

Radiological Indicators to Serve the Purpose of Juvenile Justice System Ordinance, 2000

Nizamuddin Memon, Muhammad Umar Memon, Khairunissa Memon, Afzal Memon

ABSTRACT

OBJECTIVES: To document radiological age indicator for differentiating Juvenile from adult offender for the purpose of Juvenile Justice System Ordinance, 2000 of Pakistan.

STUDY DESIGN: Perspective descriptive study.

SETTING: Department of Radiology and Imaging, Liaquat University Hospital Jamshoro/ Hyderabad, Sindh, Pakistan.

STUDY PERIOD: June 2007 to December 2008.

METHOD: Radiological study of adolescents both males and females (Total 394 comprising of 145 females and 249 males) subjects studying in various academic institutions of Hyderabad, representing the heterogeneous population was conducted with an object to observe the union of various bones that can provide an age indicator of 18 years for both genders.

RESULTS: X - Ray pelvis showing fusion of iliac crest with the rest of the bone and X- Ray medial end of clavicle showing appearance, represents age 18 years + 2 months in females, whereas in males X- Ray shoulder joint showing complete Epiphyso- Diphyseal union and their X- Ray pelvis still showing no fusion of iliac crest, represents same age group of 18 years+ 2 months. Radiologically female subjects are one year ahead of their counterparts, so for the skeletal maturity findings are concerned.

CONCLUSION: This study concludes that for females, if appropriate radiographs (X- ray pelvis and X- ray chest) showing fusion of iliac crest and appearance of epiphysis at medial end of clavicle the age is 18 years. In male population when radiograph of proximal end of humerus bone gives impression of union, it is concluded that the person has attained the age of 18 years.

KEY WORDS: Bony age, Ossification, Radiology, Medico legal, Juvenile Justice System Ordinance.

This article may be cited as: Memon N, Memon MU, Memon K, Memon A. Radiological Indicator to Serve the Purpose of Juvenile Justice System Ordinance, 2000. J Liaquat Uni Med Health Sci. 2015;14(01):06-11.

INTRODUCTION

Over the years, society's general attitude towards criminals has changed dramatically, from capital and harsh punishment to lenient and reformatory approach. Abolishment of death penalty, flogging, and detention in solitary confinement are few steps towards this direction. Voices against war crimes, sexual molestation and harassment of detainees, torture and rights abuses are frequently raised by civil society and rights groups. Individual states are responding to these voices and changes in laws are being done though at different paces, somewhere slowly and elsewhere rapidly. This approach can be exemplified from the fact that most democratic countries like Canada, Australia, New Zealand, almost all of Europe and much more of Latin America are among western countries that have abolished capital punishment and harsh treatment. First to abolish capital punishment was Portugal¹. Pakistan is also not an exception.

Promulgation of Juvenile Justice Ordinance, 2000² is the step taken following the pursuit of other countries, to protect the rights of under age accused.

Under this law, child is defined as a person who at the time of commission of an offence has not yet attained the age of 18 years. As the justice demands absolute decision, it is required by the courts to know the exact age of the accused so that the rights of the underage accused can be preserved and also nobody can misuse or take advantage of the latitude given to an individual under the afore mentioned law³.

Border line cases where the apparent physical growth correspond and or do not match the 18 years age; require intelligence, scientific determinant of age to solve the problem beyond any shadow of doubt.

This radiological study is aimed to formulate a simple, scientific, accurate, objective, permanently preserve able, presentable, readable and transparent method to help the courts to arrive at just conclusion.

SUBJECTS AND METHOD

Total numbers of subjects included in this study are 394, studying in various well known academic institutions of Hyderabad who volunteered themselves for this scientific study. The number of female volunteers remained low (145 female: 249 male) because of cultural barriers. All subjects belong to good socio-economic strata of the society according to the Pakistan's standards. The schools chosen for this study are those which keep their admission and progress record updated along with other information about their pupils, in order to get their exact dates of birth through birth certificates and to contact their parents. Random verification of the birth date of the selected subject was asked by putting questions, asking for bringing their birthday celebration congratulation cards or cross-examining the parents.

