Estimation of Age from Spheno-Occipital Synchondrosis Closure using Computed Tomography in Yemen

Abstract

Background: The spheno-occipital synchondrosis was chosen as an age marker of interest since past researches suggested that there is considerable variation in the time of closure which required further investigation. In order to obtain the most accurate estimations of age population specific data are required.

Objective: The aim of the present study was to determine the chronology and pattern of union of the spheno-occipital synchondrosis among Yemeni subjects using CT scanning to assess if this age marker is a useful tool for age estimation.

Subjects and Methods: In this cross-sectional study, a sample of 217 subjects of both sexes whose ages ranged between 15 and 25 years was examined. The studied group was formed of 121 males and 96 females. The state of fusion of the SOS or basilar synchondrosis was examined as a biological age indicator using a high resolution multi-slice CT scans of the head.

Results: Mean ages of open, semi-closed, closed sutures with scar and closed sutures without scar were 16, 18, 21.32 and 21.78 years in males, and 15, 20, 21.56 and 20.41 in females, respectively. Complete fusion was seen at 16 years old or above in males and 15 years old or above in females. Spearman's correlation ratio coefficient showed a linear correlation between age and suture situation in both sexes ($p<0.000$* for both and rho = 0.509 & 0.080 for males and females, respectively).

Conclusion: Our findings indicated that the stage of fusion of the spheno-occipital synchondrosis using computed tomography could be a useful forensic tool to determine age in both sexes in Yemen population.

Keywords: Age estimation, Spheno-occipital synchondrosis, Computed tomography, Yemen.

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Introduction

Estimation of age is one of the important factors that help in identification. The determination of age is needed for employment, marriage, majority, management of property, voting right, competency as witness and testamentary capacity. The significance of determination of the age is most important in the criminal cases, such as rape, infanticide, kidnapping, prostitution, juvenile delinquency and criminal responsibility [1]. There has been increasing interest in the study of skeletal age markers in recent years due to growing pressure on forensic practitioners to provide more accurate age estimations [2].

Determination of the age of individuals from bones is one crucial step in forensic medicine. Numerous studies over the past century have been conducted to assess the accuracy of qualitative and quantitative observations for estimating bone age. As complete dependence on one bone to determine individual's age is not so reliable, it has become necessary to develop techniques for age estimation from as many different bones bearing age markers as possible [3]. In general, estimating the age is problematic because of human variability in the growth and aging processes. Analysis of errors associated with skeletal age estimation methods is necessary so that the performance of these methods is not overestimated and the uncertainty of these skeletal techniques can be quantified and better understood [4].

According to Iscan Y [5], nearly every bone contains an age marker, but it is important that we "know where to look and how to recognize and interpret them." This pursuit to properly interpret which areas of the skeleton exhibit morphological changes with age has been immense. Some of the most well-documented and utilized age indicators include cranial suture closure, dentition, epiphyses and ossification centers, and the articulating surfaces of the ox coxae (pubic symphyses and auricular surface). Below the age of 14–15 years, the developing dentition and hand/wrist ossification provide reasonably accurate age estimations but, once these development sites have completed growth, accurate age estimation becomes far more difficult. Determination of adult or adolescent status of an unknown age individual is difficult due to the paucity of skeletal and dental age markers available around this age; the only readily examinable markers being the 3rd molar tooth and the medial clavicular epiphysis, both of which display considerable variation in development [2].

One of these indicators that have been advocated as a good age indicator is the state of fusion of the spheno-occipital synchondrosis, although there are different ideas about its reliability [6]. Recent developments in technology, however, have streamlined the ability to collect and analyze data and open the door for new and more accurate methods to be created. Though such technologies were not developed specifically for forensic or anthropological investigation, their extended application has been very useful. For instance, X-rays, CT scans and MRI primarily used in the field of diagnostic medicine, have now become tools in anthropological investigation [7].

