

# Roentgenographic Evaluation of Bones at Wrist Joint For Osteological Maturity for Academic and Judicial Interest

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## Abstract

**Introduction:** In the living, age determination is the most important issue to the Courts and to the common citizens as well. Determination of the age of an individual from the appearance and the fusion of the ossification centers is a well accepted fact in the field of Medical and Legal professions. Extensive work of determination of age of the epiphyseal union has been carried out in abroad and different states of India, which revealed difference in the age of epiphyseal union. The difference may be an account of varying Sexual dimorphism, dietetic, geographic, and hereditary and other factors. Keeping in mind that a very less literature is available relevant to the population of this particular region of India present study is being undertaken for academic as well as in judicial interest. **Objectives:** To study the age of ossification, bilateral difference in age of ossification, Country wise and Globe wise difference of age of ossification. **Materials and Methods:** Only the indigenous female population of central India was included in this study of age estimation from ossification of lower end of Radius and Ulna at Wrist joint radiologically with standard accepted procedures, guidelines and after due ethical clearance. **Conclusion:** This study was very much beneficial and yielding as it revealed age specific, bilateral difference of ossification and remarkable difference in age of ossification as compared to the foreign countries and other parts of India. Such studies are recommended with good sample size and at regular intervals for academic as well as in judicial point of view. For correct age estimation in judicial cases X-rays of bilateral sides of relevant joints for particular age should be taken to avoid miscalculation of age and miscarriage of justice.

**Keywords:** Age, ossification centers, Wrist joint, roentgenographically, bilateral difference, less literature.

## Introduction

Age is helpful in identification of an individual which in turn is helpful in both civil and criminal cases according to Sangma William Bilkey ch. et al<sup>1</sup>. Epiphysis of the bones unites at the particular age and this is helpful in age determination. In law the crime and punishment is entirely based on criminal responsibility and this in turn depend on the age of a person <sup>2</sup>.

**Forensic Osteology** is the branch of Forensic medicine which deals with the study of the bones. Epiphysis of the bones unites during age periods which are remarkably constant for a particular epiphysis<sup>3</sup>. It has been also stated that the study of epiphyseal union of bones is considered a reasonable scientific and accepted method for age determination by the law courts all over the world<sup>4</sup>. India is a vast country with diversity in social customs, multiple religions, dietary habits and variations in climatic conditions. In Modi's textbook it is quoted that owing to variation in climatic, dietetic, hereditary and other factors affecting the people of the different states of India, it cannot be reasonably expected to formulate a uniform standard for the determination of the age of the union of epiphyses for the whole of India<sup>5</sup>. Mehta Homi S (1963) observed that it has been approved by research in our country that the epiphysio-diaphysial

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union in Indian occurs about a year or two in advance of the age at which that occurs in Europeans<sup>6</sup>. According to Parikh CK Union of epiphysis in cartilaginous bones takes place earlier in the females by about 2 years than in males except in case of skull sutures where obliteration sets in little later and proceeds more slowly in females than in males and under tropical conditions ossification is observed earlier than in temperate areas<sup>7</sup>. Reddy KSN stated that (2009) the bones of human skeleton develop from a number of ossification centers. At eleventh to twelfth week of intrauterine life, there are 806 centers of ossification, at birth there are about 450. The adult human skeleton carries only 206 bones<sup>8</sup>. According to Iscan M.Yasar and Loth Susan R (1984). Estimation of age from the adult skeleton has been the most difficult part of Human identification studies. Human growth is continuous process which goes through, first a developmental stage and second, the maintenance of status quo. In the developmental stage, changes in skeletal and dental morphology occur in an age –age predictive sequence<sup>9</sup>. Jit and Balbir Singh revealed that Precocity of epiphyseal union has been attributed to racial and climatic factors. Works in different regions of India-North (Punjab, Delhi and UP), East (Bengal) and South (Madras) have given different ages of fusion of the epiphysis. Further, workers in the same region have also given different ages of fusion of the epiphysis of the same bone and in the same sex. This difference could possibly be due to inadequate material or recording of incorrect ages of the subjects<sup>10</sup>. It was, therefore, decided to reinvestigate the problem in the central part of India by radiological examination, taking care that adequate material was examined and only those subjects investigated whose ages has been recorded with reasonable degree of accuracy.

**Objectives:** Radiological evaluation of the bones forming the Wrist joints i.e. Lower end of Radius and Ulna was undertaken with the following objectives:

- 1) To estimate the age from ossification of bones of Wrist joint in relevant Subjects in central India.
- 2) To assess the age specific difference in ossification of lower end of Radius and Ulna at Wrist joint in all subjects.
- 3) To study the difference in right and left side in ossification of bones of Wrist joint in all subjects.
- 4) To assess and evaluate the difference in the

ossification of bones of Wrist joint in Central part of the India with other part of India on the basis of literature available.

- 5) To compare the deduced data with previously available data of other countries.

