



Radiological Staging of Progressive Bony Union of Ossification Centers in Elbow Joint

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Abstract

Determination of age is important in criminal offences, in employment, in inheritance, and in identifying the dead persons in natural or manmade calamities.

Objectives: *To evaluate the elbow joint ossification centers with complete bony union in 14,15 year old boys and to compare ossification status in 14+ and 15+ healthy boys. An attempt is made to compare the age of ossification of epiphyses in our study sample with those from other regions in India and with those from other countries*

Material and Methods: *Healthy school going children (200 Boys) of age group 14 – 16 years (128 of age 14 years and 72 of age 15 years), resident of Bagalkot city (North Karnataka, India) were examined for ossification status at elbow joint Radio graphically*

Results: *In 14 – 16 years Boys, at elbow joint conjoint epiphyses was in 0% in both 14 and 15 years of stage 1 stage 2 of ossification (lower level of ossification) while 31% of 14 years and 78% of 15 years were in stage 5 respectively (Higher level of ossification). The medial epicondyle was in stage 1 of 0% and 1% in the 14 years and 15 years respectively (lower level of ossification) while 8% and 33% were in stage 5 (Higher level of ossification). The proximal end of radius was in 0% in both 14 and 15 years of stage 0 and stage 1 (lower level of ossification) while 6% and 33% of stage 5 in 14 years and 15 years respectively. (Higher level of ossification). Olecranon process or proximal end of ulna was in 6% and 0% in 14 years and 15 years respectively (lower level of ossification) while 8% and 12% were in stage 5 in 14 years and 15 years boys respectively (Higher level of ossification).*

Conclusion: *Throughout the study it was found that, ossification was progressive with ages in males of 14 – 16 years.*

Keywords: *Epiphyseal union, elbow joint, conjoint epiphyses [ossification of lateral epicondyle with lateral condyle (capitulum), and medial condyle (Trochlea)].*

Introduction

Amid present scenario of increased number of litigations, cases of both criminal as well as civil,

forensic specialists are heavily burdened with cases of determination of age of individuals either living or dead. In developing countries like India,

because of illiteracy and ignorance regarding the importance of official records like birth and death, vast majority of population fails to give information of such vital events to the appropriate authorities entitled with this job. This causes paucity in such information when needed in medico – legal cases.

The determination of age in adolescents is important in medico – legal work. It arises in relation to fixing up of criminal responsibility, rape, kidnapping, awarding judicial punishment and employment. Determination of age is much more important in homicidal cases where any skeletal remains are available for analyses. Sometimes bones are found disposed off in jungles, in open ditches or rubbish dumps etc, or may be found while digging foundations for building or skeleton may be exhumed.

In cases of mass disaster, where many person die in the same area and same time from fire, air crashes etc, the help of forensic expert is sought in identification. ^(1, 2)

Material and Method

The elbow radiographs were taken with standardized in the AP and Lateral view. The sequence of capitulum, radial head, internal (medial) epicondyle, trochlea, olecranon and external (lateral) epicondyle [CRITOE] ossification centers of each one of boys were noted. Complete ossification was considered with complete obliteration of growth plates. The study was carried out involving 200 boys of age group of 14-16 years from Basaweshwar English Medium High School, Bagalkot. The subjects were selected randomly from 1st day of 14th year to 364th day of 15th year. All boys of age group between 14-16 years were listed and then selected randomly.

Inclusion Criteria: Healthy normal boys between age group who have completed 14 years but not completed 16 years of age. Subjects who had documentary evidence of age in the form of birth certificate issued by municipal authority and of school records. Subjects who were born and brought up in Bagalkot District.

Exclusion Criteria: Subjects with skeletal trauma /deformity, congenital or heritable anomalies, malformation or injury. Subjects with severe malnutrition, endocrinal disorders, chromosomal aberrations/ osteochondral dysplasia or chronic illnesses.

Informed consent was taken from all subjects after explaining them the purpose and procedure of study. A proforma was prepared to collect all relevant information from the subjects.

