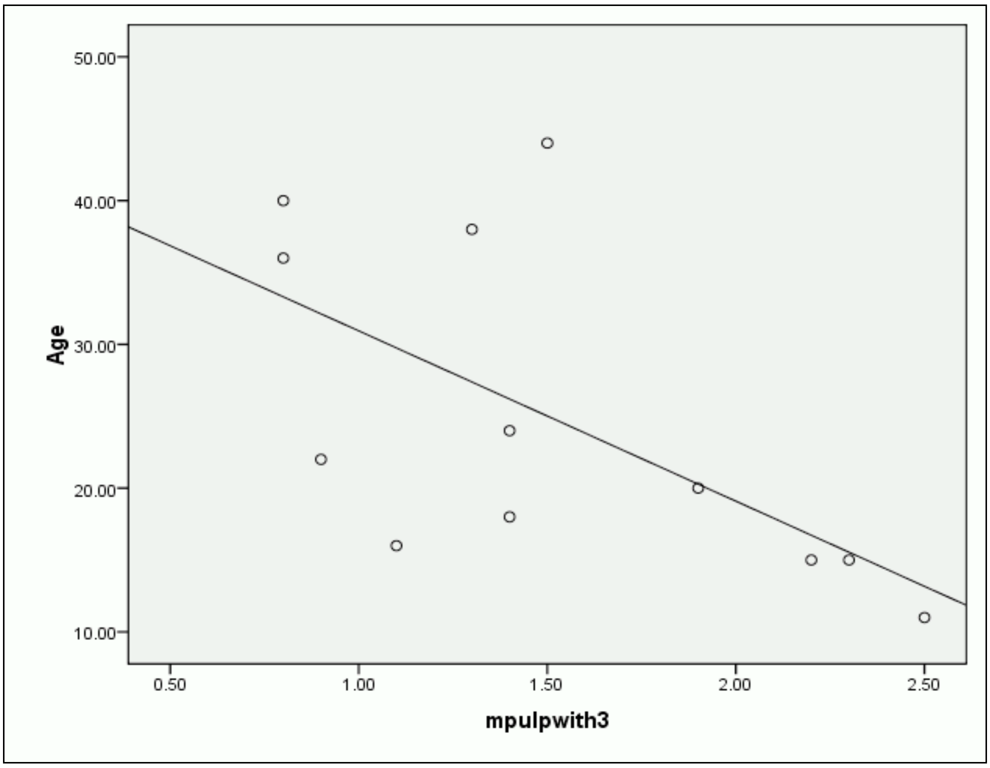

Figure (10): Pulp width at mid pulp level in mesio-distal view.

Correlation of age with different measurements of upper first premolar

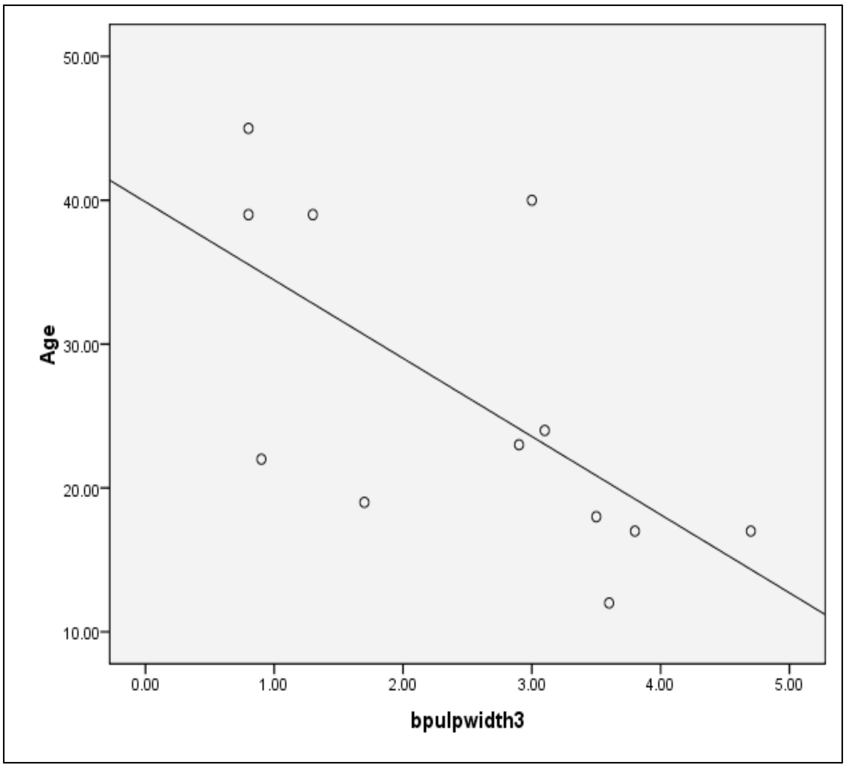

Figure (11): Pulp width at mid root level at buccolingual view.