## Material and Method

Total fifty female individuals (50) were taken in this study from age ranging from zero to twenty years (0-20). The female individual chosen for the study were evaluated and confirmed for the confirmed proof of date of birth, physical fitness and their native place of central India Individual involved in study were predominately right handed. A written informed consent and permission from Ethical Committee of the Institute was obtained **Procedure of radiography** After taking the written consent the thorough physical examination and radiological evaluation was done. Training of Researcher was undertaken to get well acquainted with the all radiological procedures essential for X-Ray examination and developing X-Ray films. X-Rays were taken with the help of X-Ray machine in the Department. Minimum shots were taken to expose the joints involved in study and minimum and appropriate voltage settings of X-Ray machine were applied so as to avoid unnecessary radiation exposure of the subjects to get the desired qualities of X-Rays. The developed X-Ray films were studied and reporting was done with the help of by experienced Radiologist and Anatomist. All the radiological procedure was undertaken according to the present accepted standards. Skeletal maturity was evaluated according to the **Jits** and **Kulkarnis classification** of four stages, **Appearance, Non fusion, Partial fusion, and complete fusion** (abbreviated as “AP”, “NF”, “PF”, “CF” respectively)<sup>11</sup>. **Nonfusion** X-Rays showing clear gap between the epiphyseal and diaphysial end. The saw tooth like appearance (“NF”) **Partial fusion** X-Rays showing a line replacing the hiatus between the epiphyseal and diaphysial ends and not showing saw tooth like appearance (“PF”). **Complete fusion** X-Rays showing the same bony architecture in the diaphysis and epiphysis and showing scar of the previous stage have been treated as complete fusion (“CF”). The master chart was prepared and tabulated as per code number given above. It was classified, analysed and compared with known standards. 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.

**Table 1: Ossification of distal End of Radius in female subjects on right and left side.**

Age in years	Side	NA	NF	PF	CF	Total
<1-5	R	1(2%)	7(14%)	2(4%)	0(0%)	10(20%)
	L	1(2%)	7(14%)	2(4%)	0(0%)	10(20%)
6-10	R	0(0%)	1(2%)	12(24%)	0(0%)	13(26%)
	L	1(2%)	2(4%)	10(20%)	0(0%)	13(26%)
11-15	R	0(0%)	0(2%)	12(22%)	0(0%)	12(24%)
	L	0(0%)	0(0%)	12(24%)	0(0%)	12(24%)
16-20	R	0(0%)	0(0%)	1(2%)	14(28%)	15(30%)
	L	0(0%)	0(0%)	1(2%)	14(28%)	15(30%)
Total	R	1(2%)	8(16%)	27(54%)	14(28%)	50(100%)
	L	2(4%)	9(18%)	25(50%)	14(28%)	
χ <sup>2</sup> -value	R	105.8				
	L	70.34				
p-value	R	P < 0.0001, Significant				
	L	P < 0.0001, Significant				

Note: - Figures in parenthesis indicates percentage.

Distal End of Radius was non fused in 7(14%) subjects on both sides in <1-5 age group. It was non fused in 12(24%) subjects on right side and 10(20%) on right side in 6-10 age group. It was partially fused in 12(24%) subjects on both sides in 11 - 15 age group and it was completely fused in 14(28%) subjects on both sides in 16-20 age group.

**Table 2: Ossification of distal end of Ulna in female subjects on right and left side**

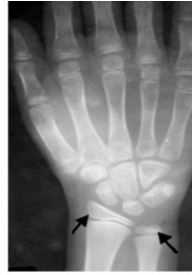
Age in years	Side	NA	NF	PF	CF	Total
<1-5	R	10(20%)	0(0%)	0(0%)	0(0%)	10(20%)
	L	9(18%)	1(2%)	0(0%)	0(0%)	10(20%)
6-10	R	1(2%)	8(16%)	4(8%)	0(0%)	13(26%)
	L	1(2%)	7(14%)	5(10%)	0(0%)	13(26%)
11-15	R	0(0%)	1(2%)	11(22%)	0(0%)	12(24%)
	L	0(0%)	1(2%)	11(22%)	0(0%)	12(24%)
16-20	R	0(0%)	0(0%)	1(2%)	14(28%)	15(30%)
	L	0(0%)	0(0%)	1(2%)	14(28%)	
Total	R	11(22%)	9(18%)	16(32%)	14(28%)	50(100%)
	L	10(20%)	9(18%)	17(34%)	14(28%)	
χ <sup>2</sup> -value	R	63.45				
	L	95.02				
p-value	R	P < 0.0001, Significant				
	L	P < 0.0001, Significant				

Note: - Figures in parenthesis indicates percentage.

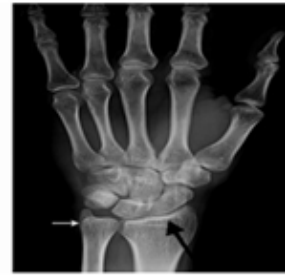
Distal End of Ulna was non fused in 8(16%) subjects on right side and 7(14%) on left side in 6-10 age group. It was partially fused in 11(22%) subjects on both sides in 11 - 15 age group and it was completely fused in 14(28%) subjects on both sides in 16-20 age group.