In Yemen, a reliable documentation of birth certificates is lacking furthermore, this is particularly the case with the increasing numbers of undocumented individuals moving across international borders resulting in the need to determine the age status of many of these people; particularly around the adolescent/adult cut-off point of 18 years, an important legal demarcation in many jurisdictions. The current research is an endeavor to establish a new quantitative method in Yemen to study the closure of one of the most important cranial sutures, which can address continuous variability more adequately, using computed tomography. The goals of this study are to determine the sequence and timing of closure of the spheno-occipital synchondrosis among Yemeni subjects using CT scanning and to assess if this radiological tool is a useful method for age estimation for individuals around the age of 18 years and then, to construct a specific regression analysis equation for Yemen population.

Subjects and methods

Study Design

This is a cross-sectional study of the relationship between spheno-occipital synchondrosis closure and chronological age.

Sample

The study population consisted of a random sample of Yemen society. A sample of 217 High resolution multi-slice CT scans of the head was evaluated to determine the ossification stage of the spheno-occipital synchondrosis in individuals aged from 15 to 25 years with verified dates of birth. The studied group was formed of 121 males and 96 females. Most images were obtained for clinical purposes from consecutive patients, with known dates of birth and who have attended the Department of Radiology of University of Science & Technology (UST) Hospital (Yemen) between January and October 2012. In each case, the identification number, gender and date of birth of the person, the date of the examination and the ossification status of the spheno-occipital synchondrosis were recorded.

The reminder of subjects in the same age group (between 15 and 25 years) were taken from schools and colleges of Sana'a; the capital of Yemen. The date of birth of the subjects was confirmed from birth certificates, early childhood immunization records or passport. The chronological age was calculated by subtracting the date of birth from the date of the radiological examination. The individuals who were born in other governorates and residing in Sana'a will be also included in the study. Subjects of different geographical locations, climates and socioeconomic status will be included in the study, but no attempt has been made at this stage to categorize individuals according to residence or socio-economic status, although this is the subject of future research. Clinical examination (anthropometric criteria, signs of sexual maturation) and odontological examination will be done. The main criterion considered in the study for forensic age determination in the relevant age group based on odontological examination is tooth eruption. Tooth eruption means the gingival emergence of the crown of the tooth. It is diagnosed by inspecting the oral cavity of the person concerned; no X-ray is required. Clinical examination was done just to exclude any abnormalities in growth that may alter bone age. The study was conducted in accordance with the ethical standards laid down by the Declaration of Helsinki (Finland). The World Medical Association developed the Declaration of Helsinki as a statement of ethical principles for medical research involving human subjects, including research on identifiable human material and data.

Inclusion & Exclusion Criteria

Individuals of unknown age or those who had suffered significant head trauma which potentially affected the area of interest were excluded from the sample. Individuals with endocrine diseases, metabolic, nutritional disorders, systemic chondroosseous disease, or underlying bone pathology (such as punched-out lesion or internal frontal hyperostosis) were excluded from the sample. All examinations regarding traumatologic or neoplastic changes were not included in the sample, although indications were not statistically evaluated. All examinations with poor image quality were also excluded.

Radiographic staging

The degree of SOS closure was classified in many literatures into different grades by measurement or assessment of the length of the suture itself. In our study the ossification stages of the spheno-occipital synchondrosis were defined using a four stage system modified from that developed by [2]. The stages are as follows:

Stage 1: Completely open

Stage 2: Closed superior border.

Stage 3: Complete fusion with a visible fusion scar

Stage 4: Complete fusion with no visible fusion scar

Radiographic Measurement

All CT data were acquired on High resolution multi-slice CT scanner, on osseous window (Brilliance 64). The imaging system utilised at the (UST) Hospital is a Siemens SOMATOM® DEFINITION AS multi slice scanner (Global Siemens Healthcare Headquarters, Germany), with the following protocol: 120kvp, 64-175mAs, collismation, 16×0.625; rotation time 0.28 seconds; pitch 0.683; section slice 4.8m, Number of slices 2 x 128, Isotropic resolution 0.33 mm, temporal resolution 75 ms). The images are then reconstructed and viewed on the scanner's workstation using the Siemens software package.

