

Original research article

ACADEMIC AND JUDICIAL SIGNIFICATION OF BILATERAL RADIOGRAPHIC EXAMINATION TO DETERMINE AGE

Authors:

Dr.P.A.Wankhade, MD, Assistant Professor, Dept of Forensic Medicine & Toxicology, JNMC, DMIMS, Sawangi(M), Wardha

Dr.S.K.Patond, MD, Assistant Professor, Dept of Forensic Medicine & Toxicology, JNMC, DMIMS, Sawangi(M), Wardha

Dr.P.M.Mohite, MD, Professor & Head, Dept of Forensic Medicine & Toxicology, JNMC, DMIMS, Sawangi(M), Wardha

Dr.A.J.Anjankar, MD, Professor, Dept of Forensic Medicine & Toxicology, JNMC, DMIMS, Sawangi(M), Wardha

Dr.S.V.Ninave, MD, Professor, Dept of Forensic Medicine & Toxicology, JNMC, DMIMS, Sawangi(M), Wardha

Dr.T.D.Wankhade, Post Graduate Students, FMT Dept, MGIMS, Sewagram, Wardha

Dr.Ashish Salankar, Post Graduate Students, FMT Dept, MGIMS, Sewagram, Wardha

Number of pages: 11

Number of Tables: 4

Number of Graphs: 4

Number of Photographs: 1

Author for correspondence:

Dr. P.A.Wankhade, M.D. Forensic Medicine
Assistant Professor,
Dept of Forensic Medicine & Toxicology,
JNMC, DMIMS, Sawangi(M), Wardha
9422422660,8623891019

drwanna.Wankhade@gmail.com, drpawan9781@gmail.com

Original research article

ACADEMIC AND JUDICIAL SIGNIFICATION OF BILATERAL RADIOGRAPHIC EXAMINATION TO DETERMINE AGE

Dr.P.A.Wankhade, Dr.S.K.Patond, Dr.P.M.Mohite, Dr.A.J.Anjankar, Dr.S.V.Ninave, Dr.T.D.Wankhade, Dr.Ashish Salankar

Abstract:

Age determination by radiography of the relevant bones & joint is well accepted fact in Forensic medicine field. Sometimes it serves an important piece of evidence of age determination in sensitive criminal cases to fix the punishment for the accused especially in cases of Juvenile or young perpetrator. Estimating the age from ossification of bones roentgen graphically is very crucial in cases of Child sexual abuse & sexual assaults, trafficking, violent deaths and also in civil cases of inheritance, Child labor, marriage etc. But usual practice is to undertake the radiological examination unilaterally. Unilateral radiological examination can yield the incorrect results of age estimation which can lead to miscarriage of justice. There is little literature available regarding existence of bilateral difference of ossification of bones. The present research article throws light over the significant bilateral difference of skeletal maturity observed during radiological examination for age estimation.

Key Words: Age determination, Unilaterally, Evidence, bilateral difference, Justice.

Original research article

ACADEMIC AND JUDICIAL SIGNIFICATION OF BILATERAL RADIOGRAPHIC EXAMINATION TO DETERMINE AGE

Dr.P.A.Wankhade, Dr.S.K.Patond, Dr.P.M.Mohite, Dr.A.J.Anjankar, Dr.S.V.Ninave,
Dr.T.D.Wankhade, Dr.AshishSalankar

Abstract:

Age determination by radiography of the relevant bones & joint is well accepted fact in Forensic medicine field. Sometimes it serves an important piece of evidence of age determination in sensitive criminal cases to fix the punishment for the accused especially in cases of Juvenile or young perpetrator. Estimating the age from ossification of bones roentgen graphically is very crucial in cases of Child sexual abuse & sexual assaults, trafficking, violent deaths and also in civil cases of inheritance, Child labor, marriage etc. But usual practice is to undertake the radiological examination unilaterally. Unilateral radiological examination can yield the incorrect results of age estimation which can lead to miscarriage of justice. There is little literature available regarding existence of bilateral difference of ossification of bones. The present research article throws light over the significant bilateral difference of skeletal maturity observed during radiological examination for age estimation.

Key Words: Age determination, Unilaterally, Evidence, bilateral difference, Justice.