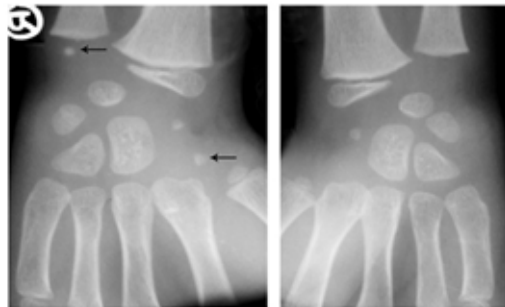
Distal end of Radius appeared and Partially fused. Distal end of Ulna appeared and not fused in a 6 Year male.



Distal end of Radius and Distal end of Ulna appeared and Partially fused. in a 13 Year male



Distal end of Radius and Distal end of Ulna appeared and Completely fused in a 17 Year male.



Bilateral Difference of Ossification: Lower end of Ulna appeared only on right side in a 5 year female girl.

### Discussion: Distal end of Radius

Franklin CA in females of Vidarbha region of Maharashtra found that the distal end of Radius fused at 17-18 year which is 1-2 year later than age of fusion appreciated in the present study<sup>12</sup>. In the study on Punjabi Population it is revealed that the distal end of Radius unites with the shaft of the Radius at the age of 16-17 year in females which is correlating with the findings of present study<sup>13</sup>. In Bengali female population the centre for distal end of Radius appeared at 1 year and fused with the shaft of the Radius at 16.5 year - 1 year later while in the present study it appeared 0-3 year later and fused at similar age nearly on both right and left sides<sup>14</sup>. In Australians population it is observed that found that in females the distal end of Radius appears at 1 year and unites with the shaft of the Radius 19 years while in present study it appeared 0-2 year later and fused 2-3 years later<sup>15</sup>. In Englanders it is observed that the distal end of the Radius appears at 10-12 months and unites with the shaft of the Radius at the age of 19-20 year in females whereas in present study the centre for distal end of Radius appeared at 2 months - 2 year later in some cases and fused with the shaft of the Radius 3 - 4 year earlier on both right and left sides<sup>16</sup>.

**Distal end of Ulna:** Franklin CA in females of Vidarbha region of Maharashtra found that the distal end of Radius fused at 17-18 year which is 1-2 year later than age of fusion appreciated in the present study<sup>12</sup>. In study on Bengali female population the appearance of the centre for distal end of Ulna was found at 8-10 year which is 2 year later and fusion at 17 year which is 0-1 year later than age of ossification observed in the present study<sup>14</sup>. In observations on Australians population found that in females the distal end of Ulna unites with the shaft of the Ulna at the age of 19 year which is 0-1 year later than age of ossification in present study<sup>15</sup>.

In study on Englanders it is found that the distal end of Ulna appears at 7-8 year which is 0-1 year later and unites with the shaft of the Ulna at the age of 20 year which is 3-4 year later than age of ossification in present study<sup>16</sup>.

### Summary and Conclusion

1. This study was conducted exclusively on the young female indigenous population of Central India keeping in mind that very less literature about the age estimation from ossification of lower end of Radius and Ulna at Wrist joint on right and left side is available involving this particular region of India.

2. The centre of ossification of lower end of Radius and Ulna in female subjects on right and left side appeared at 1-3 year and 6-8 year in all instances (100%) respectively.

3. The ossification of lower end of Radius and Ulna in female subjects on right and left side is completed in all instances (100%) at the age 17-18 year respectively.

4. The remarkable difference in the time of appearance of ossification centers is observed on right side. Ossification was appreciated earlier on right side than left side in most of the cases. Contributing factors for this bilateral difference are not studied in this study, however right handedness in most of the subjects for earlier ossification in them cannot be denied taking into consideration the available literature.

5. By comparing the available literature the age of skeletal maturity in females in this region is nearly similar to those in state of Punjab.

6. By comparing the available literature ossification center appear and fuse one to two years earlier in this study with population of Central India than those in Australia and England.

7. As the sample size is limited further studies are necessary. Region wise studies should be conducted for better correlation and comparison.

8. As this study is done in Central India region the application of standards of this study can be considered ideal for application in the region of Central India.

9. For correct age estimation in judicial cases X-rays of bilateral sides of relevant joints for particular age should be taken to avoid miscalculation of age and miscarriage of justice.

10. Due to changing life style pattern, dietary, climatic, behavioral factors age of ossification is changing as mentioned in the available literature. So as to evaluate these changes, studies are recommended in every region of India at regular time period for academic and Judicial interest.

11. The opinion about age should be given always in the range. From this study range of 1-2 years of margin of error can be concluded.

12. Along with the clinical and dental examination, radiological study plays an import role to arrive at the

opinion about the age in medicolegal cases.

**Conflict of Interest:** No conflict of interest was reported during conduction of study and preparation of this research article

**Source of Funding:** No fund was taken to carry out this study and preparing the article.

**Ethical Clearance:** Due ethical clearance from institutional ethics committee was taken.

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