Statistical analysis

All the images were staged by one observer. After 1 month, 30 images were randomly selected from the sample and reevaluated by the same as well as a second observer. Inter and intra-examiner agreement was determined using Cohen's Kappa coefficient (non-parametric test). Regression Analysis was carried out taking age as a dependent variable (Y) and degree of fusion (open=0, semi closed= 1, closed with visible scar= 2, closed with no visible scar= 3) as an independent variable (X) for the whole sample and in both sexes separately. The following statistical measures were calculated for all studied variables: minimum age, maximum age, mean with standard deviation. The Pearson correlation coefficient between variables in both sexes was calculated. The analyses were performed on the entire group and separately for males and females.

All statistical analyses were performed using SPSS for Windows version 17 (statistical package for social science, Chicago, Illinois, USA).

Results

The sample included 217 subjects (121 males and 96 females) whose ages ranged between 15 and 25 years. Regarding the age distribution of the sample population there was no significant difference in sex among different age groups (p value > 0.05 and Pearson chi-square= 2.814).

Male Subjects

With regards to male subjects, 13 cases had open suture with a mean age of 16±1.53 years, twenty cases had semi-closed suture with a mean age of 18.5±2.54 years. In the group with semiclosed suture, twenty-five male cases had closed suture with persistent scar their mean age was 21.32±2.21 years. Furthermore, sixty-three cases had closed suture without any visible scar. In this group the mean age was 21.78±2.94 years. There was a significant difference in SOS stage among different age groups (p<0.000*) (Table 1 & Figure 1).

One-way ANOVA showed significant difference between age and suture closure in male group (P<0.001*). Spearman's correlation ratio coefficient showed linear correlation between age and suture closure (P<0.001*). Regression analysis was carried out taking age as a dependent variable (Y) and degree of fusion (open = 0, semi-closed = 1 closed without scar = 2 and closed with scar=3) as an independent variable (X). Linear regression gave the following formula for age prediction: $Y = 14.905 + 1.788 \times X$ ($R2 = 0.335$). Linear regression parameters for prediction of age in male subjects by Spheno-occipital suture closure status are shown in (Table 2). Thus the mean age of male subjects with open Spheno-occipital suture was 16 years (with 95% confidence interval 13.4-16.4 years). The mean age of male subjects with semi-closed Spheno-occipital suture was 18.5 years (with 95% confidence interval 17.2-20.7 years). In the male subjects with closed spheno-occipital suture with persistent scar the mean age was 21.32 (with 95% confidence interval 20.0-23.6 years). Also the mean age of male subjects with closed spheno-occipital suture without any visible scar was 21.78 years (with 95% confidence interval 20.4-24.0 years).

Female subjects

With regard to female subjects, 3 cases had open suture, their mean age was 15 years and nine cases had semi-closed suture with mean age 20±2.35 years. Moreover, sixteen female cases had closed suture with persistent scar. In this group, the mean age was 21.56±2.31 years and sixty-eight cases had closed suture without any visible scar with a mean age of 20.41±3.24 years (Table 3 & Figure 2).

One-way ANOVA showed a significant difference between age and suture closure in the female group (P<0.001*). Spearman's correlation ratio coefficient showed linear correlation between age and suture closure (P<0.001*). Regression analysis was carried out taking age as a dependent variable (Y) and degree of fusion (open = 0, semi-closed = 1 closed without scar = 2 and closed with scar = 3) as an independent variable (X). Linear regression gave the following formula for age prediction: $Y = 18.614+0.633 \times X$ ($R2 = 0.025$). Linear regression parameters for prediction of age in female subjects (weighted by age) by Spheno-occipital suture closure status are shown in Table 7. Thus the mean age of female subjects with open Spheno-occipital suture was 15 years (with 95% confidence interval 14.5-15.8 years). The mean age of female subjects with semi-closed Spheno-occipital suture was 20 years (with 95% confidence interval 19.5-20.8 years). In the female subjects with closed spheno-occipital suture with persistent scar the mean age was 21.56 (with 95% confidence interval 21.1-22.4 years). Also the mean age of female subjects with closed Spheno-occipital suture without any visible scar was 20.41 years (with 95% confidence interval 20.0-21.2 years) (Table 4).