Introduction:

Forensic Osteology: Branch of Forensic Medicine which deals with the study of the bones. Determination of the age of an individual from the appearance and the fusion of the ossification centres is a well-accepted fact in the field of Medical and Legal profession¹. Epiphysis of the bones unites during age periods which are remarkably constant for a particular epiphysis. In law the, crime and punishment is entirely based on criminal responsibility and this in turn depend on the age of a person².The estimation of age plays an important role in Medicolegal work. Age is helpful in identification of an individual which in turn is helpful in both civil and criminal cases. In the living, age determination is the most important issue to the court and to the common citizens as well. It is essential to establish the identity of the person at the time of admission to school, colleges and institutes or while competing in the sports, tournament at regional, state and national, international level.

Legal Preview: In *Biswanath Ghosh v state*(1957) in the present state of development of and the present state of our knowledge, we must proceed on evidence of age furnished by the ossification test³.

- In *Laimayum Tonjou v Manipur administration* (1962) stated that the test of ossification of bones is of value in determining age where it is to be determined whether the age of a girl is below 15 years and X-ray examination of the bones is absolutely necessary.
- In *Alekh Prasad v state* (1964) stated that if the other evidence of age is wholly unsatisfactory, the ossification test may be accepted as a surer ground for determination of age particularly when the accused gets a benefit of doubt on that basis.
- In *Paramjit v state of Himachal Pradesh* (1987) stated that opinion based on fusion of epiphysis of the bones is more trustworthy.

Background for the study

In the males the centers appear earlier on the right than on the left side, but this preference is indeterminate in females⁴. It was observed that there is no appreciable difference in the age of complete union on both right and left side of the body⁵. The results showed that the sequence of appearance of Scaphoid, Trapezium and Trapezoid is masculine feature with earlier appearance in left Wrist⁶. It has been stated that "Owing to the variations in climatic, dietetic, hereditary and other factors affecting the people of the different provinces of India it cannot be reasonably expected to formulate a uniform standard for the determination of age of the union of epiphyses for the whole of India⁷. The variation of one year or two on either side in the opinion regarding age based on ossification test⁸. Relying upon a judgment of the Supreme Court in *Jaya Mala v Home Secretary, Government of Jammu and Kashmir* (1982) and the Defence Council submitted that the Court could take notice that the marginal error in age ascertained by radiological examination is two years on either side. 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. Present study is being undertaken in indigenous population of central India from ossification around Wrist and Elbow joints roentgen graphically.

Aims and Objectives:

- To estimate the age from ossification of lower end of Ulna bone of Wrist joint in relevant Subjects in central India.
- To assess the age specific difference in ossification of lower end of Ulna bone.
- To assess and to compare male and female sexual difference in ossification of bones of lower end of Ulna bone.
- To study the difference in right and left side in ossification of lower end of Ulna bone.
- To assess and evaluate the difference in the ossification of bones of lower end of Ulna bone in Central part of the India with other part of India on the basis of literature available.
- To compare the deduced data with previously available data of other countries.

Materials and Methods:

The study was carried out with the objective to assess the general skeletal maturity of subjects Central India. Total one hundred and four individuals (104) were taken in this study from age ranging from zero to twenty years (0-20).

The individual was selected from the following sources:

- Students from the Primary school, Secondary school, High school and Art, Science, and Nursing Colleges.
- Children and infants admitted in Hospital for treatment purpose.
The individual chosen for the study were evaluated and confirmed for the following:
 - They are born to parents native of Central India and lived here since birth.
 - They have authentic documentation of their date of birth. (Birth certificate, School leaving certificate, Hospital records, School records)
 - The subjects should not have any bony deformity or pathology, congenital malformation, nutritional deficiency, endocrinal disorders, history of chronic drug intake (e.g.) anti-epileptic drugs, steroids and chronic illness thus affecting the skeletal growth and development of the individual.
 - Individual involved in study were predominately right handed.

Consent and permission for the study

- A written consent was obtained from the individuals personally those who are above the age of 12 years.
- For individuals those who are below the age of 12 years, consent was taken from the parents, guardians or respective head of the institute.
- Permission of Ethical Committee was obtained by submitting the title and synopsis of the study.