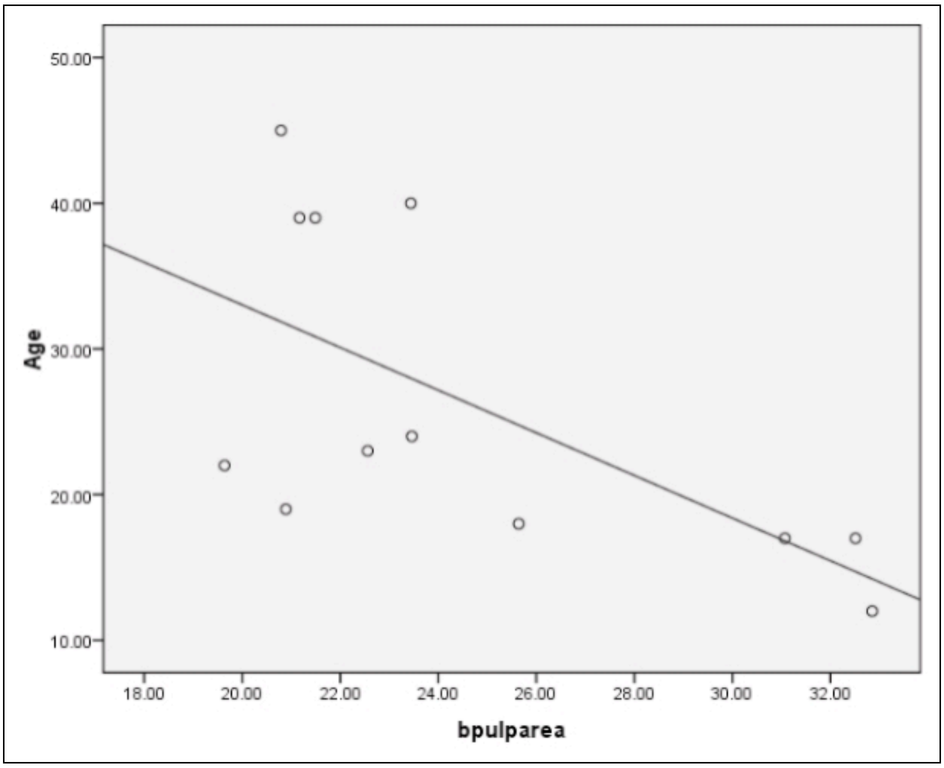

Figure (12): Pulp area at bucco-lingual view.

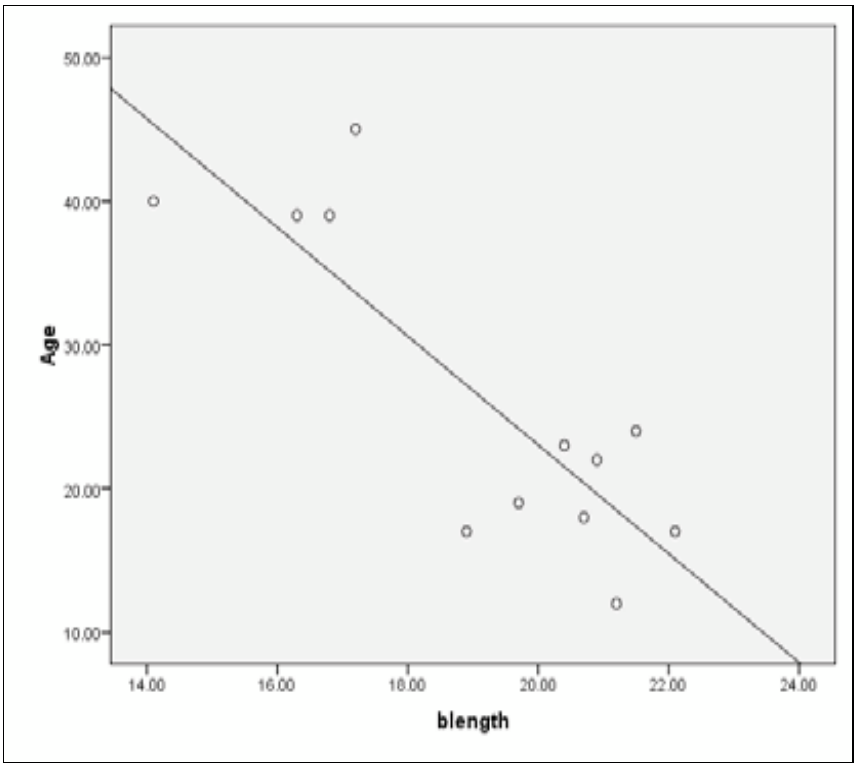

Figure (13): Pulp length at bucco-lingual view.