Radiological Examination: All boys were subjected to x-ray examination of right elbow joint in the department of radio diagnoses and imaging at HANAGAL SHRI KUMARESHWARA (HSK) HOSPITAL and RESEARCH CENTER, BAGALKOT (Karnataka, India). The x-rays of elbow joint was taken in both anteroposterior (AP) view and lateral view using a factor of 55KVP and 9MAS. The sequence of capitulum, radial head, internal (medial) epicondyle, trochlea, olecranon and external (lateral) epicondyle [CRITOE] ossification centers of each one of boys were noted. Complete ossification was considered with complete obliteration of growth plates.

Staging of Epiphyseal Union: The ossification status around elbow joint was staged based upon ossification given by Galstaun (1930) ⁽⁶⁾, McKern and Stewart (1957) ⁽¹⁵⁾ and Kothari (1974) ⁽⁷⁾. In the present study, ossification status around elbow joints based upon union of epiphyses and appearance and progression of ossification center was taken as follows:-

Stage 0 – Not appeared

Stage 1 – Beginning

Stage 2 – Active.

Stage 3 – Advanced.

Stage 4 – Recent union.

Stage 5 – Complete union.

Data Analyses & Statistical Method Used: The findings were tabulated and statistically analyzed with aid of SPSS (20.0). The data was analyzed using percentage, chi square test and fisher exact test.

Results**Table 1 :** Age wise distribution of study subjects

Age group	Males (n= 200)
14 years	128
15 years	72
Total	200

Above table depicts the age wise distribution of study subjects. For the purpose of comparison and analyses 128 boys of 14 years (14-15 years) and 72 boys of 15 years (15 -16 years) were selected for present study.

Table 2: Ossification status around the elbow joint

Ossification Status	14 Years boys		15 Years boys		Total	
	N	%	N	%	N	%
Conjoint epiphysis						
Stage 0	27	21	02	03	29	14.5
Stage 1	00	00	00	00	00	00
Stage 2	00	00	00	00	00	00
Stage 3	52	41	14	19	66	33
Stage 4	9	07	00	00	09	4.5
Stage 5	40	31	56	78	96	48
Total	128	100	72	100	200	100
Medial epicondyle						
Stage 0	00	00	00	00	00	00
Stage 1	00	00	01	01	01	0.5
Stage 2	08	06	00	00	08	04
Stage 3	106	83	45	63	151	75.5
Stage 4	04	03	02	03	06	03
Stage 5	10	08	24	33	34	17
Total	128	100	72	100	200	100
Proximal end of radius						
Stage 0	00	00	00	00	00	00
Stage 1	00	00	00	00	00	00
Stage 2	02	02	00	00	02	01
Stage 3	110	86	34	47	144	72
Stage 4	08	06	14	20	22	11
Stage 5	08	06	24	33	32	16
Total	128	100	72	100	200	100
Proximal end of ulna						
Stage 0	00	00	00	00	00	00
Stage 1	07	06	00	00	07	3.5
Stage 2	31	24	08	11	39	19.5
Stage 3	68	53	27	38	95	47.5
Stage 4	10	08	09	12	19	9.5
Stage 5	12	09	28	39	40	20
Total	128	100	72	100	200	100

Above table (2) shows ossification status of conjoint epiphyses around elbow joint in our study. The conjoint epiphyses was in stage 0 in both in both 14 and 15 years of stage 1 and stage 2 of ossification (lower level of ossification). 31%

of 14 years and 78% of 15 years were in stage 5 respectively (Higher level of ossification).

Further the table shows ossification status around medial epicondyle of elbow joint in our study. The medial epicondyle was 0% and 1 % of stage

1 in 14 years and 15 years respectively (Lower level of ossification) while 8% and 33% of stage 5 in 14 and 15 years respectively (Higher level of ossification).

Further it depicts ossification status around proximal end of radius of elbow joint in our study. The proximal end of radius was 0% in both 14 and 15 years of stage 0 and stage (Lower level of Ossification) while 6% and 33% of stage 4 and 5 respectively 1 (Higher level of Ossification)

Finally ossification status around proximal end of ulna around elbow joint in our study.

Olecranon process or proximal end of ulna was in 6% and 0% of stage 1 in 14 years and 15 years respectively (Lower level of ossification). While 9% and 39% of stage 5 in 14 years and 15 years respectively (Higher level of ossification).