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.** 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). The master chart is prepared and tabulated as per code number given above. It is 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. Critical evaluation of the results was done

Results:

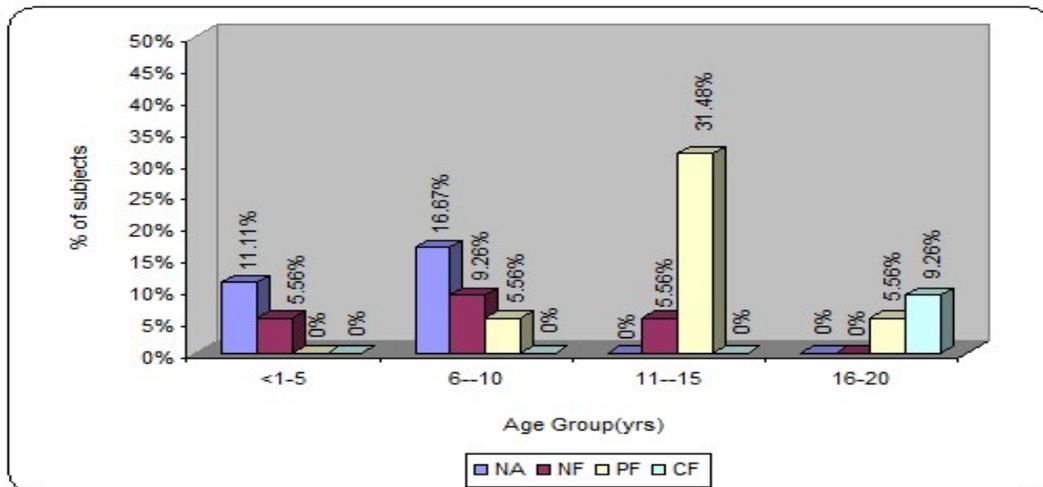
1) Table showing ossification of distal end of Ulna in Males on Right side.

Age in yr	NA	NF	PF	CF	Total
<1-5	6(11.11%)	3(5.56%)	0(0%)	0(0%)	9(16.67%)
6-10	9(16.67%)	5(9.26%)	3(5.56%)	0(0%)	17(31.48%)
11-15	0(0%)	3(5.56%)	17(31.48%)	0(0%)	20(37.04%)
16-20	0(0%)	0(0%)	3(5.56%)	5(9.26%)	8(14.81%)
Total	15(27.78%)	11(20.37%)	23(42.59%)	5(9.26%)	54(100%)

2x-value: 63.45, p-value: P<0.0001,S

Distal End of Ulna was appeared and non fused in 3(5.56%) subjects in <1-5 age group and completely fused in 5(9.26%) subjects in 16-20 age group.

Graph showing ossification of distal end of Ulna in Males on Right side.

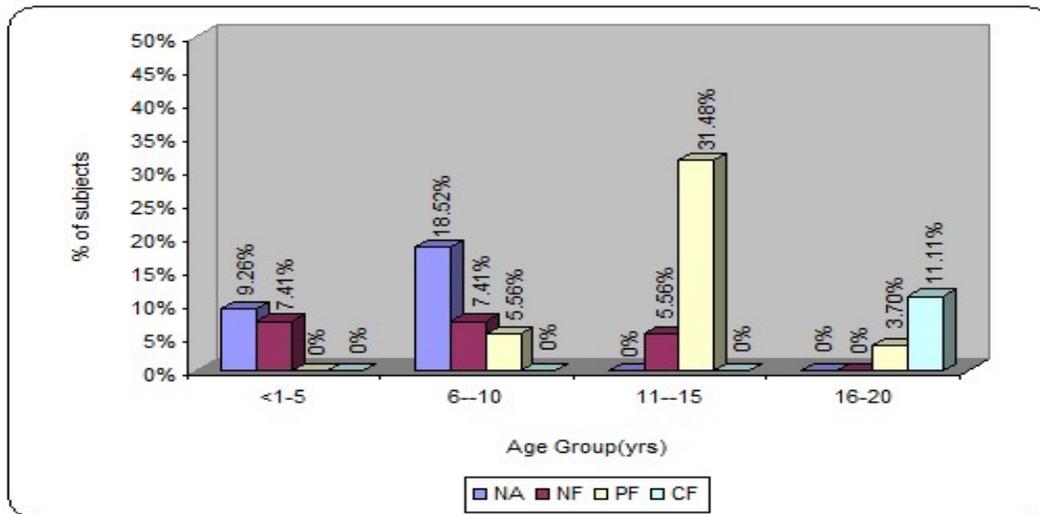


2) Table showing ossification of Distal end of Ulna in Males on left side.

