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Forensic Assessment of Age Using Pelvic Bone X-rays in Libyan Population in Tripoli

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Selection of appropriate methods for estimate age depends of course on what skeletal elements are present and what general age is represented. Techniques utilized to estimate age at mature individuals differ from those needed to analyze the skeleton. This study aimed to determine the forensic age using pelvic X-rays on a sample of the Libyan population in Tripoli. A cross-section study was carried out at the Orthopedic Traumatic Center of Tripoli Hospital study includes two groups; Group I which includes 78 patients and aged between (15-20 years) and divided into Group Ia (39 Male) & Group Ib (39 females). Group II which includes 78 patients and aged between (21-25 years) and divided into Group IIa (39 Male) & Group IIb (39 females). All subjects will be subjected to poster anterior pelvis X-rays to determine age by Cameriere's method. The attainable results regard age estimation was assessed by applying the Cameriere's method showed measuring the area of iliac crest apophysis (1+2) to area of iliac wing (A) in two persons. By comparison of the ratio of iliac crest apophysis to the area of iliac wing (ICA/IW), the study results showed that there was a highly statistical significance increase in ICA/IW ratio among Group II compared to Group I. Pearson's correlation coefficient used to calculate correlation between quantitative variables. There was a statistical significance highly positive correlation between ICA/IW ratio and age in the two studied groups but more in group II. There was a statistical significance increase in frequency of cases had bony extension among male compared to female in both studied groups. The accuracy of the measured parameters was estimated. The accuracy of the height of ilium in determination of male sex at cut off more than 14.55 mm was 68.6% and that of inter-acetabular distance at cut off less than 15.05 mm was 64.1%. The modified approach of Cameriere used for the iliac crest apophysis is potentially applicable in the forensic age estimation of living individuals. The ICA/IW ratio is of interest in age estimation for forensic purposes, both in the living and the deceased. X-ray examination is a good and reliable tool in estimation of forensic age.

Keywords: Pelvic Bone X-rays, Cameriere's method and ICA/IW ratio.

INTRODUCTION

Estimation of age of the victim or remains are important guides that help in the process of identification (Byers, 2016). Age estimation is important in forensic medicine for identification of deceased victims and also for crimes and accidents. The process of the identification of the

skeletal remains in forensic anthropology as it reduces the number of possible matches by half (Saukko and Knight, 2016). In living, it is important to determine the true age of individuals in radiology and forensic medicine (Norouzi et al., 2019). The legal age of adolescents and young people is an important issue in civil, criminal, and

immigration law (Wittschieber et al. 2013). Moreover, in forensic medicine, it is important to determine the exact age of individuals (Bartolini et al. 2018). In recent years, the subject of forensic age and sex estimation in living individuals has developed itself to a well-established forensic research field using different approaches and criteria (Keough et al. 2017). In many European countries, the relevant age thresholds for numerous aspects in criminal, civil and asylum law lie between 14 and 25 years. Accordingly, the study group on forensic age diagnostics of the German society of legal medicine developed recommendations for these legal fields comprising radiological assessments of the bone changes such as pelvic bones (Schmeling et al. 2016). The pelvis is possibly the most accurate bone in the human body for age with the accuracy being 95% when completed. In addition, it is estimated that the accuracy of gender identification from the subpubic angle, ventral arc, and composite is approximately 98%. The study of the pelvis in cadavers has long been used for forensic purposes (Hartnett, 2010; Schmeling et al. 2016). In the living, the analysis of the process of ossification and fusion of pelvic bones has mainly focused on the iliac crest (Martins et al. 2012). There are many previous studies that used the pelvis X-rays to determine forensic age (Bartolini et al. 2018). Therefore, this study is aimed to determine the forensic age using pelvic X-rays on a sample of the Libyan population in Tripoli.

MATERIALS AND METHODS

A cross-section study was carried out at the Orthopedic Traumatic Center of Tripoli Hospital during the period study from 1 January 2020 to 31 March 2020. Approval of the study was obtained from the Department of Forensic Medicine and Toxicology and Institutional Review Board (IRB), Faculty of Medicine, Zagazig University, Egypt.

Inclusion and exclusion criteria:

Subjects included in the study with age from 15 to 25 years of both sex (males and females). While, patients with any bone deformities, age < 15 years and > 25 years, patients with known congenital or acquired skeletal diseases or pelvic trauma and subjects with a history of developmental bone disorders were excluded from this study.

Technical Design:

The study includes two groups: Group I which includes 78 patients and aged between (15-20 years) and divided into Group Ia (39 Male) & Group Ib (39 females). Group II which includes 78 patients and aged between (21-25 years) and divided into Group IIa (39 Male) & Group IIb (39 females). All patients were clinically examined and analyzed of Antero/ posterior pelvic X-ray at Orthopedic Traumatic Center by the senior of radiologist. Only specific variables of each patient were recorded for this study, including date of birth, gender and identification number. Corresponding medical records did not reveal any disease affecting the skeletal development of the patients.

