

Original Research Paper

Age Determination from Radiological Study of Epiphysial Appearance and Union around Wrist Joint and Hand

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Abstract

To establish exact identity of an individual age determination is essential not only in cases of living but also for the dead too. Age has to be determined not only for identification purpose but also for various civil and criminal purposes. The determination of age presents a task of considerable importance from the view-point of the administration of justice. A roentgenographic study was carried out with the objective to assess the general skeletal maturity around wrist and hand, of subjects in Mumbai region. 205 males and 94 females between age group of 3-25 years attending the outpatient department of this hospital are selected. Age confirmed from history and noting the birth dates. The cases selected after ruling out the nutritional, developmental, and endocrinal abnormality which affects the skeletal growth. Data analysis was done in P4 computer using HPSS software. At the end conclusions were drawn which are compared with available results of various previous studies

Key words: Age Estimation, Wrist Joint, Radiological

Introduction:

To establish exact identity of an individual age determination is essential not only in cases of living but also for the dead too. Age has to be determined not only for identification purpose but also for various civil and criminal purposes. Determination of age presents a task of considerable importance from the view-point of the administration of justice. It is not possible to enunciate a hard and fast rule for age determination from this union for the whole India because India is composed of areas which differ in climatic, dietetic and disease factors which affect skeletal growth. Age Determination of an individual from appearance & fusion of ossification centers is a well accepted fact. The present study was carried out retrospectively to study the epiphysial appearance and union at wrist joint with hand in subjects between age group of 3 to 25 years attending outpatient department of this hospital.

Aims and Objectives:

- To assess the skeletal maturity at wrist joint and hand for a known chronological age
- Comparative study of appearance & fusion of ossification centers at wrist jt. and hand.

- To evaluate sex related variation & its correlation with age.
- To know variation if any & exception of appearance & fusion of centers of ossification.
- To evaluate the medico-legal aspects of different ages.
- To suggest any additional radiological investigation to aid and to reduce range in determining age.

Material and Methods:

The study was carried out in Government Hospital in Mumbai which is a tertiary referral centre attached to Government Medical College with the objective to assess the general skeletal maturity of wrist joint and hand of subjects in Mumbai region. 205 males and 94 females between age group of 3-25 years attending the outpatient department of this hospital are selected. Age confirmed from history and noting the birth dates. The cases selected after ruling out the nutritional, developmental, and endocrinal abnormality which affects the skeletal growth. X-ray of wrist with hand is taken at department of radiodiagnosis. The epiphysis of wrist with hand were observed appearance (A) and not appeared (NA) and different phases of fusion were graded according to Dr. William Sangma et al and Mckern and Stewart 5 stages as fallows

Stage 1 (F1): Non union – when the epiphysial cartilage did not begin to decrease in thickness

Stage 2(F2): Commence of union – when the thickness of epiphysial cartilage was found to be reduced appreciably (1/4th united)

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Stage 3(F3): Incomplete union – when the epiphysis has begun to fuse with shaft and complete union was well underway (1/2 united)

Stage 4(F4): Complete union – when the epiphysal cartilage was bony in architecture and its density indistinguishable from the epiphysis and diaphysis in its neighbourhood but an epiphysal line called epiphysal scar could still be distinguished. (3/4 united)

Stage 5(F5): Complete union – with absence of epiphysal scar.

Skeletal maturity was evaluated radiologically studying the various centres of ossification and the results were compared with the previous known standard studies. Only appearance and last two stage of fusion cases were taken in this paper, remaining cases were in early stages of fusion

Results and observations:

Fusion of distal end of radius: It is clear from table-1 that in male subjects in majority of cases in age group 15-16 and 16-17 show near fusion (F4), where as in age groups 17-18 and onwards majority of cases showed fusion (F5)

It is clear from table-2 that in female subjects in majority of cases in age group 15-16 and 16-17 show near fusion (F4), where as in age groups 17-18 and onwards majority of cases showed fusion (F5)