Subjects included in this study belong to different ancestral and linguistic backgrounds, themselves residing in the city since birth or early child hood. The nature, quantity and quality of the diet taken by them show more or less similarity.

Prior to their inclusion in Radiological Study, informed written consent of school authorities and parents of each examinee were taken on a pro-forma designed for the purpose.

In groups, all the selected subjects were transported to the Department of Radiology and Imaging, Liaquat University Hospital, Hyderabad City Campus for Radiology.

The subjects of either gender were divided into three groups on the basis of their stated / documented age, viz Group A (16-17 Years), Group B (17-18 Years) and Group C (18-19 Years).

This grouping was done to observe skeletal changes in various bones in Sequential manners to get the exact or least near exact bony indicator for 18 years of age. One or two radiographs of each age group were taken Viz Right wrist joint A.P view, Proximal End of Humerus (Right Shoulder) Iliac crest (Right Hip Joint) and medial end of clavicle (Right side Chest P.A view) with minimal radiation permissible dose⁴.

TABLE I: SHOWING PARTS RADIOGRAPHED IN EACH GROUP

Group	Age	Radiographs taken	
		Females	Males
A	16 to 17 Yrs	Proximal Humerus A.P View	Wrist Joint A.P View
B	17 to 18 Yrs	ILIAC CREST Medical END of Clavicle	Proximal Humerus
C	18 to 19 Yrs	—	ILIAC CREST Medical END of Clavicle,

Additionally, physical examination about secondary sex characters, general physique, facial hair distribution, change of voice, and prominence of Adam's apple, history of onset of menarche and nocturnal emission, dental data were observed⁵.

Radiographs thus exposed were observed and findings regarding each area recorded. The union of Diphyso-Epiphyseal components occurring at proximal end of Humerus, union of iliac crest with its respective bone and appearance or otherwise of the Epiphysis for medial end of clavicle was the main tangents for study to assess the mean age indicator for certifying and differentiating Juvenile Offender from an adult one with scientific accuracy.

Inclusion Criteria

All apparently healthy adolescents whose dates of birth are confirmed from admission registers of institutions and birth certificates and showing other growth indicators like height, weight, appearance of secondary sexual characteristics proportional to their age group are included.

Exclusion Criteria

The subjects showing some clinical manifestation of hormonal imbalance like dwarfism, over-weight or having previous history of nutritional and cardio-pulmonary disease were excluded.

Observations/Findings

GROUP A: (Documented age between (16-17 years)

Female: (Number of subjects radiographed = 67)

- Epiphysis for proximal Humerus is fused. Mean age being 16 years 9 months.
- Epiphysis for medial end of clavicle did not appear.

Male: (Number of subjects radiographed =109)

- Epiphysis for distal Radius & Ulna fused. Mean age being 16 years 10 months
- Epiphysis for proximal humerus not fused
- Epiphysis for medial end of clavicle does not show appearance

GROUP B: (Documented age between (17-18 years)

Female: (Number of subjects radiographed = 58)

- Epiphysis of iliac crest shows fusion with other bone Mean age = 18 years
- Medial end of clavicle appeared, Mean age 18 years

Male: (Number of subjects radiographed = 75)

- Fusion of epiphysis of proximal Humerus seen Mean age 18 years
- Appearance of medial end of clavicle not seen.

GROUP C: (Documented age between (18-19 years)

Female: (Number of subjects radiographed = 20)

- Epiphysis for medial and of clavicle not fused.

