ORIGINAL ARTICLE

Epiphyseal Fusion of Ischial Tuberosity in Adolescents - An Age Estimation Criterion

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ABSTRACT

Introduction: Age is one of the important pillars in the establishment of personal identity of an individual required in civil and criminal cases during life and after death. It becomes more important in developing countries where birth records are poorly maintained. Among all other age determinants, radiological examination of bone for appearance and fusion of ossification centers is rated to be a more accurate and reliable method for assessment of skeletal maturity by the legal and medical authorities as the union of epiphysis with the respective diaphysis of that bone occurs during an age period which is almost specific for that particular bone.

Aims and Objectives: The objective of this study was to assess skeletal maturity of ischial tuberosity by radiological examination for a known chronological age of the subjects with age bracket 17-25 years atShalamar Hospital Lahore.

Materials and Methods: The present cross sectional survey study was conducted in the radiology department of Shalamar Hospital Lahore in 200 subjects of both genders of 17 – 25 years, having known date of birth using Digital X-Rays machine to evaluate the fusion of ischial tuberosity. Cases were selected after ruling out the nutritional, developmental and endocrinal pathology which affects the skeletal development. Data analysis was done using SPSS Version 23.Conclusions were drawn and compared with available results of previous work done in this field.

Results and Observations: Out of 200 subjects, there were 132 males (66 %) and 68 females (34%).The mean ± SD age of both genders was 21.24± 2.77. The mean ± SD age of complete union for ischial tuberosity amongst males was 21.52± 2.77 years and amongst females was 20.69 ± 2.72 years with p value < 0.05.

Conclusion: The fusion of ischial tuberosity is not affected by ethnicity. Factors like diet and nutrition directly affect bone growth and hence bone age. More studies should be conducted across the country to formulate a standard in setting up a uniform criterion for assessing age of adolescents.

Key Words: Ischial tuberosity, Ossification, Age of Medico Legal Importance, Skeletal Radiography.

INTRODUCTION

Age is one of the important pillars in the establishment of tentative personal identity of an individual required in civil and criminal cases during life and after death[1].It is a very important task assigned to forensic experts particularly in legal matters where criminal responsibility has to be considered to impose punishment or to grant privileges of civil rights according to the age group of the claimant[2]. In under developed countries, age estimation becomes problematic due to least interest the of the public in the registration of births mostly because of illiteracy[3].

Age can be determined by different methods. These include general appearance, dental and skeletal examination. General appearance including height, weight and other body measurements are not very helpful in estimation of age due to wide variations in body size. Dental data is very helpful but not after 16 years of age as most of the dentition has erupted by this time. The eruption of third molar tooth shows a wide variation from person to person[3]. Assessment of age of a person on the basis of appearance and subsequent union of ossification centers of bones provides a methodical and logical technique which is well acknowledged by the medical and legal authorities[4].

Amongst all the determinants of age, radiological examination of bone ends till the

completion of the process of ossification has been found to be a very accurate and reliable methodby the medical experts hence acceptable to the legal authorities[5].

Large scale research in many parts of the world has been conducted for the estimation of age by this method. According to these studies there is reasonable variation amongst the populations. Such variations also exist between the population of the subcontinent and the West[6].Hepworth et al,[7] observed that Indians precede English and American people in the union of bones because of hereditary, dietary and socioeconomic factors.

Degree of maturation of ischial tuberosity is helpful in estimating age after 18 years of age due to its relatively late completion of maturation[8]. Radiological examination ofischial tuberosity of a person can be helpful to assess the age in civil and criminal proceedings like identification of an individual, age of attainment of majority for boys and girls for marriage, capital punishments, vote casting in elections or contesting elections as a candidate of assemblies, consent for participation in risky sports[9].

Due to paucity of data about this age group from the local population, this study was designed to determine roentgenographic appearance of epiphyseal centers and complete union of ischial tuberosity of pelvis of subjects between 17 to 25 years of age of both genders at Shalamar Hospital, Lahore. Hence, the main objective of my study is to provide a basic guide line to identify and assess the correct age of fusion of ischial tuberosity at local level, which can ultimately be useful in making criteria at national level for assessing age of fusion of ischial tuberosity. This study will help to contribute to the better administration of justice in many civil and criminal cases.

AIMS AND OBJECTIVES

To determine the age of the subject by radiological examination of pelvis, from fusion of the ischial tuberosity in both genders atShalamar Hospital, Lahore.