Appearance of distal end of ulna: It is clear from table-3 that in male subject in majority of cases in age group 7-8 and 8-9 does not show appearance of distal end of ulna. The appearance of ulna is seen in age group 9-10, 10-11, 11-12 in male

It is clear from table-3 that in female subject in majority of cases in age group 6-7 and 7-8 does not show appearance of distal end of ulna. The appearance of distal end of ulna is seen in age group 8-9, 9-10, 10-11 in females

Fusion of distal end of ulna: It is clear from table-4 that in male subjects in majority of cases in age group 16-17 and 17-18 show near fusion (F4), where as in age groups 17-18, 18-19 and onwards majority of cases complete showed fusion (F5).

It is clear from table-5 that in female subjects in majority of cases in age group 15-16 and 16-17 show near fusion (F4), where as in age groups 16-17, 17-18 and onwards majority of cases complete showed fusion (F5).

Carpel bones appearance in both males and females: In male subjects below 8 years of age (13.66%) scaphoid is not appeared where as in age group 7-8 and above (86.34%) its appearance is seen. Lunate is not appeared below 6 years of age (6.345) where as in age group 5-6 and above (93.66%) its appearance is

seen. Pisiform is not appeared below 13 years of age (34.15%) where as in age group 12-13 and above (66.85%) its appearance is seen. Trapezium is not appeared below 6 years of age (10.73%) where as in age group 5-6 and above (89.27%) its appearance is seen. Trapezoid is not appeared below 6 years of age (2.92%) where as in age group 5-6 and above (97.07%) its appearance is seen.

In female subjects below 7 years of age (15.96%) scaphoid is not appeared where as in age group 6-7 and above (84.04%) its appearance is seen. Lunate is not appeared below 5 years of age (8.51%) where as in age group 5-6 and above (91.49%) its appearance is seen. Pisiform is not appeared below 12 years of age (35.11%) where as in age group 10-11 and above (64.89%) its appearance is seen. Trapezium is not appeared below 6 years of age (9.57%) where as in age group 5-6 and above (90.43%) its appearance is seen. Trapezoid is not appeared below 5 years of age (5.32%) where as in age group 4-5 and above (94.68%) its appearance is seen.

Fusion of base of 1st metacarpal: It is clear from table-6 that in male subjects in majority of cases in age group 15-16, 16-17, and 17-18 show near fusion (F4), where as in age groups 16-17, 17-18 and onwards majority of cases showed complete fusion (F5)

It is clear from table-6 that in female subjects in majority of cases in age group 14-15, 15-16, and 16-17 show near fusion (F4), where as in age groups 15-16, 16-17 and onwards majority of cases showed complete fusion (F5)

Fusion of phalanges in males: It is clear from table-7 that in male subjects for proximal row of phalanges in majority of cases in age group 15-16, 16-17, and 17-18 show near fusion (F4), where as in age groups 16-17, 17-18 and onwards majority of cases showed complete fusion (F5). for middle row of phalanges in majority of cases in age group 15-16, 16-17, and 17-18 show near fusion (F4), where as in age groups 16-17, 17-18 and onwards majority of cases showed complete fusion (F5). for terminal row of phalanges in majority of cases in age group 15-16, 16-17, and 17-18 show near fusion (F4), where as in age groups 16-17, 17-18 and onwards majority of cases showed complete fusion (F5).

Fusion of phalanges in females: It is clear from table-8 that in female subjects for proximal row of phalanges in majority of cases in age group 14-15, 15-16, and 16-17 show near fusion (F4), where as in age groups 15-16, 16-17 and onwards majority of cases showed complete fusion (F5). for middle row of phalanges in majority of cases in age group 13-14 and 14-15

show near fusion (F4), where as in age groups 15-16 and onwards majority of cases showed complete fusion (F5). for terminal row of phalanges in majority of cases in age group 14-15, and 16-17 show near fusion (F4), where as in age groups 15-16, 16-17 and onwards majority of cases showed complete fusion (F5).