- Male: (Number of subjects radiographed = 65)
- Fusion of epiphysis of iliac crest = 19 years
 - Appearance of epiphysis of medial end of clavicle = 19 years

(Table II) shows time of appearance at Fusion of epiphysis in each group along with social & legal importance and number of subjects examined in each

The mean age therefore is 18 years in the females to display the above mentioned radiographic findings. In 249 male subjects, 210 (82.32%) show the fusion of Proximal end of humerus bone at the end of 214 months (17-10-00 years) and the remaining 39 (17.68%) showed the same finding at the later age of 218 months (18-02-00 years). The mean age where

TABLE II: DIVISION OF AGE GROUPS ALONG WITH THEIR IMPORTANCE:^{6, 7, 8, 9} (MEDICAL – LEGAL – SOCIAL)

Group	Appearance & Fusion Epiphysis	Number of Subjects			Importance
	YEAR MONTH-DAY (Y-M-D)	Females (F)	Males (M)	Total	
A 16 –17 Years	Fusion of Epiphysis Females: Y-M-D Proximal Humerus 16-10-00 Males: Distal ULNA & Radius 16-10-00	67	109	176	Social & Legal 16 YEARS Females: Marriage contract. Skeletal Maturity.
B 17 –18 Years Fig-I Fig-II	Fusion of Epiphysis Females: Y-M-D ILIAC CREST 17-10-00 to 18-02-00 Appearance of Epiphysis of Medial END of Clavicle 17-10-00 to 18-03-00 MALES: Proximal Humerus 17-10-00 to 18-02-00	58	75	133	Social & Legal Distinction of between juvenile & Adult offenders. Marriage contract (Male 18 Years). Granting civil Rights. I.D Card & Driving License. Casting Vote. Property maintenance and disposal. Skeletal Maturity
C 18 - 19 Years	Fusion of Epiphysis MALES : Y-M-D Iliac Crest 18-10-00 to 19-02-00 Appearance of Epiphysis of Medial END of Clavicle, 18-10-00	20	65	85	Social & Legal Females & Males: (18 Years) (Age of Majority) Adult hood According to factory act. Criminal responsibility (kidnapping + Crime) -Skeletal Maturity
Total		145	249	394	

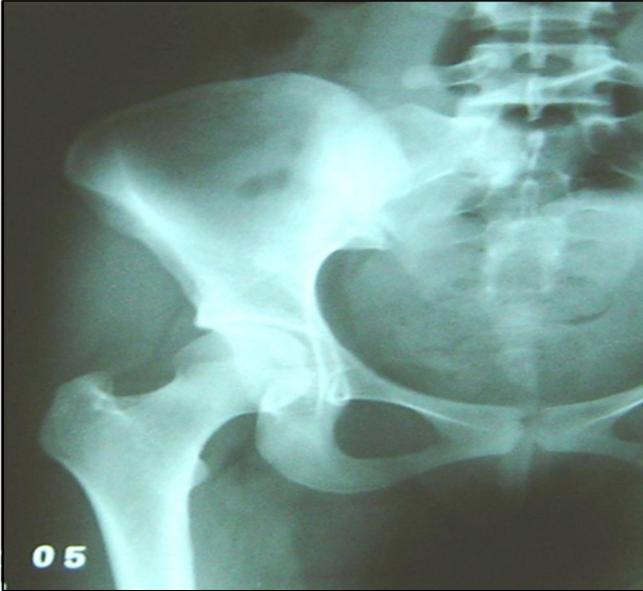
group. (Females & Males)

RESULTS

In the female subjects under study, 110 (75.85%) of the total 145 radiographed show, fusion of iliac crest as well as the appearance of medial end of clavicle at the age of 214 months (17-10-00) years whereas the 35 female (24.15%) show the identical X-ray findings at the chronological age ranging between 218-219 months (18-02-00 _ 18-03-00 years)

the findings are observed in male is 18 years. Compared to female subjects, in male gender, 236 (95%) the epiphysis of iliac crest is fused along with appearance of medial end of clavicle at the mean age of 18-10-00 years, meaning that biologically female are about 1 year ahead of their counterpart males. In all the cases number of days rounded to nearest months. The results of this study will help the courts of Juvenile trials with more accuracy in determination of age with

**FIGURE I: FUSION OF ILIAC CREST IN FEMALE
AGE: 17 YEARS AND 10 MONTHS**



**FIGURE II: FUSION OF EPIPHYSES OF PROXIMAL HUMERUS IN MALE
AGE: 17 YEARS AND 10 MONTHS**



DISCUSSION

The forensic use of Radiography started within months of discovery of X- rays by Wilthem Roentgen in 1895, when a bullet lodged in the leg of a gunshot victim was located using X- rays¹⁰.