Regression analysis was carried out for the whole sample (combined male and female sample) taking age as a dependent variable (Y) and degree of fusion (open = 0, semi-closed = 1 closed without scar = 2 and closed with scar = 3) as an independent variable (X). Linear regression gave the following formula for age prediction: $Y = 15.988+1.348 \times X$ ($R2 = 0.166$). Linear regression parameters for prediction of age in combined male and female subjects by Sphenooccipital suture closure status are shown in (Table 5).

Intra-examiner testing revealed slight differences when the same observer scored a series of 30 images with a 1 month time difference. There were only six instances where scores did not completely agree (80% agreement), and these differed by only one stage. Inter-examiner testing displayed a slightly lower degree of reliability with seven different readings of only one stage (76.67% agreement). Cohen's Kappa measure of agreement gave a figure of 0.729 for intra-examiner testing and 0.678 for inter-examiner testing. These values represent a good agreement and demonstrate that the stages of closure for the spheno-occipital synchondrosis are distinct and easily interpreted. These results are displayed in Table 6.

A midline ossification center within the sphenooccipital synchondrosis and or additional symmetric ossification centers on either side of the midline center were observed in 12.9% of cases (28 of 217 subjects). The percent of cases with ossification center was 81.25% (13 out of 16 cases) in those with stage 0, 51.72% (15 out of 29 cases) in those with stage 1 and almost no ossification centers were observed in stages 2&3 (Table 7)

Table 1: Descriptive Means of Age in Males by Spheno-Occipital Synchondrosis Closure Status.

SOS Stage	Mean(age) in years	Std. Deviation	Minimum	Maximum	Range	Std. Error of Mean	Number
Open	16	1.528	15	20	5	0.424	13
Semi closed	18.5	2.544	15	23	8	0.569	20
Closed with Scar	21.32	2.212	16	24	8	0.442	25
Closed without Scar	21.78	2.937	16	25	9	0.37	63
Total	20.52	3.248	15	25	10	0.295	121

ANOVA test There was a significant difference in the mean age between different SOS stage groups (p value <0.000, $F = 33.563$).

Table 2: Linear Regression Parameters for Prediction of Age in Males by Spheno-Occipital Synchondrosis Closure Status.

Coefficients (Dependent Variable: Age by years)								
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95% Confidence interval for B	
		B	Std.error	Beta			Lower bound	Upper bound
1	Constant	14.905	0.765		19.49	0	13.39	16.419
	SOS Status	1.788	0.231	0.579	7.741	0	1.331	2.246

Table 3: Descriptive Means of Age in Females by Spheno-Occipital Synchondrosis Closure Status.

SOS Stage	Mean	Std. Deviation	Minimum	Maximum	Range	Std. Error of Mean	Number
Open	15	0	15	15	0	0	3
Semiclosed	20	2.345	16	22	6	0.782	9
Closed with Scar	21.56	2.308	17	24	7	0.577	16
Closed without Scar	20.41	3.238	15	25	10	0.393	68
Total	20.4	3.14	15	25	10	0.321	96

There was a significant difference in the mean age among SOS stages (p value<0.001*, $F = 5.148$).

Table 4: Linear Regression Parameters for Prediction of Age in Females by Spheno-Occipital Synchondrosis Closure Status.