Age in yr	NA	NF	PF	CF	Total
<1-5	5(9.26%)	4(7.41%)	0(0%)	0(0%)	9(16.67%)
6-10	10(18.52%)	4(7.41%)	3(5.56%)	0(0%)	17(31.48%)
11-15	0(0%)	3(5.56%)	17(31.48%)	0(0%)	20(37.04%)
16-20	0(0%)	0(0%)	2(3.70%)	6(11.11%)	8(14.81%)
Total	15(27.78%)	11(20.37%)	22(40.74%)	6(11.11%)	54(100%)
2x-value: 71.23, p-value: P<0.0001,S					

Distal End of Ulna was appeared and non fused in 4(7.41%) subjects in <1-5 age group and completely fused in 6(11.11%) subjects in 16-20 age group.

Graph showing ossification of distal end of Ulna in Males on left side.

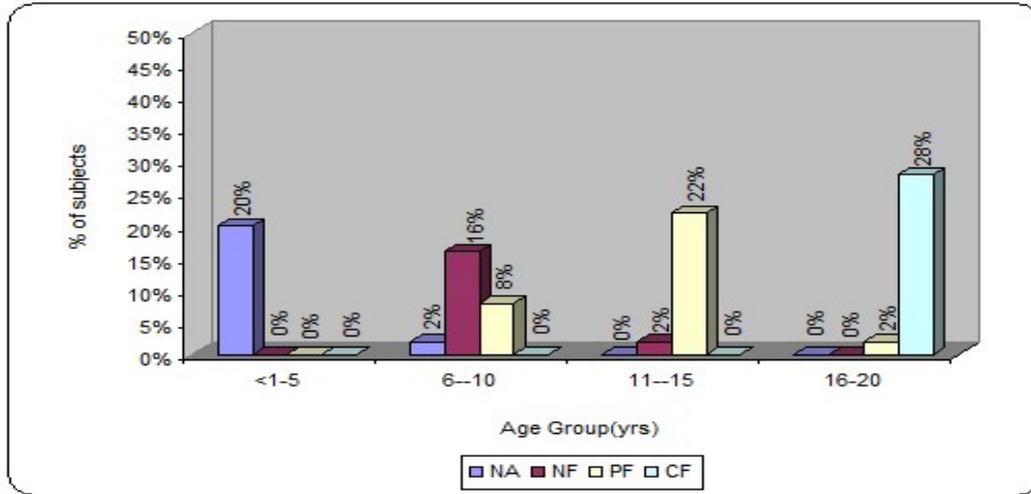


3) Table showing ossification of distal end of Ulna in Females on right side.

Age in yr	NA	NF	PF	CF	Total
<1-5	10(20%)	0(0%)	0(0%)	0(0%)	10(20%)
6-10	1(2%)	8(16%)	4(8%)	0(0%)	13(26%)
11-15	0(0%)	1(2%)	11(22%)	0(0%)	12(24%)
16-20	0(0%)	0(0%)	1(2%)	14(28%)	15(30%)
Total	11(22%)	9(18%)	16(32%)	14(28%)	50(100%)
2-value: 105.8, p-value: P<0.0001,S					

Distal End of Ulna was appeared and non fused in 8(16%) subjects in 6-10 age group and completely fused in 14(28%) subjects in 16-20 age group

Graph showing ossification of distal end of Ulna in females on right side.



