Digital panoramic estimation of chronological age among Iraqi adult population in relation to morphological variables of canine teeth

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ABSTRACT

Background: Age determination of skeletal remains is apart of many medico-legal as well as anthropological examination. Many anatomical structures have been studied, but the teeth and their measurements seem to be the most reliable method since teeth represent the most durable and resilient part of the skeleton. This study was undertaken for estimating the chronological age among Iraqi adult subjects based on various morphological variables of canine teeth using digital panoramic radiograph.

Material and methods: The sample in the current study consisted of 240 Iraqi patients attending to the dental radiological clinic at College of dentistry/ Babylon University taking panoramic radiographs for different diagnostic purposes, the study sample included both sexes with age ranged 20-60 years old, the following measurements of maxillary right canine have been taken with the aid of computer program (2008): Maximum tooth length, root length measured from midpoint of cemento-enamel junction to the root apex, pulp length, root width at cemento-enamel junction, root width at mid-root level, root width at mid-point between cemento-enamel junction and mid-root level, pulp width at cemento-enamel junction, pulp width at mid-root level, pulp width at mid-point between cemento-enamel junction and mid-root level, tooth area, pulp area. The data were subjected to statistical analysis using Statistical Package for Social Sciences version 13.

Results: The result of the current study showed that from the various parameters measured, the differences between real age and estimated age of subjects were not statistically significant except for root length and pulp area which show significant difference between real age and estimated age with p-value 0.004 and 0.002 respectively.

Conclusion: Age of the subjects can be estimated using regression equations including root length and pulp area for the examined tooth.

Keywords: Forensic dentistry, Age estimation by canine teeth, Orthopantomography. (J Bagh Coll Dentistry 2013; 25(4):44-48).

الخلاصة :

تحديد العمرمن بقايا الهيكل العظمي يعتبر جزء من فحوصات الطب الشرعي وكذلك الأنثروبولوجيه ولقد تم دراسة العديد من الهياكل التشريحية ولكن الأسنان وقياساتها تعتبر الأكثر موثوقية ومرونة والأكثر دواما" كجزء من الهيكل العظمي.

الهدف من الدراسة : أجريت هذه الدراسة لتقدير العمر الزمني لعينه من السكان العراقيين البالغين وذلك بالأعتماد على مختلف المتغيرات الشكلية للأنياب باستخدام الاشعه البانورامية الرقمية.

المواد وطرائق العمل : العينة في الدراسة الحالية تتألف من 240 مريضا عراقيا حضروا الى العيادة الأشعاعية في كلية طب الأسنان/ جامعة بابل لأخذ صورة بانورامية لأغراض مختلفة من كلا الجنسين وبعمر يتراوح من 20-60 سنة, من كل صورة بانورامية اخذت القياسات التالية من ناب الفك العلوي الأيمن بمساعدة برنامج حاسوب يدعى التصميم الهندسي: الحد الأقصى لطول الأسنان، طول الجذر يقاس من منتصف ال (CEJ) إلى قمة الجذر، وطول اللب ، عرض الجذر في CEJ، عرض الجذر في مستوى منتصف الجذر، عرض الجذر في منتصف نقطة بين CEJ ومستوى منتصف الجذر، عرض اللب في CEJ، عرض اللب في مستوى منتصف الجذر، عرض اللب في منتصف نقطة بين CEJ و مستوى منتصف الجذر، مساحة السن، ومساحة اللب. واستخدمت البيانات للتحليل التمييزي بأستخدام برنامج احصائي (.SPSS.version13) .

النتائج : أظهرت نتائج الدراسة الحالية من مختلف المتغيرات التي قيست, عدم وجود اختلاف احصائي بين العمر الحقيقي والعمر المقدر بأستثناء طول الجذر ومنطقة اللب التي تظهر اختلاف احصائي كبير بين العمر الحقيقي والعمر المقدر مع قيمة V 0.004 و 0.002 على التوالي. الجنس ليس له تأثير احصائي على تقدير العمر.

الأستنتاجات : يمكن تقدير العمر بأستخدام معادلات الأنحدار المتضمنه طول الجذر ومساحة اللب للسن المقاس.

مفاتيح البحث: طب الاسنان القضائي, تحديد العمر من اسنان الانياب, الاشعه البانوراميه الرقمية.