Age represents biological progression and retrogression of various human faculties. These processes are multidimensional in nature, start a specified and step wise course from the day of conception to a time when the human faculties are well developed to work independently and up to their maximum capabilities¹¹. All these changes within the ambit of normality occur

at a predictable time and in a definite fashion. Medical science take advantage of these gradual changes , termed them as 'milestones' and frequently use them as age indicators and any discrepancy between age and growth is considered as abnormality or deficiency¹². Society grants some rights and privileges and bestows responsibilities as its member considering age as a parameter.

Law acknowledges the approach of science and wisdom of society but lays more emphasis on mental/ physical development of an individual whenever a criminal case is reported to it.

The Juvenile Justice Ordinance, 2000 considers a person under 18 years of age as child and provide for protection of rights of children involved in criminal litigation¹³. This law provides some special treatment for the child, like detention of child in Borstal jail, trialed separately from adults in Juvenile courts presided by Juvenile magistrates, preferably female. No child can be awarded punishment of death, ordered for labor, handcuffed, put in fetters or given any corporal punishment at any time during custody. This law also directs determination of age by medical examination/ report.

Various clinical parameters have been studied indicating changes in human body proportionately to chronological age like height and weight, orderly eruption, shedding of the teeth and their replacement by the permanent set, changes at puberty due to hormonal influence. However, their applicability is limited to certain age group and their reliability is questionable. Wisdom teeth is also unreliable to fix the age as its appearance is not a constant feature and also shows variable time of its eruption from 17 to 25 years¹⁴.

For the purpose of age estimation, radiographic studies were conducted throughout the world since turn of last century. Radiological examination for bone age assessment is time tested, trustworthy procedure, universally used for its simplicity, vast availability, minimum radiation exposure and of course presence of multiple ossification centers and their union at a specified period, for evaluation. The courts also rely on the radiographic evidence about age and commonly refer the procedure as 'ossification test' in their vocabulary¹⁵.

Medical literature depicts the initial work of Parsons¹⁶ on male English subjects. His work was limited to the study of hip joints of males only. His study of 1927 showed that the fusion of iliac crests occurs with the rest of the bone at the age of 23 years. Peterson¹⁷ in 1929 studied both males and females of British origin showing fusion of Proximal end of Radius at the age of 19 to 20 years in females and 21 years in males whereas the ulna showed the same age group in both genders for Diphyso-epiphyseal unification.

Sindas and Deery¹⁸ in 1931 studied the Egyptian Male population and found the Proximal radius and ulna are fused with their respective shafts at the age of 19- 20 years.

Gulstaun¹⁹ studied Bengalis Indian in 1937 and put the figures at 16 years for female radius and 18 for males whereas for ulna 17 years for female sand 18.5 years for males. He also studied the union of iliac crest and observed the union at 17-19 years in females and 19-20 years in their male counterparts. Flecker²⁰ (1942) studied the Australian subjects and found that in females union of radius is seen at the age of 18 and in males at the age of 19 years whereas union at ulna seen at the age of 17 in females and in males at 19 years of age.