MATERIALS AND METHODS

The present cross sectional survey was conducted in the Department of Radiology Shalamar Hospital, Lahore during January 2015 to December 2015 on 200 subjects of both genders ranging from 17-25 years of age at Department of Radiology, Shalamar Hospital, Lahore.

Inclusion criteria:

- Individuals with age bracket of 17 to 25 years with any known documentary evidence of birth as CNIC, Form B, birth certificate of the municipal committee or hospital, school certificate, driving license.
- Both Genders
- Subjects belonging to any socio economic status.
- Subjects belonging to any ethnic group.
- Individuals with Normal Body Mass Index (18.5 to 24.9)

Exclusion Criteria

- Subjects suffering from any chronic illness e.g. congenital heart disease, any pulmonary disease, any bone disease or any endocrinal disorder. This was excluded by taking history and clinical examination.
- Chronic drug intake which interferes with bone growth directly or indirectly e.g. steroids or anti-epileptic drugs.
- Foreign nationals or children of foreign nationals excluded by history.
- Subjects having congenital bony deformities.
- Fractures of Pelvic bone, recent or old.
- Pregnant women.
- Individuals having severe malnutrition –weight for age isless than 60%.

Informed written consent was obtained from these selected subjects prior to X-ray exposure. Their height, weight, sex, stated age and other features were recorded on predesigned Performa.

Digital X rays of the pelvic bone showing ischialtuberositiy in antero-posterior view was taken. Changes in the epiphysis and the extent of union werevisualized for ischial tuberosity of pelvison the X-ray film. The radiological findings were reconfirmed by a single consultant radiologist of the Radiology Department Shalamar Hospital Lahore.

Skeletal maturity was assessed from stages of epiphysis union of ischialtuberosityand divided into three stages described by Stevenson (10) and (Singh, 9) as under:

Non Union: There is a clear gap between epiphyseal ends which appears as translucent area on X-rays.

Partial union: There is a bridging over or knitting together of the two margins. On X-rays, intervening

translucent areas between or on the sides of the bridged areas are distinguishable.

Complete union White line formed by the fusion of the two fusing layers of epiphysis disappears completely and becomes merged with normal trabeculae in this region. X-rays revealed the same bony architecture in the epiphysis without aepiphyseal scar.

This data was analyzed by using SPSS version 23.0 (Statistical Package for Social Sciences). Qualitative data like gender and stage of union was described statistically in frequencies and percentages. Quantitative data like age was described statistically after finding median, mean and standard deviation.

Age of study subjects was divided into 9 groups starting from 17 through 25 years. Age group 17 was considered as those who had completed their 16 years but they were less than 17 years, same for the other age groups.

Stages ofnon union, partial union and complete union were compared with these age groups for both genders (Tables 2, 3, 4).

RESULTS AND OBSERVATIONS

1-Age and Sex Distribution:

200 subjects between the ages of 17 through 25 years participated in this study. For both genders, mean ± SD age was 21.24 ± 2.77 years and median of age was 21 years.

Table-1: Age and Sex Distribution of the Subjects

Age in years	Male		Female		Total	
	N	% Age	n	% Age	n	% Age
17	14	60.9%	9	39.1%	23	11.5%
18	13	54.2%	11	45.8%	24	12.0%
19	10	58.8%	7	41.2%	17	8.5%
20	15	65.2%	8	34.8%	23	11.5%
21	11	61.1%	7	38.9%	18	9.0%
22	10	62.5%	6	37.5%	16	8.0%
23	14	737%	5	26.3%	19	9.5%
24	20	76.9%	6	23.1%	26	13.0%
25	25	73.5%	9	26.5%	34	17.0%
Total	132	66.0%	68	34.0%	200	100.0%
Mean					21.24	
Median					21.00	
Std. Deviation					2.776	

Table-2: Frequency of Extent of Fusion of Ischial tuberosity in different Age Groups among Males.

Age group (years) (%age)	Non union		Partial Union		Complete Union		Total	
	n	% Age	n	% Age	N	% Age	n	% Age
17	7	50.0%	5	35.7%	2	14.3%	14	10.6%
18	4	30.8%	6	46.2%	3	23.1%	13	9.8%
19	0	0.0%	2	20.0%	8	80.0%	10	7.6%
20	0	0.0%	2	26.7%	13	86.7%	15	11.4%
21	0	0.0%	1	9.1%	10	90.9%	11	8.3%
22	0	0.0%	0	0.0%	10	100.0%	10	7.6%
23	0	0.0%	0	0.0%	14	100.0%	14	10.6%
24	0	0.0%	0	0.0%	20	100.0%	20	15.2%
25	0	0.0%	0	0.0%	25	100.0%	25	18.9%
Total	11	8.3%	16	12.2%	105	79.51%	132	100.0%
Mean							21.52	
Median							22.00	
Std. Deviation							2.773	
P. Value*							0.000	

*The Chi-square test is significant at the .05 level.