INTRODUCTION

Forensic Odontology is a relatively new science that utilizes the dentist's knowledge to serve the judicial system. Worldwide, dentists qualified in forensic science are giving expert opinion in cases related to human identification, bite mark analysis, craniofacial trauma and malpractice.

Human identification relies heavily on the quality of dental records; however Forensic Odontologists can still contribute to the identity investigation in the absence of dental records through profiling the deceased person using features related to teeth [1].

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It is often necessary to estimate an individual's age due to certain questions related to legal requirements in paleodemographic research or in a forensic context.

Although several parts of the body can be used for age estimation, the poor condition of the remains in particularly severe crashes or fires in cases of those recently dead; or of moisture and burial conditions in the case of historic subjects, make many parts of the body unusable. For these reasons, teeth are the part of the body most frequently used for identification and age estimation [4].

In children, age determination from teeth is a relatively simple, accurate procedure and is based on the stages of development and eruption of

teeth. However, in adults it is a challenge to medico-legal science [5].

Up to now, a multiplicity of methods have been applied to this problem, including methods which analyze the various forms of tooth modification such as wear, dentin transparency, tooth cementum annulations, racemization of aspartic acid and apposition of secondary dentin. Canines were chosen to assess age and gender for a number of reasons: they have the longest functional survival rate in the mouth, undergo less wear as a result of diet than posterior teeth, are less likely than other anterior teeth to suffer wear as a result of particular work, and are the single-root teeth with the largest pulp area and thus the easiest to analyze [9].

The study of tooth radiographs is a non destructive and simple process which can be applied to both living and deceased persons [10].

Panoramic radiography is a radiological technique for producing a single image of the facial structures. It is become a very popular in dentistry [15]

In the present study digital panoramic radiography used for determination of age and gender in Iraqi adults subjects.

MATERIAL AND METHODS

The study sample consisted of 274 subjects, 34 subject excluded because they were not fit to the criteria of inclusion designed for the current study. After clinical and radio-graphical examination 240 subjects (108 male and 132 female) of different age groups ranged 20-60 years selected in the study sample, the collected sample include patients attended for different diagnostic purposes to the Dental Radiology Department at the College of Dentistry, University of Babylon.

Those subjects were divided according to the age range into four groups,

Criteria of inclusion

Fully erupted right maxillary canine;
1- Right maxillary canine free from any pathology such as caries, pathological lesion, periodontitis, abrasion, erosion or fracture.
2- Absence of restoration and endodontic filling of the right maxillary canine.
3- Absence of mal-aligned or rotated right maxillary canine.

Digital Panoramic radiograph of each patient was taken, using certain exposure factors for each gender (male and female) according to user manual.

The images were examined on the monitor for the clear representation enhancement of the resolution was done if needed then saved, the images were entered as 1024*768 pixel digital images (JPEG files) in the computer system, and then imported to Adobe photo-shop image editing software program (Adobe system Incorporated, San Jose, (A,USA) (1990-2002).

Minimum of 20 points around the edge of tooth outline and minimum of 10 points around the pulp outline of the right maxillary canine were identified, then image were printed and tracing of these points by 0.5 pencil, in order to evaluate the measurements of the canine tooth area and the pulp area from the radiographic image[12], figure 1.

Next the images were imported to the Auto CAD program, it was appear in the master sheet on which the points were determined, and then measurements were obtained, after correction of magnification by multiplying the readings by the magnification factor which was obtained as a ratio between a real distance measurements for a scale and the distance measurements for the same scale from radiographic image, after that the measurements were saved on an Excel sheet.

The following measurements for the right maxillary canine were taken on the panoramic images:
1- Maximum tooth length.
2- Root length measured from midpoint of cemento-enamel junction (CEJ) to the root apex.
3- Pulp length.
4- Root width at CEJ.
5- Root width at mid-root level.
6- Root width at mid-point between CEJ and mid-root level.
7- Pulp width at CEJ.
8- Pulp width at mid-root level.
9- Pulp width at mid-point between CEJ and mid-root level.
10- Tooth area.
11- Pulp area.

Statistical analysis was performed using SPSS v. 13(SPSS Inc., Chicago, USA). Linear regression model for age estimation was developed by selecting those variables which contributed significantly to age estimation. Student's t- test was used to compare the morphological variables of males with those of females and to compare observed age with estimated age. A p value ≤ 0.05 was considered statistically significant.