It was the remarkable work of Gruilish and Pyle who studied extensively the American population in 1942 and published their work Radiographical Atlas of skeletal development of hand and wrist. Their standard work drew attention of both Pediatricians and Radiologists of the world and soon became the 'Gold standard' for referring skeletal maturity. Publication of their work triggered and motivated the researchers throughout the globe to get alternate method of skeletal maturity and also to develop radiological study for their population as the variation in Diphyso-epiphyseal union of the same bones came to limelight due to racial, climate, social economic conditions and other factors. Presently practically every country has their own data for skeletal maturity and age determination. Pediatrician used the Atlas as a reference after taking the radiography of left hand of the child under examination for diagnosing the abnormality or otherwise of the skeletal development²¹.

However, all the studies are directed towards clinical approach rather than application for Forensic purpose. Later, Macky²² (1952) studied East African, Hansman²³ (1962) Americans. Their study involved a limited area of interest and also the number of their subjects was small.

In Pakistan too, Rikhasor, Sajda²⁴ (1992), Rikhasor and Qureshi²⁵ (1994) and Shaikh, Rikhasor and Qureshi²⁶ (1994) contributed their data in the skeletal maturity literature. The number of Radiographs studied by Rikhasor, Sajda (1992) and Rikhasor and Qureshi (1994) 26 was too small as compared to the present study, Further, this study included heterogeneous population as compared to the above quoted authors as their subjects belong to homogeneous hue. Therefore, the results are showing differences of at least 6 months. For females, union at the Radius show 16 years age, in Rikshore and Qureshi series where as present study is showing the same findings at 15-10 years. For male, this study presents 18 year's age for union at distal radius, the present study shows an

earlier age 16-10-00 for the same bone.

For ulnas in female, union is noticed by Rikshor and Qureshi at 15.5 years, this study observed 15-10-00 years for the same bone in female. For male subjects, the ulna showing 17.5 years of age in their series whereas our series of cases keep the figure at 16-09-00.

In the subcontinent, Radiography is being used as a routine for legal demand of age ascertainment. In Pakistan Radiographers and forensic experts rely on the data about union of bony ends published by foreign authors specially Indians. Comparisons of Indian data about the age groups of 18 years in both sexes, shows remarkable difference so far the union of bones of wrist, shoulder, iliac crest and appearance of medial end of clavicle is concerned. The comparison showing difference of 1-2 years, not of months so their data cannot be utilized for our country.

The present study on the local heterogeneous population living under same conditions, involving more subjects provides data for comparison in more precise and specific fashion required for formulating an opinion for legal purpose to differentiate between juvenile and adult offenders.

CONCLUSION

This study concludes that for females, if appropriate radiographs (X-ray pelvis and X-ray chest) showing fusion of iliac crest and appearance of medial end of clavicle the age is 18 years and in male population when radiograph of proximal end of Humerus bone gives impression of Union, it is concluded that the person attained the age of 18 years.

ACKNOWLEDGMENT

The author Acknowledges Higher Education commission of Pakistan for the approval and funding and support throughout the project. Author also acknowledges the support by various schools principals, teachers and the parents for understanding the importance of Project and giving consent and helping in providing the subjects to be included in the study.

This is also to acknowledge the entire staff of department of diagnostic Radiology and Imaging, Liaquat University Hospital Hyderabad, Sindh-Pakistan for helping me for collection and preservation of the required record.

REFERENCES

1. Biswas G: Legal Procedure. In Review of Forensic Medicine and Toxicology. 2nd Edition, New Delhi. Japee Bros, 2012: 34-44.
2. [Http://www/karachieast.org/dec file/juvenile.doc](http://www/karachieast.org/dec_file/juvenile.doc).
http://www/Punjablaws.punjab.gov.pk/.../d3381_2-bbc9-49b5-a3e9.44913flad580. <http://>