Technique of pelvis X-ray examination:

The pelvic radiographs were done according to standard procedures: lying patient, anterior/posterior path of rays, approx. 75 kV on average and usage of a digital luminescence radiography system. Pelvic radiographs with projection artefacts, fractures and superimposition of foreign material or intestinal loops were excluded from image assessment. Image evaluation and manual segmentations were done at a standard picture archiving and communication system (PACS) workstation using the following software: GE Centricity RIS-i 4.2 Plus, version 4.2.26.8;1;6;8;9;21;12, 2011 GE.

Bone pelvis age estimation (Cameriere's Method):

This method provides a measurement of areas on X-rays according to Cameriere's approach for age estimation in the living and requires the measurement of the area of the ossification center (s) of the iliac crest apophysis (ICA) and the area of the iliac wing (IW); ICA/IW ratio is used for linear regression analysis and the elaboration of a formula that allows an estimation of age. The evaluation of the images and measurements was performed at a computer workstation provided with standard picture archiving and communication system (PACS). Cameriere's approach for age estimation analysis method (AM) was applied blindly and separately to both sides of the pelvis.

Statistical Analyses:

The collected data were computerized and statistically analyzed using SPSS program (Statistical Package for Social Science) version 25.0. Linear regression models were calculated.

Age was the dependent variable. Comparison of left vs. right side was performed using the t test for paired observations. Comparison of the sexes was done by variance analysis. Qualitative data were represented as frequencies and relative percentages. Chi square (χ^2) test was used to calculate difference between qualitative variables. Independent t-test was used to calculate difference between quantitative variables in two groups in normally distributed data and Paired sample t-test was used to calculate difference between quantitative variables in the same group at different times. Pearson's correlation coefficient used to calculate correlation between quantitative variables and Linear regression analysis used to calculate the equation to estimate the age from (ICA/IW) ratio. As follow: ($y = c + b*x$). The significance Level for all above mentioned statistical tests done. The threshold of significance is fixed at 5% level (P-value), P value of <0.05 indicates significant results.

RESULTS

The attainable results regard age estimation was assessed by applying the Cameriere's method showed measuring the area of iliac crest apophysis (1+2) to area of iliac wing (A) in two persons (Figure 1). By comparison of the ratio of iliac crest apophysis to the area of iliac wing (ICA/IW), the study results showed that there was a highly statistical significance increase in ICA/IW ratio among Group II compared to Group I (Figure 2).

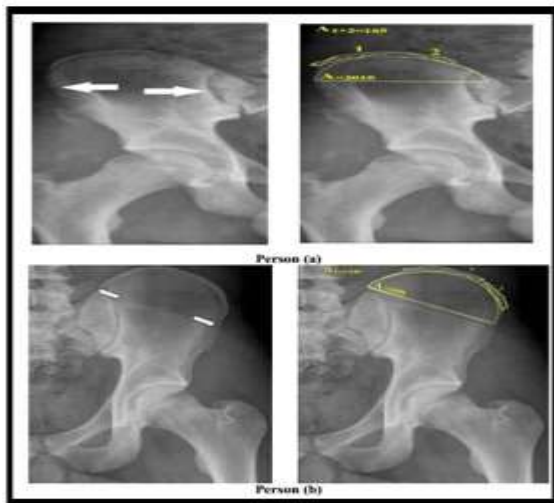


Figure 1: Anteroposterior view of pelvic bone X-ray showing Cameriere's approach for age estimation by measuring the area of iliac crest apophysis (1+2) to area of iliac wing (A) in two persons.

The linear regression analysis used to calculate the equation to estimate the age from (ICA/IW) ratio. As follow: $y = c + b*x$ (Table 1). Pearson's correlation coefficient used to calculate correlation between quantitative variables. There was a statistical significance highly +ve correlation between ICA/IW ratio and age in the two studied groups but more in group II (Figure 3).