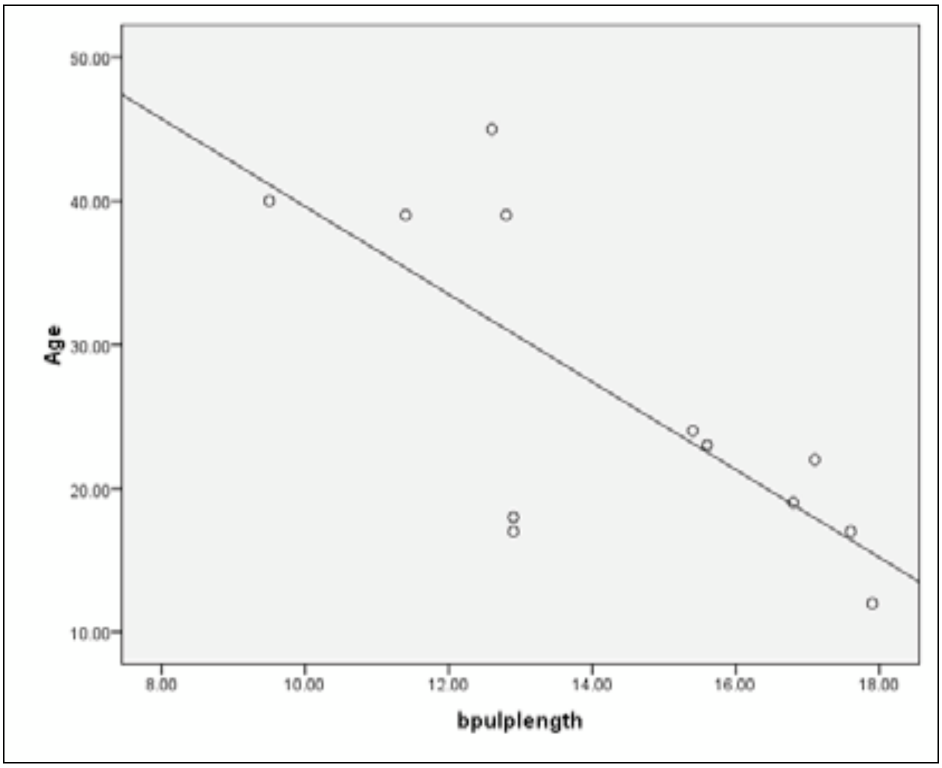

Figure (14): Tooth length at bucco-lingual view.

Discussion

Quantification of the teeth morphological changes nearly always requires extraction and sectioning of teeth, which is unethical and impossible in living individuals. Therefore techniques that have been developed for age estimation in living individuals mostly rely on radiological imaging of teeth (Bosmans et al., 2005).

In previous studies of dental age estimation from two dimensional dental radiographs, the ratio between the pulpal size and root size and the ratio between the pulpal size and tooth size have successfully been used (Kvaal, 1995) . As the size of the pulp is reduced with age, the correlation coefficient between age and the ratio is negative . Based on these earlier studies the ratio between pulpal volume and tooth volume has been chosen as a possible age indicator in the present study, whereas the use of Cone beam computed tomography(CBCT) provides plenty of 3D volume information of the teeth on living individuals in the target area by a single scan (Fan et al., 2006) .

CBCT was first introduced in the early 1980s. It has a high resolution images, a favorable cost/benefit ratio, and a small radiation dose. Therefore, it had a great evolution in terms of both distribution and applications, being nowadays widely available (Faccioli et al., 2010).

Cone-beam CT in dental use provides plenty of 3D volume information of the teeth on living individuals in the target area by a single scan (Macleod and Heath, 2008). The measurement of the volumes of pulp and canal at different views and levels of tooth can be operated non-destructively and accurately for age estimation.

Several studies utilize CBCT to correlate pulp/tooth volume with chronological age of persons (Fan et al., 2006) since attrition, caries and periodontal recession may influence tooth volume measurements. The present study was done on the use of pulp/root volume ratio’s which might give a better results and could facilitate the collection of samples.

Earlier studies by (Someda et al., 2009) and (Star et al., 2010) utilized one tooth, either upper or lower central incisor for their analysis. In the present study, upper central incisor, lateral incisors, upper canines and upper first premolars were studied in each subject resulting in a database containing volume information of 96 central incisors, 96 lateral incisors, 96 canines, and 96 first premolars to reveal statistical evidence of relation between the pulp/canal volume ratio and age estimation that may differ between the types of teeth.

