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The use of medial epiphysis of the Sudanese clavicle to determinate age group (20-24 Years)

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Abstract
Bone age determination is a procedure performed in radiology to describe the maturation degree of bone which takes great importance in forensic age determination. Development of medial clavicular epiphysis is a useful tool in age identification because the clavicle is last long bone ossified. This study was done to evaluate the ossification of medial claviclular epiphysis in Sudanese people in Khartoum state from Sep.2010 to Jan.2011, aimed to determinate the bone age. The study was conducted in Khartoum and Gaffer Ibnaof Hospitals, Chest X-rays (posteroanterior view) have been taken for group of 50 individuals from 20 to 24 years, and 35 of these images permitted assessment ossification of medial epiphysis. 15 images not allowed the ossification assessment due to overlapping of structures. The study found that ossification of medial clavicular epiphysis is partially-ossified from 20 to 24 year in male. However in age 24 in female it is semicomplete ossified, complete fusion of Sudanese medial clavicular epiphysis was not observed in this age group 20-24 years. These findings was compared to previous studies and showed that fusion of medial epiphyseal plate of the clavicle is partial at this age group, and there is a landmark of rapid ossification in females in age 24. It was concluded that plain chest radiographs can essentially be used to analyze the clavicular ossification. It was recommended that in case there is overlapping posterior-anterior views impeding evaluation, additional radiographic examinations, should also be taken to facilitate age determination.

Keywords: bone age determination, medial clavicular epiphysis and ossification

1. Introduction
The clavicle is useful for age estimating its epiphysis fused at post-pubertal period (Singh & Chavali 2011) [8]. There are two primary ossification centers medial and lateral, which appear during the 5th and 6th weeks of intrauterine life and normally fused during fetal life (Benson & Williams 2008) [8]. Secondary ossification center appears at the sternal end form medial clavicular epiphysis that begins to fuse with the shaft between 18 and 25 years of age and is completely fused to it between 25 and 31 years (Moore 2006) [5].
D Errico 1928 mentioned that union occurred between 18 and 29 years. The medial clavicular epiphysis start to unite by age 21 and united completely by age 25. There is no significant sex or race differences.
Analyzes of 380 individuals under the age of 30 years, showed that appearance epiphyseal ossification center occurred between ages 11 and 22 years. Partial fusion was found from age 16 until age 26 years while complete fusion was first noted at age 22 years and in 100 % of the sample at age 27 years (Kreitner *et al*. 1998) [4].
In both sex medial clavicuar ossification stages as follows; stage 2 was first noted at age 15, in male the earliest occurrence of stage 3 was detected at age 17, in female at age 16, Stage 4 was first achieved by both at age 21, stage 5 was first observed in female at age 21 and in male patients at age 22 (Schulz *et al*. 2005) [6]. CT scans was done to study the medial epiphyseal plate ossification of the clavicle of 100 patients (50 male and 50 female) between 16 -25 years. Turnover from stage 3 to stage 4 was observed at the age of 21 years, 95% of stage 4 over 21 years while 75% of the patients with stage 3 were less than 21 years (Dirk *et al*. 2006) [3]. Stage 2 of medial clavicular epiphysis ossification was observed at the age of 15 years, the earliest age at which stage 3 was noted was 16.9 years, and stage 4 was first noted at the age of 23.8 years (Sven *et al*. 2007) [7].

2. Objectives
2.1 General Objective
- To determinate the age of individuals by using ossification of medial epiphyseal plate of the Sudanese clavicle through radiological evaluation.

2.2 Specific Objectives
- To study the status of ossification of medial clavicular epiphysis in males and female and compare between male and female in growth rate.
- To initiate base line data for future studies in Sudan since there is lake in researches concerning the bone age estimation.

3. Materials and Methods
3.1 Study Design
Posteroanterior radiographs of the sternoclavicular joints was obtained to determine the ossification stage of the medial clavicular plate.

3.2 Study area and Duration
This cross sectional descriptive study was conducted at the Radiology Units of Khartoum, Omdurman and Gaffer Ibna of Hospitals, from September 2010 to January 2011.

3.3 Study Population
X.ray chest have been taken by X.ray Machine Toshiba 1996, for group of 50 (25 for each gender) Sudanese people (Male& Female) age from 20-24 years during their admition to the hospitals at radiology unit.

3.4 Materials
The plain chest x-ray was used to determine the ossification of the medial clavicular epiphysis. To assess the degree of ossification of the medial clavicular epiphyseal cartilage, the classification into four stages commonly applied in anatomical and radiological studies as follows:
Stage 1: The ossification centre has not ossified.
Stage 2: The ossification centre has partially ossified.
Stage 3: The ossification centre has semi complete ossified.
Stage 4: The ossification centre has completely ossified.

3.5 Inclusion Criteria
35 permitted to evaluate medial clavicular epiphysis with posteroanterior chest x.ray.

3.6 Exclusion Criteria
15 of the cases are not possible to perform evaluation of medial clavicular epiphysis for many causes due to overlapping of structures at medial end of the clavicle.