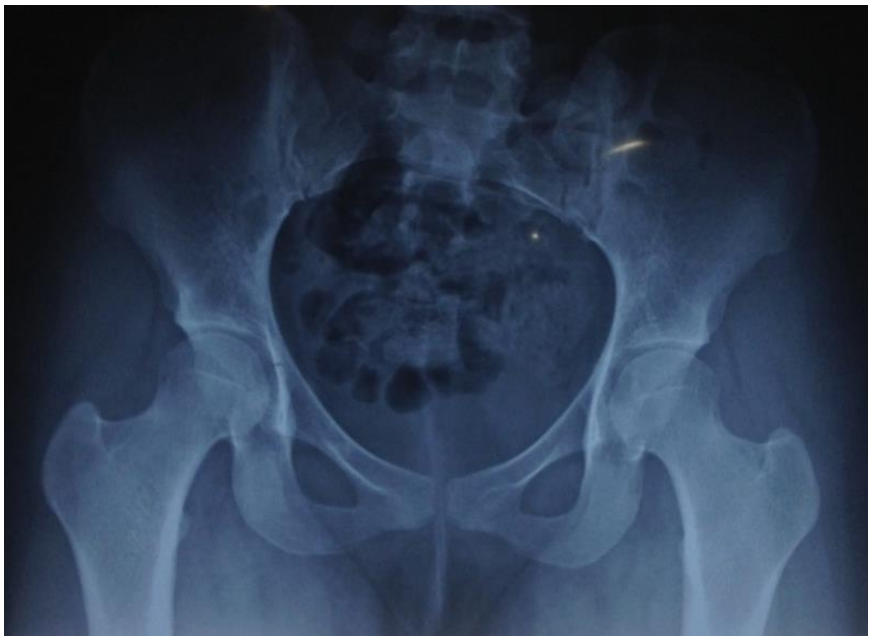
Table-3: Frequency of Extent of Fusion of Ischial tuberosity in Different Age Groups among Females.

Age group (years) (%age)	Non union		Partial Union		Complete Union		Total	
	n	% Age	n	% Age	n	% Age	n	% Age
17	3	33.3%	4	44.4%	2	22.%	11	13.2%
18	2	18.2%	7	63.6%	2	18.2%	15	16.2%
19	0	0.0%	4	57.1%	3	42.9%	9	10.3%
20	0	0.0%	1	12.5%	7	87.5%	8	11.8%
21	0	0.0%	0	0.0%	7	100.0%	7	10.3%
22	0	0.0%	0	0.0%	6	100.0%	6	8.8%
23	0	0.0%	0	0.0%	5	100.0%	5	7.4%
24	0	0.0%	0	0.0%	6	100.0%	4	8.8%
25	0	0.0%	0	0.0%	9	100.0%	3	13.2%
Total	5	7.4%	16	23.5%	47	69.1%	66	100.0%
Mean							20.69	
Median							20.00	
Std. Deviation							2.722	
P. Value*							0.000	
*The Chi-square test is significant at the .05 level.								

1-IMAGES OF NON UNION OF ISCHEAL TUBEROSITY
Date of Birth: 24-11-1998
Chronological age: 16 Years, 10 Months, 15 Days

2- IMAGES OF PARTIAL UNION OF ISCHEAL TUBEROSITY
Date of Birth: 18-11-96
Chronological age: 18 Years, 09 Months, 23 Days

3-IMAGE OF COMPLETE UNION OF ISCHEAL TUBEROSITY
Date of Birth: 08-05-1994
Chronological age: 20 Years, 6 Months, 26 Days



The subjects with reference to age were divided into 9 age groups starting from 17 through 25 years. Frequency distribution of the subjects with reference to sex is 132 males (66 %) and 68 females (34%). (Table-1)

2- Extent of Fusion of Ischial tuberosity in Males:

Table-2 shows that out of 132 males, there were 105 cases (79.5%) of complete fusion.100 % subjects showed complete union in the age groups of 22-25 year. There were 16 cases (12.2%) of partial union in 17 to 21 years age-groups and 11 cases (8.3%) of non-union in the 17 to 18 year age-groups. The mean ± SD age of complete fusion in male was 21.52± 2.77 years and median of age was 22.0 years. The P-value comes out to be 0.000 for male which is significant as it is <0.05.