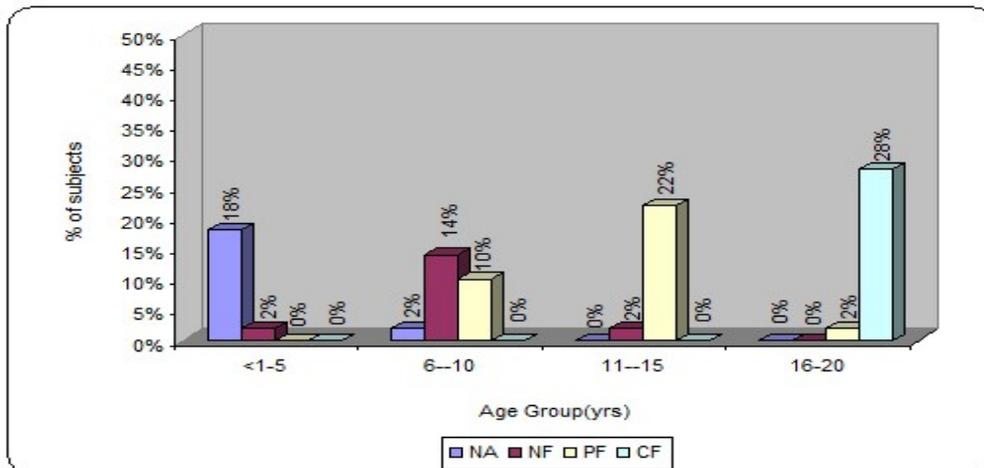
4) Table showing ossification of distal end of Ulna in females on left side.

Age in yr	NA	NF	PF	CF	Total
<1-5	9(18%)	1(2%)	0(0%)	0(0%)	10(20%)
6-10	1(2%)	7(14%)	5(10%)	0(0%)	13(26%)
11-15	0(0%)	1(2%)	11(22%)	0(0%)	12(24%)
16-20	0(0%)	0(0%)	1(2%)	14(28%)	15(30%)
Total	10(20%)	9(18%)	17(34%)	14(28%)	50(100%)

2x-value: 95.02, p-value: P<0.0001,S

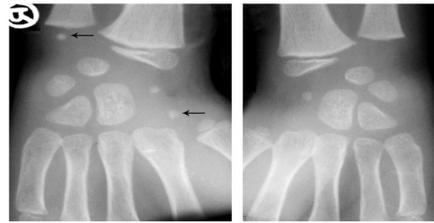
Distal End of Ulna was appeared and non fused in 1(2%) subjects in <1-5 age group and completely fused in 14(28%) subjects in 16-20 age group.

Graph showing ossification of distal end of Ulna in females on left side.

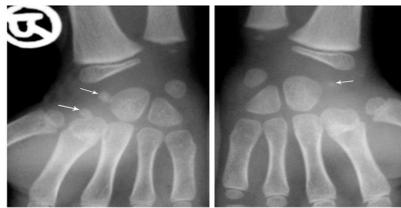




Six views of a subject taken only in 3 X-ray, shots to minimise radiation exposure. 4 AP views of wrist & Elbow taken in 1 shots. 2 lateral views of elbow taken in next 2 shots.



Lower end of Ulna appeared on right side only. Trapezium appeared only on right side in a 5 Year female subject.



Trapezium appeared only on right side, Scaphoid appeared more prominently on right side in a 4 Year male subject.



Composite epiphysis more fused on right side in a 13 Year male subject.



Composite epiphysis (Lateral epicondyle, capitulum and lateral flange of Trochlea, Medial flange of Trochlea) completely fused in a 12 Year female subject.

Discussion:

Distal end of Ulna in Males

Out of 104 subjects 54 male and 50 female subjects from age 0 to 20 years, were observed for ossification of distal end of Ulna process radiologically in this study. In the male age group of <1-5 years of age centre had not appeared in 6(11.11%) subjects and appeared, non fused in 3(5.56%) subjects on right side while not appeared in 5(9.26%) subjects and appeared, non fused 4(7.41%) on left side of the Wrist joint. It showed the difference of maturity of ossification in the same individuals over right and left sides. In the male age group of 6-10 years of age distal end of Ulna was not appeared in 9(16.67%) subjects and appeared, non fused in 5(9.26%) subjects and appeared, partially fused in 3(5.56%) subjects on right and distal end of Ulna was not appeared in 10(18.52%) subjects and appeared, non fused in 4(7.41%) subjects and appeared, partially fused in 3(5.56%) subjects on left sides of the Wrist joint. In this age group also significant bilateral variation in maturity of ossification is appreciated. In the male age group of 11-15 years of age distal end of Ulna was appeared, non fused in 3(5.56%) subjects and appeared, partially fused in 17(31.48%) subjects on both right and left sides. In this age group no bilateral variation in maturity of ossification is appreciated. In the male age group of 16-20 years of age group distal end of Ulna was appeared, partially fused in 3(5.56%) subjects and appeared,