Table (5): Linear regression analysis for independent predictors for age in Group I (15-20 years) and Group II (21-25 years):

Group	B	SE	t	P	Constant
All groups (n=156)	20.1	0.73	27.61	<0.001**	14.26
Group I (n=78)	15.04	2.06	7.32	<0.001**	14.99
Group II (n=78)	14.97	1.84	8.15	<0.001**	16.61
Male (n=78)	20.69	0.84	24.64	<0.001**	14.07
Female (n=78)	19.64	1.21	16.11	<0.001**	14.46

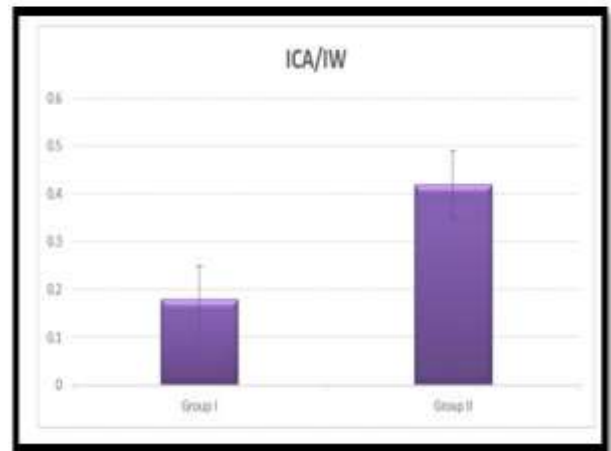


Figure 2: Bar chart showing iliac crest apophysis to iliac wing ratio (ICA/IW) among Group I (15-20 years) and Group II (21-25 years)

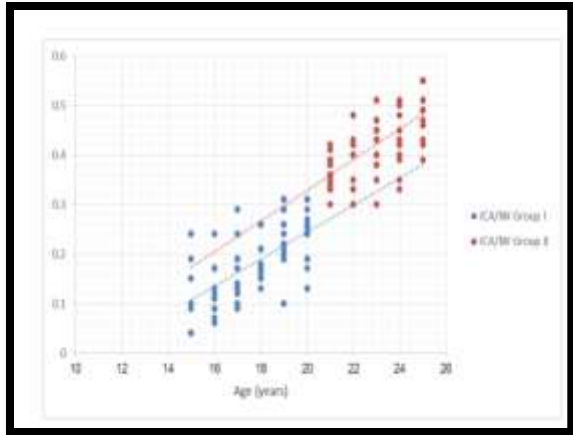


Figure 3: Correlation between iliac crest apophysis to iliac wing ratio (ICA/IW) and age among Group I & II.

DISCUSSION

According to pelvic bone age estimation, the methodological approach of Cameriere which is used in this study to estimate age allows for definitions of new points on the pelvic radiograph by which, compared to other systems, the basis of a grading system might be considered as more objective (Cameriere et al. 2009).

Going with this study, Wittschieber et al. (2013) presented an innovative approach for the evaluation of the ossification of the iliac crest, inspired by the Cameriere's method. Unlike the other staging methods, this new suggested approach is not based on a subdivision in stages but on measurements and ratios of certain areas. The ratio between the area of the ICA and the iliac wing IW was calculated and used for linear regression analyses.

The current study showed that there was a statistical significance increase in iliac crest apophysis and iliac wing (ICA/IW) ratio among Group II (21-25 years) compared to Group I (15-20 years).

Since the age of a case can affect the results of anthropological measurements, it is advantageous and sometimes indispensable to perform studies on equally distributed populations by age (Bartelink et al. 2018). It is generally believed that the pelvis is possibly the most accurate bone in the human body for age and sex determination, with the accuracy being 95% when completed (Cappella et al. 2017). In addition, it is estimated that the accuracy of age and sex

identification from the subpubic angle and ventral arc is approximately 98% (Varzandeh et al. 2019). In this study, the pelvic bone was assessed, which has important differences in age. Therefore, purpose of this study was to determine the forensic age and sex using pelvic X-rays on a sample of the Libyan population in Tripoli.

Bartelink et al. (2018) were able to define and calculate the area of the apophysis of the iliac crest and then apply the method only up to 18 years of age in males and 20 in females (instead of 24). But analyzing the threshold of applicability in close detail, it seems to be lower for females. All females over 17 years, with the exception of one aged 20, reached such an advanced level of ossification as to prevent the applicability of the method. They concluded that, the iliac crest ossification is of interest in age estimation for forensic purposes. The evaluation of the pelvis X-ray, in addition to the other common skeletal methods, could become a useful supplementary tool in age estimation for the 14 year threshold in order to fulfill forensic-level requirements. Khan et al. (2018) concluded that, there was significant differences exist between Indian and European and African anthropometry in age estimation. In the present study, we found that the breadth of the pelvic inlet was significantly higher in females. This result was similar to findings by Mullaji et al. (2010) and Sitek et al. (2012) who studied the mean breadth of the pelvic inlet was different between these studies which could be due to the methodological differences.

CONCLUSION

The modified approach of Cameriere used for the iliac crest apophysis is potentially applicable in the forensic age estimation of living individuals. The ICA/IW ratio is of interest in age estimation for forensic purposes, both in the living and the

deceased. The statistical analysis showed very good reliability and good correlation with age. X-ray examination is a good and reliable tool in estimation of forensic age.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

AUTHOR CONTRIBUTIONS

All authors read and approved the final version.

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