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A STUDY OF FUSION OF RADIAL HEAD USING ULTRASONOGRAPHY AND ITS APPLICATION IN FORENSIC AGE ESTIMATION

Forensic Medicine

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ABSTRACT

Age is one of the essential factors in establishing the identity of a person. Skeletal age can be assessed by the appearance or fusion of secondary ossification centers using X-rays, ultrasonography or MRI. Ultrasonography employs sound waves for imaging of the tissues. It does not involve ionizing radiation. It can be repeated any number of times without any harmful effect on the subjects. In the present study, the fusion of the head of the radius was studied using ultrasonography. It was found that the fusion started early in girls than boys and by 16-17yrs of age, all the subjects had fused radial head.

KEYWORDS

Age estimation, Radial head, Sonography.

INTRODUCTION:

Determination of age is helpful in both civil and criminal cases like in identification, marriage, rape etc.[1] Establishment of age can be done by various methods like physical, dental and radiological evaluation. One of the commonest and easiest ways of establishing age is by skeletal examination. The ossification centres in the body appear and fuse at a specific range of ages and hence it is possible to deduce the age by evaluating these ossification centres.[2]

X-rays are the most commonly used modality to study the appearance and fusion of epiphyseal centres, as they are easily available, inexpensive and reliable. As X-rays have ionizing radiation, their use may be limited in growing children and pregnant women. To overcome these limitations, newer modalities like ultrasonography and MRI have been used. MRI is very expensive and not available everywhere so ultrasonography serves as a better alternative.[3] Hence the present study was undertaken to determine the skeletal age from the fusion of the radial head using ultrasonography and recommend the usage of sonography as an substitute to X-rays in skeletal age estimation.

MATERIALS AND METHODS:

The study was performed on 80 subjects of chronological age between 14-17 years. Out of these subjects, 40 were girls and 40 were boys. Informed written consent was obtained from the guardian (Parent / Principal of the school) for the study. Subjects with trauma or recent surgery were excluded.

Subjects fulfilling the inclusion and exclusion criteria were selected from a nearby School. Ten girls and 10 boys representing each age in the chosen age group of 14- 17 years were selected randomly. Date of birth was confirmed from their birth certificates. Height and weight were measured. They were subjected to the sonographic examination of the left elbow by an experienced radiologist. The radiologist was blinded for the chronological age of the subjects.

The ultrasound examination was performed using a Philips HD11XE ultrasound machine. A linear transducer of 5-12MHz (L 5-12) was used with the proprietary musculoskeletal setting. The left upper limb was chosen for the study as it is a non-dominant limb in the majority of the population.

The subject was made to sit relaxed on the couch. The left upper limb was supported by the right hand of the patient. The forearm was placed in a supine position with the wrist in mid pronation. After using an adequate amount of ultrasound gel, the transducer was placed longitudinally over the lateral aspect of the elbow. (Fig 1) This demonstrated the radial head (RH) and the capitellum.(Fig 2) The radial head appeared as a disc-shaped echogenic structure in the upper aspect of the forearm and a gap is present between head and shaft indicates non fusion. (Fig 3) The fusion of the radial head with the shaft was demonstrated by the lack of sonographic lucency between the epiphysis and the respective shaft in the longitudinal scans. (Fig 4)



Figure 1 : Position for the transverse ultrasound scan of the elbow)

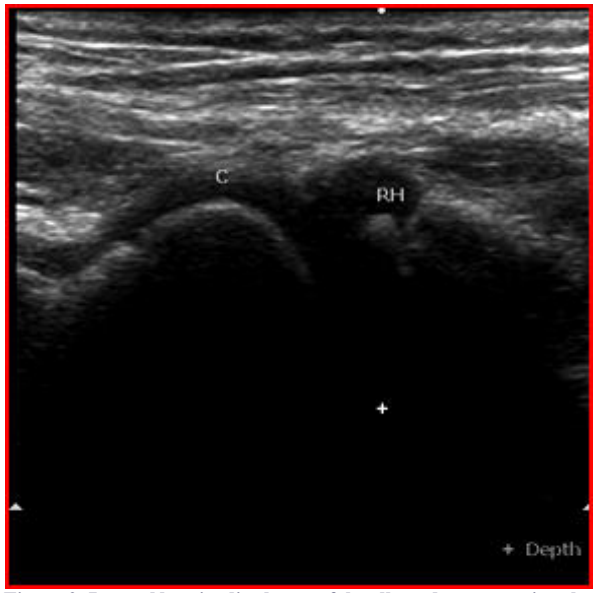


Figure 2: Lateral longitudinal scan of the elbow demonstrating the appearance of the radial head (RH) and Capitellum (C)