	Coefficients (Dependent Variable: Age by years)							
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B	
		B	Std.error	Beta			Lower bound	Upper bound
1	Constant	18.614	0.330		56.488	0.000	17.967	19.260
	SOS Status	0.633	0.090	0.157	7.011	0.000	0.456	0.810

Table 5: Linear Regression Parameters for Prediction of Age in the Whole Sample by Spheno-Occipital Synchondrosis Closure Status.

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
1 (Constant) SOS_CODED	15.988	.713		22.432	.000	14.583	17.393
	1.348	.206	.407	6.540	.000	.941	1.754

Table 6: Observer Agreement.

	Intra-Examiner	Inter-Examiner
No. of Cases	30	30
Mean of difference	0.0	0.0
SD of difference	0.643	0.587
Score Agreement (%)	80%	76.67%
Cohen's Kappa (K)	0.729	0.678

Table 7: State of Ossification Centers in Spheno-Occipital Synchondrosis.

Stage	State of Ossification Centers				Total
	Present		Absent		
	No	%	No	%	
Stage 0	13	81.25	3	18.75	16
Stage 1	15	51.72	14	48.28	29
Stage 2	0	0	41	100	41
Stage 3	0	0	131	100	131
Total	28	12.90	189	87.10	217

Table 8: Time of Spheno-Occipital Synchondrosis Closure in our Study Compared with Different Studies.

Current Study, 2012 (Yemeni Subjects; CT scan):		
SOS Stage *	Males	Females
Stages 0 – 1	≤ 23	≤ 22
Stages 2- 3	≥ 16	≥ 15
*SOS Stages: 0: Open, 1:Semi-closed, 2: Closed with scar, 3: Closed without scar.		
Akhlaghi, et al. [6] (Iranian Subjects; Direct Inspection):		
SOS Stage*	Males	Females
Stages 0 – 1	≤ 21	≤ 13
Stages 2	≥ 15	≥ 12
*SOS Stages: 0: Open, 1: Semi-closed, 2: Closed.		
Sahni, et al. [21] (Indian Subjects; Direct Inspection, X- ray & CT scan):		
SOS Stage*	Males	Females
Stages 0 – 1	< 19	< 17
Stages 2	≥ 15	≥ 13
*SOS Stages: 0: Unfused, 1: Partially fused, 2: Completely fused.		