completely fused in 5(9.26%) subjects on right side and distal end of Ulna was appeared, partially fused in 2(3.70%) subjects and appeared, completely fused in 6(11.11%) subjects on left side. In this age group significant bilateral variation in maturity of ossification is appreciated.

Distal end of Ulna in Females

In the female age group of <1-5 years of age ossification centre for distal end of Ulna was not appeared in 10(20%) subjects on right side while not appeared in 9(18%) subjects and it was appeared, non fused in 1(2%) subjects on left side. Thus, it shows the difference of appearance ossification centre for lower end of Ulna on right and left side in the same single Individual. In the female age group of 6-10 years of age distal end of Ulna was not appeared in 1(2%) subjects and was appeared, non fused in 8(16%) subjects, while it was appeared, partially fused in 4(8%) subjects on right sides. In the same age group distal end of Ulna was not appeared in 1(2%) subjects and was appeared, non fused in 7(14%) subjects, while it was appeared, partially fused in 5(10%) subjects on left side. Again in this age group, the bilateral difference of ossification is appreciated in an individual. In the female age group of 11-15 years of age distal end of Ulna was appeared, non fused in 1(2%) subjects, while was appeared, partially fused in 11(22%) subjects on right and left sides. In this age group no bilateral difference is appreciated. In the female age group of 16-20 years of age group distal end of Ulna was appeared, partially fused in 1(2%) subjects and was appeared completely fused in 14(28%) subjects on both right and left sides. In this age group no bilateral difference is appreciated.

In this study distal end of Ulna was appeared and completely fused earliest at 17 years in male subject and at 16 years in female subjects on both right and left sides.

Hence it can be concluded that in this study in female subjects centre for distal end of Ulna appeared at 6-8 year and fused at 16-17 year on both right and left sides. In male subjects centre for distal end of Ulna appeared at 4-7 year and fused at 17-18 year on both right and left sides.

Most of the studies don't revealed any bilateral difference of ossification unlike this study. This study revealed difference in appearance and fusion of ossification on right and left side in Individuals.

Galstaun G. (1937%) in Bengali population found appearance of the centre for distal end of Ulna appeared at 8-10 year and fusion at 17 years in females. In males he found appearance of the centre at 10-11 year and fusion at 18 year⁹. This observation is not in accordance with the findings in the present study. In present study in females the centre for distal end of Ulna appeared at 2 years earlier on both right and left sides. Centre for Distal end of Ulna fused with the shaft of the Ulna at 0- 1 year earlier on both right and left sides. In case of males the centre for distal end of Ulna appeared at 4 – 6 year earlier on both right and left sides. Centre for distal end of Ulna fused with the shaft of the Ulna 0 - 1 year earlier on both right and left sides.

Basu and Basu (1938) found in his study conducted on Bengalis Hindu Females that the distal end of Ulna unites with the shaft of the Ulna at the age of 16-17 year¹⁰. The findings of present study are also persistent with this study in females.

Davies & Person (1927) in his study on Englanders found that the distal end of Ulna appears at 7-8 year and unites with the shaft of the Ulna at the age of 20 years both in male and females. In the present study, the centre for distal end of Ulna appeared at 0 - 1 year earlier in females. In females the centre for distal end of Ulna fused with the shaft of the Ulna at 3 – 4 year earlier. In case of males the centre for distal end of Ulna appeared at 1 – 3 year earlier in upper limit of age group. In males the centre for distal end of Ulna fused with the shaft of the Ulna at 2 – 3 year earlier on both right and left sides.