- www.freeencyclopedia.wikipedia.org/wiki/juvenile_Justice-system Ordinance. <http://www.pljwsite.com/html/statuteview.asp?D=2826>.
3. [Http://Dawn.com](http://Dawn.com), January 31, 2013.
 4. Comp Med imaging graph 2007. 31 (4-5), 299-310.
 5. Parikh CK. Personal identification. In Parikh's Text book of Medical Jurisprudence, Forensic Medicine and Toxicology. 8th Edition, Delhi. CBS publishers. 2005; 2.1-2.38.
 6. Sharma R: Age determination by Radiology. Homeopathic Journal; 2008 (II) 5. [Http://www.Homeozone.com](http://www.Homeozone.com).
 7. VIJ K: Identification; In Text Book of Forensic medicine and Toxicology 4th edition. New Dehli: Elsevir, 2008, P 46-87.
 8. Dikshit PC: Identification. In Text Book of Forensic Medicine and Toxicology; New Delhi, Peepee, 2007, P 65- 88.
 9. Rao NG: Forensic identity. In Text Book of Forensic Medicine and Toxicology. 2nd Edition. New Delhi, 2010: 65- 118.
 10. The new marvel in photography. An article on an interview with Rontgen. In McCrure's Magazine 1896, 6(5).
 11. Awan N: Personal Identity. In Principles and practice of Forensic Medicine; Lahore 2000;31-45.
 12. Spasmpinto C: Skeletal Bone Age Assessment. University of Catania- Department of Informatic and Telecommunication engineering - Viale Andrea Doria 6, 95125 Catania_Italy.
 13. Memon N, Memon MU, Memon K, Junejo H, Memon J. Radiological Indicators for Determination of Age of Consent and Criminal Responsibility. JLUMHS. 2012;(02):64-70.
 14. Stanley J N, Major MA. Development and eruption of teeth. In dental anatomy, Physiology and occlusion. 9th Edition, St Louis, 2010. 22-47.
 15. [Http/ Dawn.com](http://Dawn.com). May 3, 2013.
 16. Parson D. J of Anatomy. 1927; 62.58.
 17. Petreson RS: Radiological investigation of the epiphysis of long bones. J. Anat, 1929;64.28-46
 18. Sindus G. Decry DE, Dates of Union of some Epiphysis in Egyptians from X-Ray photographs, J. Anat, 1931.65. 196-21.
 19. Gulstan G: A study of ossification centers observed in Indian subjects, J. Med, Res, 1937. 25. 267-327.
 20. Flecker H; Time of ossification and fusion of ossification centers as observed by Roentgen graphic Method, Aust. J.R 1942, 47-97.
 21. Grulich ww. Pyle SL; Radiological Atlas of Skeletal development of hand and wrist: 2nd Edition Stanford. Stanford University Press. 1971,61- 183.
 22. Mackay DH: Skeleton maturation of hand. A study of development in East African Children. Trans R Soc, Trop Med Hug 1952. 46, 135-150.
 23. Hansmon C: Appearance and fusion of ossification centers in the human skeleton: Am J Radiology, Radio therapy and Medicine, 1962, 61-185.
 24. Riskasor M, Sajida A: Time of appearance of ossification centres of hand and wrist. 1992. Pak J of Medicine.
 25. Riskasor M, Qureshi AH: Determination of Skeletal age of Children from 1_ 7, Pak Medical Journal. 1994:38-40.
 26. Shaikh AH. Rishasor R. M , Qureshi AM. Determination of age in children aged 8-18 years. J. Pak Assoc. 1998;48(4):104-6.



AUTHOR AFFILIATION:

Dr. Nizamuddin Memon (Corresponding Author)

Professor, Department of Radiology
Liaquat University of Medical & Health Sciences
(LUMHS), Jamshoro, Sindh-Pakistan.
Email: drnizammemon@hotmail.com

Dr. Muhammad Umar Memon

Professor, Department of Forensic Medicine
DOW University, Karachi, Sindh-Pakistan.

Dr. Khairunissa Memon

Professor, Department of Gynae Obstetric
Peoples Medical University
Shaheed Benazirabad, Sindh-Pakistan.

Dr. Afzal Memon

Professor, Department of Forensic Medicine
LUMHS, Jamshoro, Sindh-Pakistan.