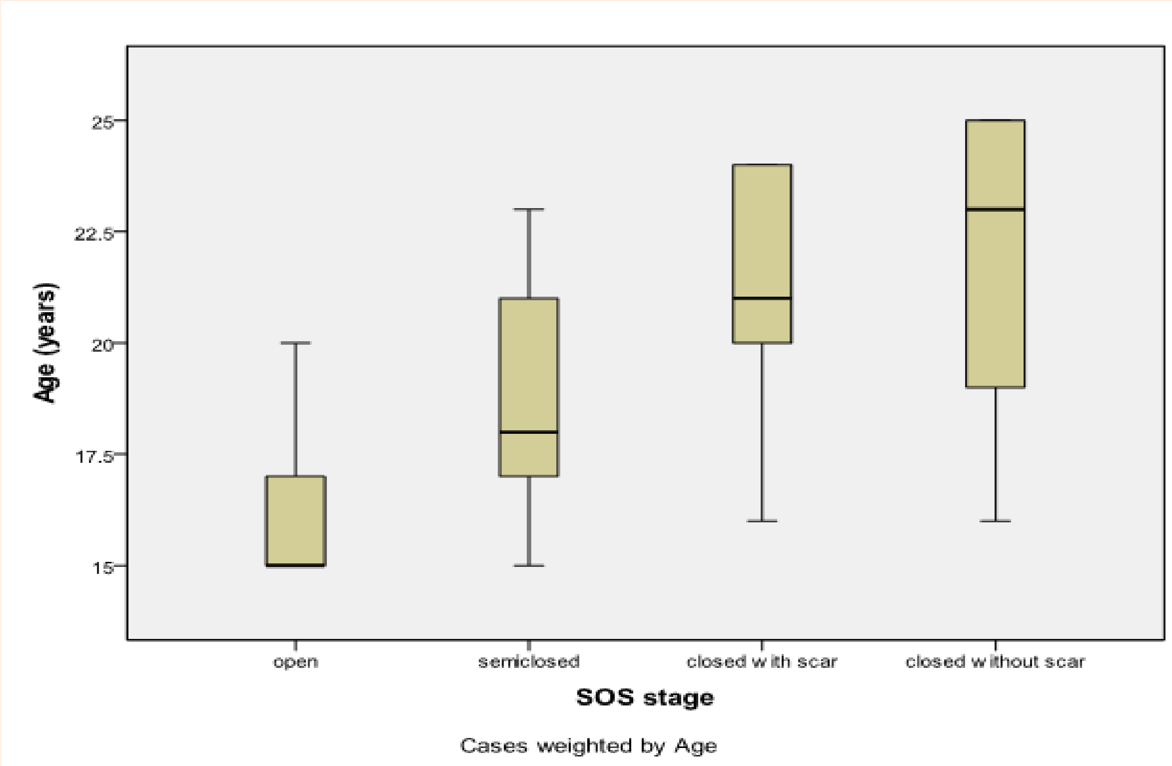

Figure 1: Box-Plot of Spheno-occipital Synchondrosis Status in Male Subjects by Age.

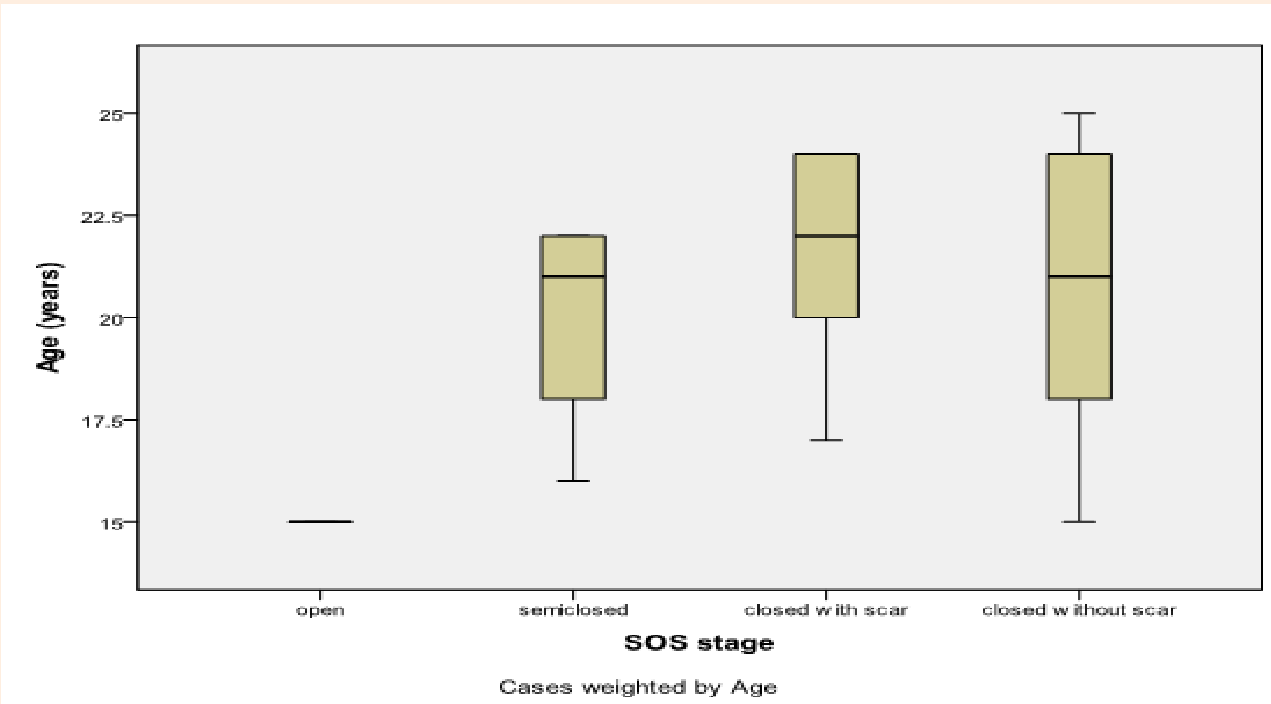

Figure 2: Box-Plot of Spheno-occipital Synchondrosis Closure Status in Females.