3.7 Data Analysis
The collected data was analyzed with Computer program SPSS version 16. The mean and standard deviation were estimated for quantitative data and frequency and ***%*** were calculated for qualitative data. The results presented in shape of tables and figures.

4. Ethical Considerations
All individuals were informed about the research objectives and procedures during the interview period. Written valid consent was obtained from all participants.

5. Results
This study was done to evaluate the fusion of medial clavicular epiphysis of participants ranges from 20-24 years. 25 male & 25 female as shown in the following tables: Table 1: Demonstrate that from 25 male 16 permitted evaluation, in contrast 25 of females19 allowed evaluation. Table 2: Show ages of male individuals, epiphyseal plate was detected in male ranged from 20 to 24 years. Table 3: Show ages of female individuals, epiphyseal plate was detected in female ranged from 20 to 24 years. Table 4: Distribution of study sample according to the gender valid cases. female percentage 54.3% male percentage (45.7%).

Table 1: Distribution of Individuals by their Age and Gender

Age	Sex	Valid	Miss-valid	Total
20	Male	4	1	5
	Female	5	0	5
21	Male	4	1	5
	Female	4	1	5
22	Male	3	2	5
	Female	4	1	5
23	Male	3	2	5
	Female	3	2	5
24	Male	2	3	5
	Female	3	2	5
Total	Male + Female	35	15	50

Table 2: Male Individuals -Types of Ossification

Age	Types of Ossification			
	Non Ossified	Partially Ossified	Semicomplete Ossified	Complete Ossified
20	0	4	0	0
21	0	4	0	0
22	0	3	0	0
23	0	3	0	0
24	0	2	0	0

Table 3: Female Individuals - Types of Ossification

Age	Types of Ossification			
	Non ossified	Partially ossified	Semicomplete ossified	Complete ossified
20	0	5	0	0
21	0	4	0	0
22	0	4	0	0
23	0	3	0	0
24	0	0	3	0

Table 4: Distribution of Study Sample According to the Gender

Gender	Frequency	Percent
Female	19	54.3
Male	16	45.7
Total	35	100.0

6. Discussions
Clavicular epiphyseal ossification in most cases it is necessary to state that the individuals has reached the criminal liability threshold of 21 years, as the other system on which the development analysis is based are fully matured by this time. This study focused in bone age determination through ossification status of medial clavicular plate in sample 50 individual 25 for each genders their ages group ranged between 20year-24year in Khartoum state Hospitals.
The findings of the present study found that medial epiphyseal plate of the clavicle was not completely ossified, in male group it was partially-ossified from age 20 up to 24 as it mentioned in table (2). Female age group in table (3) was showed that partially-ossified in ages 20 to 23, at age 24 in female the medial epiphyseal plate was semi-completelly

ossified this give indication of rapid growth in female more than male gender. Medial clavicular epiphysis completely fused to the shaft between 25 and 31 years (Moore 2006) [5].
Others reporters mentioned that fusion of the epiphysis occurred between 18 and 29 years. The ossifying epiphysis begins to unite around age 21, and union is fused complete by age 25. No sex differences were reported (Todd & D'Errico1928). In comparison to this study group result there is agreement that the beginning of fusion of medial epiphyseal plate was occur from 20 and 21years and continue up to 24 years male while in female up to 23 year, also this study agree with the fact that no complete fusion until age 24.
Appearance of epiphyseal ossification center was reported between ages 11 and 22 years, partial union was found from age 16 until age 26 years, complete union was first noted at age 22 years and in 100 % of the sample at age 27 years (Kreitner *et al*. 1998) [4]. The findings of this study reveal that partial medial epiphyseal fusion (91.4%) from 20 to 24 years and no evidence of complete union at this range. Schmeling *et al*. 2004 [6] findings were in line with those of this study, they mentioned that stage 3 is partially ossified as this comparable to the presents result its same stage corresponds with stage 2 in which the epiphyseal plate is partially-ossified in both sexes, and there is no complete fusion of medial epiphyseal plate this study group (Andreas *et al*. 2004) [1]. The sample taken in this study was not detected the exact age at which complete fusion of medial epiphyseal plate of the clavicle occur, so the coming studies should maximize the sample size and take over my age group to give more details for fully ossification.

7. Conclusions
Assessment of the sample taken found that there was no complete fusion of the meial clavicular epiphseal plate from age 20 to 24 years in both genders, the female age 24year show semi-complete ossified plate vary from male same age, and this is significant of rapid growth rate of female. The study evaluation found that x-rays has crucial impact in bone age estimation.

8. Recommendations
This study recommended that performing x. ray in three plane posteroanterior, oblique and lateral should be done to asses all the samples in the study in order to ensure a maximum of accuracy in age estimation practice. It is recommended to use this data as guide for future studies.

9. References

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