Figure3: Lateral longitudinal scan of the elbow demonstrating the unfused radial head (RAD) with the shaft



Figure4: Lateral longitudinal scan of the elbow demonstrating the fusion of the radial head (arrow) with the shaft

Fusion of the radial head:

Fusion of the radial head started by 15 years in boys (Table 1) and by 14years in girls.(Table 2) Hundred per cent of all the girls of age 16years had fused radial head. The radial head was fused in all the subjects of the age of 17years.

Table 1: Showing the appearance (A) and fusion (F) of Radial Head(RH) in boys

Chronological-Age(**C-Age)** * Radial head **(RH)** * Sex			RH	
			A	A&F
Boys	C-Age	15	7	3
			70.0%	30.0%
		16	1	9
			10.0%	90.0%
		17	0	10
			0.0%	100.0%

Table 2: Showing the appearance and fusion of Radial Head in girls

C-Age * RH * Sex			RH	
			A	A&F
Girls	C-Age	14	8	2
			80.0%	20.0%
		15	4	6
			40.0%	60.0%
		16	0	10
			0.0%	100.0%
		17	0	10
			0.0%	100.0%

DISCUSSION:

Sonography is an easily available, harmless modality for the estimation of skeletal age. A study was conducted by Schulz et al, who studied prospectively the ossification of the olecranon in 309 males and 307 females aged between 10 and 25 years, using ultrasound. A four-stage classification system was used for this purpose. This stage classification system was based on whether an isolated secondary ossification centre, epiphyseal cartilage or an epiphysis completely fused with the diaphysis could be detected. Stage 1 - No epiphysis, Stage 2 - Epiphysis separate, Stage 3 - Partial fusion of epiphysis and diaphysis, Stage 4 - Complete fusion of epiphysis and Diaphysis. In their study, they found that the minimum age for stage 3 was 10.6 years for females and 13.5 years for males. Stage 4 was first found in the female participants at the age of 12.3 years, while in the male participants it was seen at 13.7 years at the earliest. In the present study, only complete fusion of epiphysis with diaphysis was considered i.e., stage 4 of the Schulz et al study. Staging of the fusion thus decreases the age limit.[4]

A Radiological study was carried out in Mumbai to assess the general skeletal maturity around the elbow joint, of subjects in the Mumbai region. 197 males and 79 females between the age group of 3-24 years were selected. The epiphysis of the elbow joint was observed for appearance and different phases of fusion were graded according to Dr William Sangma et al and McKern and Stewart 5 stages. Radial head started appearing at the age of 7-8 yrs. in males and 5-6yrs in females and complete fusion was seen by 16-17yrs in males and in females by 14-15yrs.[5]

A study was done by Memchoubi Ph, to observe the degree of epiphyseal union around the elbow, knee, wrist joints and pelvis and thereby determine the age of the majority of the Manipuri girls. 100 Manipuri Meitei girls, ages ranging from 16-20 years were X-rayed at the elbow, knee, wrist joints and pelvis. Fusion of epiphyseal centers was graded in 3 stages and all the subjects were examined and Regression Formulae with the standard errors were derived for the respective joints. The majority of the subjects showed complete fusion by 16yrs. The standard error at the elbow and knee joint was ±1.1 which was higher than the wrist and pelvis. The degree of fusion at 16 years at the elbow joint was given by a regression formulae Yc=18.15+(0) X.[6] In the present study, around 90% of boys and 100% of girls had fused radial head by 16years.

CONCLUSION

The study concludes that age of fusion of Head of the radius as interpreted from X-ray or Sonographic examination was the same. Thus, Ultrasonography has a potential application in the field of Clinical Forensic Medicine and it can serve as an alternative to the usage of radiography for the estimation of the age of the person. Our study estimated that radial head fuses early in the girls than the boys. To our best knowledge, this is the only study performed in the South Indian population to evaluate the effectiveness of ultrasonography in the estimation of the skeletal age.

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