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Discussion

Forensic Age Estimation (FAE) defines an expertise in forensic medicine which aims to define, in the most accurate way, the 6 chronological age of person of an unknown age involved in judicial or legal proceedings. The term “estimation” defines more precisely than other as “diagnosis” the real limits inherent to this expertise. The state of the art in FAE is such that nowadays there is no medical test or a group of tests that absolutely and accurately let us know the exact chronological age of a human being [8].

During the last few years, a growing section of forensic anthropology concerns the study of living individuals and, in particular, the problem of identifying and estimating age in living young adults for legal purposes [9]. Verified documentation of the date of birth is the only way of determining the exact age of an individual. However, in subjects who do not possess proper identification documents, it is of the utmost importance to verify whether these persons should be accepted as juveniles or adults. This is so not only in criminal prosecutions but also in civil hearings, including determination of refugee status. Although age thresholds change according to country of interest, in most countries, the age of relevance to criminal liability ranges between 14 and 18 years [10].

Nowadays, a new research focuses on the development of multi-factorial methods for age estimation, whereby a combination of methods (or anatomical growth markers) can provide the most accurate age estimate with the smallest possible error. The difficult task for forensic researchers assessing age for the purposes of the legal system is still to convey accurately the degree of error inherent in whatever method is used and to clarify the likelihood that an individual below 18 years of age will be wrongly classified as an adult. New techniques have been developed for older teenage individuals, which can provide age estimates with substantially narrower age ranges at the 95 % confidence level [9].

The spheno-occipital synchondrosis was chosen as an age marker of interest since past researches suggested that there is considerable variation in the time of closure which required further investigation to assess its suitability as an age estimation tool for a certain age group. Past research has demonstrated that population specific data are required in order to obtain the most accurate estimations of age [2]. Furthermore, there has also been no study of the spheno-occipital synchondrosis and its closure sequence in the Yemeni population. In this cross-sectional study, the relationship between spheno-occipital synchondrosis closure and chronological age is analyzed. The advent of multi-slice computed tomography in the forensic field has enabled researchers to examine skeletal age markers with a greater degree of detail than has previously been possible. Most research to date using this imaging modality has been confined to slice thicknesses of 3–7 mm, which whilst better than conventional radiography, does not provide sufficient resolution to enable accurate separation of growth stages for areas such as the medial clavicle and the spheno-occipital synchondrosis [11]. This study utilized 4.8 mm slices of the area of interest, which provides high resolution images that allow accurate separation into the various growth stages.

Early radiological observations [12,13] regarding the ossification of the synchondrosis vary from puberty to the third decade. After giving reference to several books, Mckern T & Stewart T [14] came to the conclusion that there was no agreement on the age at which complete fusion occurs between the two bones. Several other investigators suggest that the synchondrosis stays open throughout childhood and early adolescence and states fusion times that lie between 18-25 years [6,15-17]. This would suggest that there may be significant inter-population differences related to ancestry for this development site and highlights the need for population specific data. Kahana T, et al. [18] found no correlation between chronological age and the closure degree of the synchondrosis in males, although in females they found it a possible reliable indicator of age but they had a small sample comprising of 21 females.