RESULTS

In the present study, 108 males and 132 females (total 240 subjects) were divided into four

groups. The morphological variables did not show any significant difference between the sexes.

Table 1 shows the regression analysis in males, while Table 2 shows the result in females and Table 3 in the total study sample.

In the total study sample only root length (0.004) and pulp area (0.002) showed significant difference between real age and estimated age, which yielded the following linear regression formula to estimate chronological age: **Estimated chronological age =18.73 + 2.55 (Root length) - 0.92 (Pulp area).**

There was no significant difference between observed and estimated age for any of the age groups (Table 4). Also there was no significant difference between observed and estimated age for either males or females (Table 5).
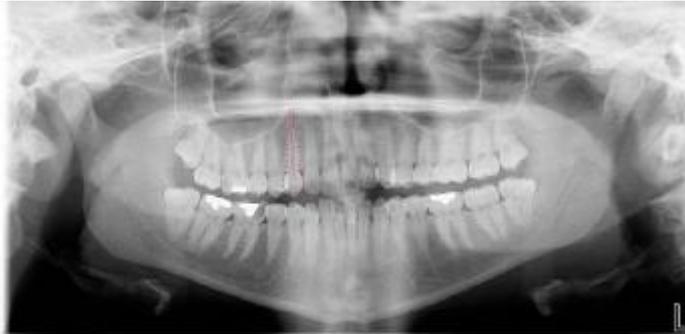
Figure 1: Panoramic radiographic image showing points on tooth and pulp outline.

Table 1: Regression analysis for all morphological variables (predictors) and age as the dependent variable in males (n = 108)

Model	Regression Coefficients	S.E.	Significant level	
			t-test	P-value
Constant	27.31	18.34	1.49	0.140 (NS)
Tooth length	-1.57	1.46	-1.08	0.285 (NS)
Root length	2.23	1.30	1.71	0.090 (NS)
Pulp length	0.29	0.65	0.45	0.656 (NS)
Root width at CEJ	3.85	2.67	1.44	0.152 (NS)
Root width at mid-root level	-2.61	3.33	-0.78	0.435 (NS)
Root width at midpoint between CEJ and mid-root level	-0.63	3.65	-0.17	0.863 (NS)
Pulp width at CEJ	-3.09	3.47	-0.89	0.375 (NS)
Pulp width at mid-root level	5.99	3.41	1.76	0.082 (NS)
pulp width at midpoint between CEJ and mid-root level	-3.11	3.56	-0.87	0.386 (NS)
Tooth area	0.09	0.14	0.67	0.504 (NS)
Pulp area	-0.69	0.38	-1.82	0.073 (NS)

Table 2: Regression analysis for all morphological variables (predictors) and age as the dependent variable in females (n = 132)

Model	Regression Coefficients	S.E.	Significant level	
			t-test	P-value
Constant	-1.90	22.43	-0.08	0.933 (NS)
Tooth length	-0.86	1.42	-0.61	0.546 (NS)
Root length	2.54	1.41	1.81	0.074 (NS)
Pulp length	0.09	1.25	0.07	0.946 (NS)
Root width at CEJ	3.67	3.62	1.01	0.313 (NS)
Root width at midroot level	0.45	3.82	0.12	0.907 (NS)
Root width at midpoint between CEJ and midroot level	2.81	4.40	0.64	0.524 (NS)
Pulp width at CEJ	12.46	5.64	2.21	0.29(NS)
Pulp width at midroot level	-1.43	6.73	-0.21	0.833 (NS)
pulp width at midpoint between CEJ and midroot level	-6.27	6.39	-0.98	0.328 (NS)
Tooth area	-0.14	0.23	-0.60	0.553 (NS)
Pulp area	-0.60	0.76	-0.80	0.428 (NS)

Table 3: Regression analysis for all morphological variables (predictors) and age as the dependent variable in the total study sample (n = 240)

