Stages of Epiphyseal Fusion at the Distal End of Radius and Ulna in Nigeria; A Radiological study

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ABSTRACT

Introduction: There is an increasing demand for age determination in living individuals for forensic and bioarchaeological contexts, especially in regions or countries where documentation is not properly made. This study was done to determine the difference between the stages of fusion of the epiphysis at the ulnar and radial ends.

Materials and Methods: Anterior-posterior radiographys of the radius's and ulna's distal ends with 185 females and 199 males aged between 9-19 years were assessed. Four (4) stages of fusion were noted; stage 0: nonfusion, stage 1: appearance, stage 2: partial fusion, and stage 3: complete fusion. Ethical Clearance was obtained from the Delta State University Teaching Hospital, Oghara. Data were analyzed with the aid of the Chi-square test.

Results: It was shown that the appearance of the epiphyseal centres at the ulnar and radial ends of males and females began at the age of 9-16. Females reached complete fusion earlier compared to that males.

Conclusion: It was found that radiographic investigation of the radius's and ulna's distal ends is an alternative for the determination of age where other means of age estimation have failed.

Keywords: Epiphysis, Radius, Radiography, Ulna.

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Introduction

Age assessment is needed in the administration of justice, employment, marriage, forensic investigations, and identification.[1,2] There is an increasing demand for determining age in living individuals for forensic and bioarchaeological contexts, especially in regions or countries where documentation is not properly made. The principal methods used for age determination are radiology and tooth morphology. These methods according to Ritz & Kaatsch[3] differ widely in relation to potential, limits, and risks. It is evident that the time wherever the epiphyses join varies very little between research groups from various geographical regions.[4,5]

The radiocarpal joint sometimes referred to as the wrist joint, is a synovial joint in the upper limb that designates the point where the forearm and the hand meet. The wrist joint is formed proximally by the distal end of the radius and the articular disk, and distally by the proximal row of the carpal bones, with the exception of the pisiform.[6]

The wrist is an ideal anatomical location for the assessment of epiphyseal union. According to previous studies, differences exist in the epiphyseal union's timing between individuals from different populations.[7] Eveleth and Tanner,[8] attribute the differences in population variability to climate, nutrition, secular change in growth, or just a lack of a consistent approach. The study's

goal is to identify the variations in epiphyseal fusion stages at the distal ends of the radius and ulna.

Materials and Methods

Research Setting

The study area is Oghara in Delta State. Ethical approval was sought from the Research and Ethics Committee of the Delta State University Teaching Hospital. The participants consisted of both sexes, between the ages of 9-16. This research is a five years retrospective cross-sectional study.

Selection Criteria

i. Patients who have not undergone ankle and wrist surgery in the past were considered for the study.

ii. Radiographs with proper birthdates were incorporated.

iii. Radiographs with poor quality were excluded from the study.

Data Collection

Four (4) epiphyseal fusion stages were noted as explained by Jits and Kulkarnis[9] AP view was used when assessing epiphyseal fusion's phases. Skeletal maturity was evaluated in accordance with Jits and Kulkarnis' classification of four stages; appearance, non-fusion, partial fusion as well as full fusion ("AP", "NF", "PF", and "CF" respectively). "Non-fusion" (NF) X-rays are those that clearly show the space between the diaphyseal and epiphyseal bones and have a saw-tooth look. "Partial Fusion" (PF) X-rays were those that showed a line filling in the gap between the epiphyseal and diaphysial ends and did not exhibit a saw-tooth appearance. "Complete Fusion" X-rays, on the other hand, were those that revealed the same bony architecture in both the diaphysis and epiphysis as well as the scar from the previous stage (CF).

Data Analysis

The collected data were examined utilizing the SPSS version 22 for statistical significance. Chi-square testing was done to show association in the fusing of the epiphyses surrounding the wrist joint in males and females, as well as the individuals' age in terms of years.

Results

Figure 1 shows the number of subjects in the study. Out of three hundred and eighty-four (384) radiographs that were used in the study, 199 (51.82%) were males' while 185 (48.18%) were females'.

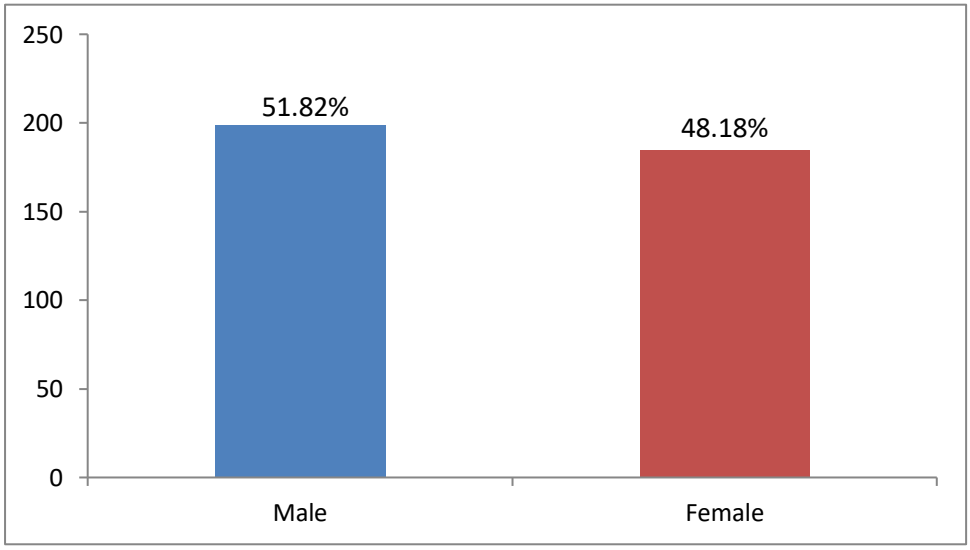

Figure 1: Distribution of subjects by sex.