Many studies show variations in the time of SOS closure which raises the issue of inter population variation. Another possible reason for this variation in fusion between studies is the different methods of analysis used by different researchers. Dry skulls, histological sections, conventional radiography, and CT imaging may possibly be interpreted differently. A synchondrosis which looks completely closed in a dry skull may not be so when a high resolution CT scan of the same skull is viewed. The same applies to conventional radiography images, which for this particular age marker are very difficult to interpret due to the difficulties involved in aligning the X-ray beam with the synchondrosis, and the large number of overlying structures which can confuse interpretation of the image [2]. In this cross-sectional study, a large sample of both sexes was examined. It is apparent that progressive closure of the synchondrosis is correlated with age. Our results showed that the closure degree of Spheno-occipital suture has a linear correlation with age. Mean ages of open, semi closed and closed suture groups were significantly different in both sexes.

We examined the state of fusion of the SOS or basilar synchondrosis as a biological age indicator in a sample of 217 subjects of both sexes whose ages ranged between 15 and 25 years. Our findings indicated that the stage of fusion of the SOS can be a useful indicator of age in male and female subjects, when estimating age of unknown individual, although further investigation on different ethnic population is recommended. Mean ages of open, semi-closed, closed sutures with scar and closed sutures without scar were 16, 18, 21.32 and 21.78 years in males, and 15, 20, 21.56 and 20.41 in females, respectively. Seemingly, their difference was significant ($p < 0.001^*$). Complete fusion (closed) was seen at 16 year olds or above in males and 15 year olds or above in females. Spearman’s correlation ratio coefficient showed a linear correlation between age and suture situation in both sexes ($rho = 0.509$, $P<0.000^*$ in males and $rho = 0.080$, $P<0.000^*$ in females). In male subjects when the suture is closed (with or without scar), age is 16 years or above and when the suture is open or semi-closed, age is 23 years or below. Males transition from closing to closed at 24 years. In female subjects when the suture is closed (with or without scar), age is 15 years or above and where the suture is open or semi-closed, age is 22 years or below. Females transition from closing to closed at 23 years.

In the males, partial fusion was seen at 15 years while a complete fusion was noticed at 16 years in 25% of the subjects. The age of a boy showing complete fusion should be 16 years or above. If there is no fusion or partial fusion he should be below 24 years as complete fusion is seen in all male subjects at 24 years. In females, the earliest partial fusion was noted at 16 years and complete fusion was present at 15 years in 62.5%. All female subjects showed complete fusion at 23 years. The minimum age of a girl showing complete fusion should be 15 years; if no fusion or partial fusion is seen, her age should be below 23 years. The small number of 15-year-old females may not represent a true sampling of this age group as all eight individuals at this age were either stage 0 or 3, whereas the same age group in males displayed greater variation, with 87.5% &12.5% of the cases was in stage 0 & 1 respectively.

By age 21 years in males no individual score was less than 1, with a progressive increase in the number of individuals scoring 2and then 3 as the fusion scar became less apparent over time. By age 23 years in females no individual score was less than 2, with a progressive increase in the number of individuals scoring 3 as the fusion scar completely disappear at the age of 25. The current study demonstrated consistency with studies of Akhlaghi M, et al. [6] in the timing of fusion particularly in male subjects (Table 8). This study also demonstrates some consistency with several other researchers in the timing of fusion [15,19,20]. Some authors stated that development in females is earlier than males; our study was compatible with such studies but in contrast with Bassed R, et al. [2] in which there was no statistical difference between the sexes after the age of 16 years.

Detailed comparison of time of spheno-occipital synchondrosis closure in our study with different studies is shown in Table 8. The present results indicated that, in general, the observer agreement is good for both intra and inter-observer variability (Cohen's Kappa (K): 0.729 & 0.678 respectively). The results of the inter- and intra-examiner error testing revealed that scoring this age marker is reliable and reproducible both with one observer, and also between different observers. There were very few differences between examiners, and no instances of greater than one stage scoring discrepancy. The differences that did occur resulted from cases where the synchondrosis could be classified as being in between two stages, and therefore more difficult to assign to a particular stage. Results of other studies utilizing the same scoring system but different examiners will therefore be comparable.

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