Flecker (1942) in Australian population found that the distal end of Ulna unites with the shaft of the Ulna at the age of 17 years in female. In males the distal end of Ulna appears at 6 years and unites with the shaft of the Ulna at the age of 19 year¹¹. In comparison with this study in present study I females the age at which distal end of Ulna unites with the shaft of the Ulna at the age of 0 - 1 year earlier on both right and left sides. In males the age at which distal end of Ulna appears is 2 year earlier and 1 year later in some cases on both right and left sides. In males the centre for distal end of Ulna fused with the shaft of the humerus at 1 - 2 year earlier on both right and left sides.

Summary and Conclusions:

- This study was conducted exclusively on the young population of Central India keeping in mind that very less literature about the age estimation from ossification of lower end of Ulna right and left side is available involving this particular region of India.
- It can be concluded that in this study in female subjects centre for distal end of Ulna appeared at 6-8 year and fused at 16-17 year on both right and left sides. In male subjects centre for distal end of Ulna appeared at 4-7 year and fused at 17-18 year on both right and left sides.
- Bilateral variation in appearance and fusion of ossification is mentioned in the places in the available literature. Bilateral Difference of appearance and fusion of ossification centers is prominently observed in this study. It is difficult to calculate such difference of ossification in terms of days and months due to non-availability of such research depicting the bilateral ossification variation.
- Difference of size of appearance ossification centre and variation in degree fusion of epiphyses is also observed in the present study
- The process of ossification was completed remarkably faster in females than males which correspond with the available literature. In one male individual exceptionally centers of ossification appeared earlier than females of same age. This new trend can be validated and explored if more such studies involving the dietary, environmental, economical, religious, physical work etc. factors are considered and performed in this region.
- By comparing the findings in this study and the available literature it is found that the age of appearance and fusion of ossification centres in the females of this region is nearly similar to the Bengali females.
- By comparing the available literature, the age of skeletal maturity in both males and females in this region is nearly similar to those in state of Punjab.
- 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.
- 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.
- Population in Central India is mixed type comprising of various religions and castes, so this study is not applicable to specific caste or religion for estimation of age.
- As the sample size is limited further studies are necessary. Region wise studies should be conducted for better correlation and comparison.
- 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.

- It can be proposed that for better age estimation in judicial cases, Bilateral radiological examination should be advised rather than Unilateral.
- Due to very narrow borderline range of differentiation between various stages of fusion, it is difficult to consider stage of fusion as age indicator.
- For radiological study proper exposure of X-ray, proper positioning while X-ray shooting and proper development of X-ray films is necessary.
- Radiological interpretations are observer dependent so the set standards should be considered under expert guidance to arrive at conclusion in such radiological studies.

References:

1. Sangma WB, Marak F K, Singh M.S, Kharrubon B. Age determination in girls of north – eastern region of India JIAFM. 2007; 29(4):102-108..
2. Srivastav A, Saraswat PK, Agarwal SK, Gupta P: A study of wrist ossification for age estimation in pediatric group in central Rajasthan. Journal of Indian Academy of Forensic Medicine. 2004; 26(4).
3. Biswanath Ghosh V state AIR 1957 cal 589, (1957) Cr LJ 1114.
4. Bramha KC and Mitra NL. Ossification of carpal bones-A radiological study in the tribal population of ChotaNagpur. J.Anat.Soc.of India.1973; 22:21-28.
5. Dehury A, Panda U &Taher SA. Radiographic study of carpal bones in school children of South Orissa, A Prelimi report. J.ofAnat.soc.of India 1982;31:83-86.
6. Kothari DR. Age of epiphysial union at elbow and wrist joint in Marwar region of Rajasthan. J Indian Med Asso. 1974; 63(8):252-256.
7. Modi PJ. in chapter Personal Identity in Modis Medical Jurisprudence and Toxicology, 22nd ed. edited by Mathiharan K and Patnaik AK. New Delhi: Butterworths India; 2005. p. 263 – 337.
8. Dholu s/o JyutuGovind V state of Madhya Pradesh (1985) 1 Crimes 403(MP).
9. Galstaun G. A study of ossification as observed in Indian subject. Indian journal of Medical Research1937; 25(1):267-324.
10. Basu SK and Basu S. A contribution to the study of diaphysio-epiphysial relation at elbow of young Bengali girls. Indian Journal of Pediatrics 1938; 5: 202-204.
11. Flecker H. Time of appearance and fusion of ossification centers. Am J Roentgenol 1942; 47: 97–159.