Discussion:

The documented study done previously in Mumbai region was by Homi S. Mehta is available for standard comparison in Mumbai region. Observation of present study correlates with Homi S Mehta for females at the centres of distal end of radius, ulna. At wrist, the complete union of epiphysis is seen by 18 - 19 years in males and 16 - 17 years in females. As compared to Flecker's study in Australians and Davies and Parsons Study in England ossification center appearance and fusion occurs one to two years earlier in this study.

The present study signifies that all centres in females mature 1-2 years earlier than in Males. These observations correlate with the previous studies. Comparison of observations of present study has been made with other workers with reference to age of fusion in both sexes. (Table 9)

Conclusions:

Apart from consideration of centers of ossification by Dr. Homi S Mehta for population of Mumbai region additional centers of ossification have been studied in this study which will be helpful to arrive at correct diagnosis with closer range.

As compared to Bengali Hindu female's ossification center fusion occurs one to two year later in Mumbai region females. As compared to Hepworth study in Panjabi region skeletal maturity is delayed by 6 months to 1 year in Mumbai region. As this study is done in Mumbai region the application of standards can be considered ideal for application in Mumbai region. Due to very narrow borderline range of differentiation between various stages of fusion (i.e. Stage 1 to Stage 5), it is difficult to consider stage of fusion as age indicator.

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<p>Dist. end radius appeared. Dist. end ulna not appeared (1yr/m)</p>	<p>b) Dist. end of radius in F1 stage. Dist. E/O ulna not appeared (4yr/m)</p>
<p>c) Dist E/O radius in F2 stage. Dist E/O Ulna appeared (9yr/m)</p>	<p>D) Dist. E/O radius in F2 stage. Dist E/O ulna in F1 stage (10yr/m).</p>
<p>E) Both Dist. E/O. Radius & ulna in F3 stage. (14yr/m)</p>	<p>F) Both Dist. E/O. Radius & ulna in F4 stage. (17yr/m)</p>
<p>G) Both Dist. E/O. Radius & ulna in F5 stage. (18yr/m)</p>	

Table-1: Fusion of distal end of radius in males

Age [Yrs]/ Stage of Fusion	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-25	Total
F4	3 (13%)	8 (34.8%)	12 (52.2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	23 (100%)
F5	0 (0%)	0 (0%)	1 (1.6%)	18 (29.5%)	14 (23%)	10 (16.4%)	7 (11.5%)	11(18%)	61 (100%)

Table-2: Fusion of distal end of radius in females

Age [Yrs]/Stage of Fusion	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-24	Total
F4	1 [8.3%]	1[8.3%]	4 [33.4%]	6 [50%]	0	0	0	0	0	12
F5	0	0	0	0	3 [9.1%]	6[18.2%]	6[18.2%]	10[30.3%]	8[24.2%]	61

Table-3: Distal end of ulna appearance

Age [Yrs]/ Stage of Fusion	Sex	3-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13 &13-14	Total
Not appeared	M	23[45.1%]	2[3.9%]	8[15.7%]	9[17.6%]	3[5.9%]	3[5.9%]	3[5.9%]	0	51
	F	11[45.8%]	7[29.2%]	5[20.8%]	1[4.2%]	0	0	0	0	24
Appeared	M	0	0	0	0	2[14.3%]	7[50%]	5[35.7%]	0	14
	F	0	0	0	2[40%]	1[20%]	2[40%]	0	0	5

Table-4: Fusion of distal end of ulna in males

Age [Yrs]/ Fusion Stage	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-25	Total
F4	0	2[9.1%]	7[31.8%]	12[54.5%]	1[4.5%]	0	0	0	22
F5	0	0	0	1[1.7%]	17[18.3%]	14[23.3%]	10[16.7%]	18[30%]	60