3- Extent of Fusion of Ischial tuberosity in Females:

Table-3 shows that out of total 68 females, there were 47 cases (69.1%) of complete fusion.100% subjects' revealed complete union in age groups of 21-25 year. There were 16 cases (23.5%) of partial union in the 17 to 20 year age-groups and 05 cases (7.4 %) of non-union in the 17 to 18 year age-groups. The mean ± SD age of complete fusion in female was 20.69± 2.72 years and median of age was 20 years. P-value comes out to be 0.000 for females which is significant as the P-value is <0.05.

It was noted that females were one year ahead (21 years) for the fusion of ischial tuberosity as compared to males (22 years). It was also observed that with advancement of age, the %age of complete fusion increased and the % age of non fused cases decreased. It was also seen that there was symmetrical fusion of ischial tuberosity bilaterally on both right and left sides of the pelvic bone.

DISCUSSION

1. Association of Fusion of Ischial tuberosity with Age and Sex.

Various studies have been carried out in the world to determine age at which ossification of ischialtuberosityis completed. This age determination is primarily concerned with medico legal purposes or criminal proceedings.

This study determined the time of epiphyseal union of theischial tuberosity to assess the age of the subject by radiological examination of pelvis in both genders atShalamar Hospital, Lahore. Total subjects selected for this study were 200 in number including 132 males and 68 females. All subjects were of known age and their age was confirmed through their CNIC, Form B and school leaving certificates. The mean age of fusion of ischialtuberosity in our study was found to be 21.24± 2.77, males having higher mean age (21.52± 2.77) than females (20.69 ±2.72).

Age of fusion in our study is close to that of Parikh (11) who noticed complete union at 23-24 years in males and 21-22 years in females. Bhise (4) documented the age of complete union at 21-22 years in both genders in Mumbay,Verma (12)quoted 21-22 years in both sexes in Gujrat, Tailor, C (13) stated the age of 20-22 years.Bilkey,W. et al (14) noticed complete union at 21 years of age in females without mentioning males in North East region of India.

Our findings are in tandem with those of Patel G (15) who noticed age of complete fusion to be 20-21 years in males and 19-20 years for females in Gujrati population,SinghP (9) mentioned the age to be 20-21 years in both sexes,R.K Gupta (16) in Kanpur stated the age to be 20 years and Galastan (17) 20 years in Bengalis in both genders.

This close matching of results of our study with those of above mentioned authors is because of almost same socio economic status, dietary habits, nutrition and climatic effects of these regions. According to list of countries by Human Development Index 2014, Pakistan stands on 2nd in low human development and 146th among 169 countries on UN's HDI 2014 (19).Human development index. Higher HDI means a higher socioeconomic status while low HDI indicates low socio economic status. Bones of the people having poor socio economic status tend to delay maturation of bone. Malnutrition plays an important role in the maturation of skeleton. (18).This finding is in conformity with other studies all over the world i.e. (20).Patel G et al (15) did not notice any such relationship of socioeconomic status with the ossification of ischeal tuberosity in his study.

The mean age of fusion of ischial tuberosity in our study is higher in males(21.52 ± 2.77) than females (20.69 ±2.72).A significant difference with p value less than 0.05 was found for both genders. Although this is in agreement with the generally accepted pattern of earlier fusion in females but it is in disagreement with a difference of about 2 years given by various authors over the world (18).

SUMMARY AND CONCLUSIONS

1. Based on the results of this study, it is concluded that mean age of fusion of ischial tuberosity is 21.24± 2.77 in the healthy population examined at Shalamar Hospital, Lahore.
2. Mean age for the fusion of ischial tuberosity for males is 21.52± 2.77 and for females is 20.69 ± 2.72.
3. There is a difference in time frame of ossification of ischial tuberosity in both genders. The females tend to show a difference of about one year earlier than males in respect of fusion of iliac crest.
4. The complete union of ischial tuberosity in our study is almost in tandem with population of India.
5. The union of ischial tuberosity occurs symmetrically on both sides of pelvic bone.

RECOMMENDATIONS

1. It is recommended that more elaborate research studies be conducted in different parts of the country on subjects with different socioeconomic and nutritional status to find out the difference if any in time frames of fusion of ischial tuberosity so that a uniform national standard be formulated. This will also help us in establishing the role of nutrition, climate and geographical factors in ossification times.
2. More studies should be conducted on time frame of ossification ofischial tuberosity using large sample size.
3. Extensive researches should be carried out to formulate national guidelines for bone age assessment for our children using different methodologies.

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