Model	Regression Coefficients	S.E.	Significant level	
			t-test	P-value
Constant	18.73	12.93	1.45	0.149 (NS)
Tooth length	-1.65	0.93	-1.76	0.079 (NS)
Root length	2.55	0.88	2.91	0.004 **
Pulp length	0.27	0.57	0.48	0.629 (NS)
Root width at CEJ	2.80	2.18	1.28	0.201 (NS)
Root width at mid-root level	-1.75	2.43	-0.72	0.473 (NS)
Root width at midpoint between CEJ and mid-root level	1.06	2.79	0.38	0.705 (NS)
Pulp width at CEJ	3.54	2.55	1.39	0.166 (NS)
Pulp width at mid-root level	-0.09	2.40	-0.04	0.971 (NS)
pulp width at midpoint between CEJ and mid-root level	1.46	2.69	0.54	0.590 (NS)
Tooth area	0.06	0.12	0.52	0.605 (NS)
Pulp area	-0.92	0.30	-3.12	0.002 **

Table 4: Comparison between real and estimated age in subjects grouped according to age.(years)

Age Groups (years)	Age in years (mean ± SD)		Significant level	
	Real age	Estimated age	t-test	P-value
20-29	24.89 ± 1.89	24.72 ± 2.78	-0.49	0.873 (NS)
30-39	34.66 ± 2.89	34.42 ± 2.97	-0.65	0.762 (NS)
40-49	44.82 ± 2.58	44.22 ± 2.98	1.33	0.640 (NS)
50-59	54.70 ± 2.78	54.78 ± 2.89	0.61	0.733 (NS)
Over all	36.62 ± 11.45	36.56 ± 2.98	0.08	0.936 (NS)

Table 5: Comparison between real and estimated age of subjects according to gender.(years)

Gender	Age in years (mean ± SD)		Significant level	
	Real age	Estimated age	t-test	P-value
Male	36.19 ± 10.44	36.67 ± 2.99	-0.51	0.609 (NS)
Female	36.97 ± 12.25	36.47 ± 2.96	0.48	0.632 (NS)
Over all	36.62 ± 11.45	36.56 ± 2.98	0.08	0.936 (NS)

DISCUSSION

The result of the present study showed that the regression analysis for all morphological variables (predictors) with age as the dependent variable showed no significant differences when compared between real age and estimated age in both males and females, as described in table 1 and 2 respectively.

And for the total study sample the regression analysis for all morphological variables (predictors) with age as the dependent variable showed non- significant differences when compared between real age and estimated age with exception of root length and pulp area which showed statistically significant differences between real age and estimated age in the total study sample(p-value for root length 0.004 and p-value for pulp area 0.002) as described in table 3, so by using age as the dependent variable and root length and pulp area as the independent variable, the linear regression formula obtained in the

current study to calculate or estimate chronological age for Iraqi population was: **Age = 18.73+2.55*(Root length)-0.92*(Pulp area).**

Cementum keeps forming throughout life, the continuous apposition of cementum is influenced by the functional state and dental changes like attrition and abrasion, correlation between age and root length infers the formation of cementum at the root apex with aging [6]. Secondary dentin with advancing age is deposited along the wall of the dental pulp chamber leading to a reduction in the size of the pulp cavity [14].

The pulp area acts as indicator of age because area decrease is due to secondary dentin formation [11].

Saxena [12] studied the age estimation by direct orthopantomographs of 120 canines (maxillary right canine) of Indian patients of both sexes with age ranging (21-60 years old), and by measuring the same variables used in the present study and according to the total sample, he found that pulp/tooth area ratio and pulp/root width ratio at

mid root level showed significant differences, he put regression model for age calculation as follow: **Age = 72.48-203.74*pulp/tooth area ratio -5169*pulp/root width ratio at mid-root level**.

This formula was designed for Indian population indicating that racial and cultural factors might play an important effect on age estimation.

The present study showed that comparison between real and estimated age in relation to age groups showed no significant difference for all the age group[2], Table 4.

The accuracy of age estimation diminishes with age, the possible reasons might be the reduction of the criteria and signs for the estimation of OPGs in older persons and the variability of the oral health status of patients in older age groups [8].

The present study showed no significant influence of gender on age estimation using canine tooth measurements [3]. Panoramic images are useful in the demonstration of the complete dentition, position and anatomy of the teeth including maxillary canines [7]. The current study performed on single tooth since accurate measurements are difficult to perform on multi-rooted teeth, and in order to create a uniform amount of distortion in all images, as the curved arch of the jaw is projected on to a flat film, so there will always be a certain amount of distortion when measuring the image [13].

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