Table-5: Fusion of distal end of ulna in females

Age [Yrs]/ Stage of Fusion	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-24	Total
F4	0	1[12.5%]	2[25%]	5[62.5%]	0	0	0	0	0	8
F5	0	0	0	1[2.9%]	3[8.8%]	6[17.6%]	6[17.6%]	10[29.4%]	8[23.5%]	34

Table-6: Fusion of base of 1st metacarpal

Age in yrs Stage of fusion	sex	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-25	Total
F4	M	0	0	2[8.7%]	7[30.4%]	9[39.1%]	5[21.7%]	0	0	0	23
	F	0	0	3[33.3%]	3[33.3%]	3[33.3%]	0	0	0	0	9
F5	M	0	0	0	0	3[4.2%]	8[11.3%]	18[25.4%]	14[19.7%]	28[39.4%]	71
	F	0	0	0	3[7.9%]	2[5.3%]	3[7.9%]	6[15.8%]	6[15.8%]	18[47.3%]	38

Table-7: Fusion of phalanges in males

Age [yrs] stage of fusion		12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-25	Total
Prox. Row	F4	0	0	0	3[14.3%]	10[47.6%]	7[33.3%]	0	0	0	21
	F5	0	0	0	0	2[3%]	5[7.5%]	18[26.9%]	14[20.9%]	28[41.8%]	67
Midd. Row	F4	0	1[4.3%]	3[13%]	8[34.8%]	5[21.7%]	6[26.1%]	0	0	0	23
	F5	0	0	0	0	7[9.5%]	7[9.5%]	18[24.3%]	14[18.9%]	28[37.9%]	74
Term. Row	F4	0	0	0	7[35%]	9[45%]	3[15%]	0	0	0	20
	F5	0	0	0	0	3[4.1%]	10[13.7%]	18[24.7%]	14[19.2%]	28[38.3%]	73

Table-8: Fusion of phalanges in females

Age [yrs] Fusion Stage		12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-25	Total
Prox. Row	F4	0	2[22.2%]	4[44.4%]	1[11.1%]	2[22.2%]	0	0	0	0	9
	F5	0	0	0	5[11.9%]	4[9.5%]	3[7.1%]	6[14.3%]	6[14.3%]	18[42.9%]	42
Midd. Row	F4	0	2[28.6%]	4[57.1%]	0	1[14.3%]	0	0	0	0	7
	F5	0	0	0	6[13.6%]	5[11.4%]	3[6.8%]	6[13.6%]	6[13.6%]	18[40.9%]	44
Term. Row	F4	2[18.2%]	2[18.2%]	4[36.4%]	0	3[27.3%]	0	0	0	0	11
	F5	0	0	0	6[14.3%]	3[7.1%]	3[7.1%]	6[14.3%]	6[14.3%]	18[42.9%]	42

Table-9: Comparison of age of fusion by different workers

Author	Present study				Galstaun study				H. S. Mehta		Pillai	Franklin
	Appearance (Yr)		Fusion (Yr)		Appearance (Yr)		Fusion (Yr)		Fusion (Yr)			
Centre of ossification	M	F	M	F	M	F	M	F	M	F		
Dist. end of radius			17-18	16-17			17-18	16.5-17	18-19	16-17	14-18	17-18
Dist. end of ulna	9-11	8-10	17-19	16-17			18	17	18-19	16-17	14-18	17-18
scaphoid	7-8	6-7			7-11	6						
lunate	5-6	5-6			5	5						
pisiform	12-13	10-12			12-17	9-12						
trapezium	5-6	5-6			7	5-6						
trapezoid	4-6	4-5			4-7	5-6						
Base of first metacarpel	3-5	----	16-18	15-17	4	3	16-18	14-15				
Phalanges- prox. row			16-18	15-17	2-4	1.5	17-18	14-15				
Midd. row	4-6		16-18	15-17	3	2-3	16-18	14-16				
Term. row	4-6		16-18	15-17	3-5	3	17-18	15				