This because apposition of secondary dentine is not homogenously spread over all the walls of the pulp cavity and even differs in relation to the examined tooth type (Macleod and Heath 2004) . The results of the present study confirmed this hypothesis and revealed that upper first premolar followed by upper central incisor then upper canine were the most accurate tooth for age estimation.

The upper first premolar sowed the highest correlation with age at different measurements. This could be explained by a reported finding; that this tooth was the least variable one in its mesiodistal dimension (Farag et al., 2012).

Also, measurement of pulp width at coronal or mid root for upper central incisor either at bucco-lingual or mesiodistal dimension was found to correlate with age. Taking into account that this tooth has the lowest morphological diversity among human teeth and that secondary dentine formation occurs first at the most coronal aspects of the pulp chamber these results would be acceptable (Drusini et al., 1997).

Prediction analysis of age with different teeth measurements revealed that the most accurate model for determination of age in upper first premolar was measurement of pulp length or pulp width at the coronal /mid root level (R was 97%). For upper central incisor, measurement of pulp width at mid root level (Bucco-lingual view) results in more accurate prediction for age (R 96%). While, age estimation for canine measurement was more accurate with measurement of tooth length at Bucco- lingual view (R was 90%).

The weakest Pearson correlation was detected for the upper lateral incisor, a tooth with the greatest variability in size (Farag et al., 2012). Also, axial view was insignificant for prediction of age with any tooth. Therefore, neither upper lateral incisor tooth nor axial views are recommended for age estimation.

So the study concluded that using CBCT is useful in detection of age by obtaining linear teeth measurements. In addition, the use of the upper first premolar tooth measurements followed by upper central incisor followed by upper canine are useful in estimating the chronologic age of any person .

Further investigation using CBCT measurement of the multi-rooted teeth is recommended.

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الملخص العربي

تقدير العمر من خلال بعض قياسات الأسنان باستخدام مخروط الشعاع التصويري المقطعي في عينة من سكان مصر العليا

هاله محمد أحمد[1] و أشرف عبد العظيم عويس[2] و نجوى محمد خطاب[3] و مها اسحق عامر[4]

ازداد دور علم الأسنان الشرعي في السنوات الأخيرة، ويعد تقدير سن ألأحياء أو المتوفين جانبا هاما من جوانب هذا العلم. ولطرق تقدير عمر الأسنان قيمة خاصة لأن الأسنان شديدة المقاومة للعوامل الميكانيكية والكيميائية والتأثيرات المادية والوقت. لذلك كان الهدف من هذه الدراسة التوصل إلى طريقه ممكنه لتقدير السن من خلال بعض قياسات الأسنان و اللب باستخدام مخروط الشعاع التصوير المقطعي الرقمي. وقد أجريت الدراسة على ثمانية وأربعين شخص (24 ذكرا و 24 أنثى). وتم اخذ قياسات متعددة شملت الأسنان القواطع العليا المركزية، القواطع العليا الجانبية، الأنياب العلوية والضرس الضاحك العلوي الأول وكذلك بقياس اللب بكل منها على مختلف المستويات (أقصى عرض للتاج، منطقة عنق السنة، في منتصف الجذر وقمة الجذر). وقد أسفرت هذه الدراسة أن النموذج الأكثر دقة لتحديد العمر هو عن طريق قياسات الضرس الضاحك العلوي الأول عن طريق قياس طول اللب + عرض اللب في منطقة التاج + عرض اللب في منتصف مستوى اللب حيث R تساوي 97%. أما العرض اللبي في المستوى المتوسط من اللب من القاطعة المركزية العليا فكانت أيضا طريقة دقيقه لتحديد عمر الأسنان(R تساوي 96%). أما قياس طول الأسنان للناب العلوي فهي طريقة اقل دقة لتحديد العمر حيث R تساوي 90%. لذا خلصت هذه الدراسة إلى أن استخدام CBCT مفيد في تحديد العمر باستخدام القياسات الخطية للأسنان، بالإضافة إلى ذلك فقد أثبتت الدراسة أن استخدام قياسات الضرس الأول الضاحك العلوي هي أدق طريقه لتحديد العمر يليها القاطعة المركزية العليا ثم الناب العلوي.

1 قسم الطب الشرعي والسموم الإكلينيكية كلية الطب جامعة المنيا
2 قسم الصحة العامة كلية الطب جامعة المنيا
3 قسم طب أسنان الأطفال كلية طب الأسنان جامعة المنيا
4 قسم الأشعة كلية طب الأسنان جامعة المنيا