Discussion

There are considerable variation in ossification of bones in different regions of the same country. In multiethnic country like India, it is difficult to follow simple standard data for determination of age for the entire country.

Ossification Status Around Elbow Joint

Ossification of lower end of humerus takes place by the fusion of four secondary centers, one for each of the following: the lateral epicondyle, the capitulum, the trochlea, and the medial epicondyle. Centers of ossification of the capitulum and the trochlea fuse together first and subsequently fuses with that of lateral epicondyle to form a conjoint epiphyses, which later on fuses with shaft of the humerus, while that of medial epicondyle unites separately with shaft of the humerus.⁽³⁾

Table 3: Comparison of age (in years) of ossification of epiphyses around elbow joint given by various workers in India with results of present study.

Study	Age of ossification of epiphyses in years			
	Conjoint epiphyses	Medial epicondyle	Proximal end of radius	Proximal end of ulna
Lal and Nat (Lucknow 1934)(4)	15-16	17	17	16
Pillai (Madras 1936) (5)	14	17	17	16
Galstaun (Bengal 1937) (6)	16	16	16	17
Kothari (Marwar 1974) (7)	15-16	17-18	17-18	16-17
Patel D.S. (Gujarat 2009) (8)	16-17	17-18	17-18	16-17
Bhise (Mumbai 2010) (9)	14-16	16-17	16-17	16-17
Potdar (Bagalkot 2012) (10)	15 - 16	Above 16	Above 16	Above 16
Jaybhaye (Bagalkot 2013) (10)	15 - 16	Above 16	Above 16	Above 16
Present study (Bagalkot 2014)	15 - 16	Above 16	Above 16	Above 16

Table 4: comparison of age (in years) of ossification of epiphyses around elbow joint given by various workers of foreign country with present study

Study	Age of ossification of epiphyses in years			
	Conjoint epiphyses	Medial epicondyle	Proximal end of radius	Proximal end of ulna
Paterson (Manchester 1929) (11)	19	18-21	19	19
Flecker (Melbourne 1932) (12)	16	16	16	16
Present study (Bagalkot 2014)	15 - 16	Above 16	Above 16	Above 16

It is also important medicolegally in males to differentiate 14 years for employment in factories. Assessment of skeletal maturity around puberty is very important because success of some surgical interventions depends upon the precise timing of when they are formed. Puberty is divided into two phases (1) Acceleration (2) Deceleration Pubertal growth spurt occurs at average 13 to 15 years in

boys is considered as Accelerational phase. Growth is rapid and the rate of growth increases during this time and increases during this time. Subsequent 3 years from 15 to 18 years for boys are considered as Decelerational phase, as growth ceases. So it means during this time, the growth becomes static and the bony union progresses. (15

to 18 years of age when all the physes are fused.)
(14)

According to Greulich and Pyle (13), the study of hand atlas for bone development, there is complete ossification of the bones of left hand in boys by 17 years of age excluding distal end of radius and ulna. This gives a apparent opinion that

it could be nutritional or ecological factors may be relatively responsible for low percentile 45% of south Indian population. In other words there seems to be relatively slow acceleration growth in Indian population as compared with western world.

Table 5: Comparative study of average age of ossification centers with our study as compared to study by Dr B. Patel. And Martin H Reed et.al⁽¹⁴⁾

	Average age of fusion (in our study Dr. P. Sahni, and Dr.Abhay)	Average age of fusion (in Dr B. Patel and Dr. M. Reed)
Capitulum	15.5	13.7
Medial epicondyle	15.5	14.9
Trochlea	15.5	13.4
Radial head	Above 16	14.8
Olecranon	Above 16	14.5
Lateral epicondyle	Above 16	14

Our study shows the relative range takes longer time for fusion in our Indian population by 1 year delay of maturation centers of ossification. The characteristics are influenced by various factors like geographical locations, climate, diet, heredity, socioeconomic status, habits, etc.

Conclusions

Though bones of hand and jaw are used in evaluation of bone estimation of adolescent in male, our study is further enhances value of elbow joint with complete ossification centers for medicolegal litigation. Our study shows 65% of the adolescent male between 15 – 16 years showing complete bony union.

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Conflict of interest: Nil

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