Table 1 reveals the number of male subjects at each stage of fusion in relation to age. The males were between the ages of 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, and 19. Appearance at the ossification centres at the distal ends of the radius and ulna began at ages 9, 10, 11, 12, 13, 14, 15, and 16. In ages 18 and 19, at the radius and ulna, there is a total fusion, a partial fusion at the ulna which is seen only at age 17.

Age (years)	Number of Subjects	Radius Stage of Fusion				Ulna Stage of Fusion				
	N	0	1	2	3	n	0	1	2	3
9	11	11	--	--	--	11	11	--	--	--
10	3	3	--	--	--	3	3	--	--	-
11	4	4	--	--	--	4	4	--	--	--
12	6	6	--	--	--	6	6	--	--	--
13	3	3	--	--	--	2	2	--	--	--
14	4	4	--	--	--	3	3	--	--	--
15	2	2	--	--	--	2	2	--	--	--
16	6	6	--	--	--	2	2	--	--	--
17	7	--	--	--	--	2	--	--	2	--
18	2	--	--	--	2	3	--	--	--	3
19	12	--	--	--	12	4	--	--	--	4

Key: 0=Appearance of fusion; 1=Non fusion; 2= Partial fusion; 3= Complete fusion

Table 1: Number of male subjects (n) at each stage of fusion for the distal end of radius and ulna in each age group (years).

Table 2 reveals the number of female subjects at each stage of fusion with respect to age. The females were between the ages of 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, and 19. Appearance at the ossification centres at the distal ends of the radius and ulna began at ages 9, 10, 11, 12, 13, 14 and 15, and 16 respectively. In the age group 16 and 17 there was a partial fusion at the distal end of the radius and a partial fusion at the distal end of the ulna which was visible only at age 17. In the age group 18 and 19 there was a complete fusion at the distal end of the radius and ulna.

Age (years)	Number of Subjects	Radius Stage of Fusion				Ulna Stage of Fusion				
	N	0	1	2	3	n	0	1	2	3
9	11	0	--	--	--	0	0	--	--	--
10	11	11	--	--	--	11	11	--	--	-
11	2	2	--	--	--	1	1	--	--	--
12	4	4	--	--	--	4	4	--	--	--
13	9	9	--	--	--	7	7	--	--	--
14	2	2	--	--	--	2	2	--	--	--
15	9	9	--	--	--	7	7	--	--	--
16	3	--	--		--	2	2	--	--	--
17	3	--	--	3	--	--	--	--	7	--
18	3	--	--	--	3	--	--	--	--	5
19	3	--	--	--	3	--	--	--	--	6

Key: 0=Appearance of fusion; 1=Non fusion; 2= Partial fusion; 3= Complete fusion

Table 2: Number of female subjects (n) at each stage of fusion for the distal end of radius and ulna in each age group (years).

Discussion

This research has shown that radiographic investigation of bones around the wrist is important in forensic studies in age determination. However, from this research, the fusing of the epiphysis at the distal end of the ulna and radius of males and females began at age 9 and continued onward to 16. A similar trend was observed in a study by Hassan et al.[10] who expressed that the underlying phase of epiphyseal fusion at the distal ulnar end was discovered between 14 and 15 years in 13–14-year-olds in 10% of the female population and 10% of the male population. Another study by Garn et al.[11] and Hepworth[12] also concurs with the above findings and reported that epiphyseal fusion at the distal end of the radius and ulna progress bilaterally symmetrical, and begins at age 16. It is clear from all the studies that age can be decided from radiographic observation of bones at the wrist joint.[13-15]

The distal end of the radius in males exhibited partial fusion at age 17, whereas the distal end of the ulna did not exhibit partial fusion at this time, according to the current study. Ages 16 to 17 saw partial fusion at the distal end of the radius in females, and age 17 saw partial fusion at the distal end of the ulna. This could be explained by females having higher levels of estrogen than males.[12] The findings from this study are in harmony with a study by Ebeye et al.[2] who reported that females displayed partial fusion in the distal end of the ulna and the radius before males.[13]

This study further demonstrated that females were constantly developing younger ages of epiphyseal fusion compared to, unlike their

masculine counterparts which were visible at ages 16, 17, 18, and 19. This difference may be owing to adolescent development spurt in females beginning at an average of 12 years, preceding relating to males by approximately 2 years.

Conclusion

When other methods of age assessment have failed, radiographic scans of bones, such as the distal end of the ulna and radius, are a useful option.

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