

ORIGINAL ARTICLE

VARIATIONS IN THE AGE OF FUSION OF ISCHIAL TUBEROSITY; A RADIOLOGICAL STUDY

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Background: Human skeleton develops from separate ossification centres which continue to ossify till the bone is completely formed. Radiological techniques are very reliable and useful method for estimating the age of individual for forensic and criminal reasons by observing these ossification centres. External inspection for age determination is liable to error. This study is thus aimed to assess the variation in age of fusion of ischial tuberosity in Pakistani population. **Methods:** It was a cross sectional study, wherein data was retrospectively collected at Bahawalpur Victoria Hospital, a tertiary referral centre in which consecutively selected 47 females and 121 males between 10 to 24 years of age, attending the outpatient, referred from National Database and Registration Authority for the confirmation of age were selected. **Results:** There were a total of 13 cases in stage I, 98 in stage II, 23 in stage III and 34 in stage IV. In stage II maximum numbers of cases were between the ages of 19–22 years whereas in stage IV the maximum numbers of cases were between 21–24 years of age. **Conclusion:** It is concluded that the earliest appearance of epiphyseal center in males occurred at 12-13 years and in females at 10-11 years. While earliest complete union was seen at the age of 19–20 years in females and 16–17 years in males. All cases in age group of 23–24 years showed complete union.

Keywords: Epiphysis; Ischial tuberosity; Ossification centres; Age determination

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INTRODUCTION

The bones of human skeleton develop from separate ossification centers. The appearance and fusion of various epiphyses occurs at a definite order and period of time in life with minor variations and the correlation between age and timing of epiphyseal Centre can be used to establish age.¹ The minor differences in the age of fusion could be due to the effects of changes in climate, economic, hereditary, dietetic conditions or simply lack of standardized methodology.^{2,3} Furthermore, sexual variations in time of epiphysis maturation were well documented. In most of the studies females have shown earlier fusion as compared to their male counterparts.⁴

These changes can be studied by means of X-rays and considered as most reliable and informative of all the available methods for assessing age, i.e., general physical development, secondary sex characteristics, dental eruption and the appearance and fusion of ossification centre.⁵ Ischial tuberosity epiphysis is one of the several areas of the skeleton which do not complete their growth until the second and third decades of life and are consequently valuable for estimating age at death in young adulthood.⁶

Determination of age in Pakistani population is essential where we have a very low literacy rate, no hospital records are available and proper system for birth certifications is not being

followed. In the current situation, we are also facing a large number of internally displaced persons whose registration and identity cards issuance is another challenge. It is also important while taking consent or in cases relating to juvenile offenders, employment in government establishments and competency as a witness. The present study is an attempt to highlight the variability in the stages of fusion of ischial tuberosity in relation to chronological age determined by other parameters.

MATERIAL AND METHODS

It was a cross sectional study, wherein data was retrospectively collected from January 2016 to November 2016, at Bahawalpur Victoria Hospital, a tertiary referral centre in which consecutively selected 47 females and 121 males between 10–24 years of age, attending the outpatient, referred from National Database and Registration Authority for the confirmation of age were selected. Age was further confirmed from radiological study of other epiphyses. The cases were selected after ruling out the nutritional, developmental and endocrine abnormalities which affect the skeletal growth.

The study was done using standard radiographic technique for pelvis in anteroposterior view with supine position. Proper positioning and evaluation criteria including symmetry, optimal exposure and collimation was ensured. Ischial tuberosity on radiographs was studied for different stages of union. Criteria for epiphyseal Centre are shown in table-1.⁷

Table-1: Stages of epiphyseal fusion

Stage	Status of epiphyseal centres and fusion	Grade
I	Epiphyseal centre not appeared	A
II	Epiphyseal centre appeared	+
III	Partial union with visible gap/line	++
IV	Complete fusion with no visible line	+++

RESULTS

The distribution of all subjects at each stage of union for different age groups is shown in table-2. One female and 3 male subjects did not show appearance of centre of ossification in ischial tuberosity (Stage-I) latest by the age of 17–18 and 21–22 years respectively. Earliest appearance of centre of ossification (Stage II) was observed at the age of 10–11 years in female and 12–13 years in male, while the latest appearance was observed at age of 21–22 years in female and 22–23 years in male. The complete fusion of centre of ossification was observed earliest at age of 19–20 years in female and 16–17 years in males. All the cases in the age group of 23–24 years had completely fused ischial tuberosity. Appearance of centres and complete fusion can be seen in figure 1 and 2 respectively. In the present study, the maximum cases of stage II were 18 in the age group of 20–21 years followed by 17 cases in the age of 17–18 years. There were maximum number of subjects between the ages of 20–22 years; out of which 31 were in stage II followed by 10 subjects in stage III, 6 in stage IV and 5 in stage I. Detailed female and male distribution of stages of fusion in different age groups is shown in figures-1, 2.

Figure-1 shows that earliest appearance of centres was seen in 10–11 years while latest appearance was seen in 21–22 years whereas maximum number of subjects was in the age group of 17–18 years. Complete union was observed at the minimum age of 19–20 years.

Figure-2 shows that earliest appearance of centres was seen in 12–13 years while latest was observed at 22–23 years whereas a maximum number of cases were in age group of 20–21 years. Complete union was observed earliest at 16–17 years.

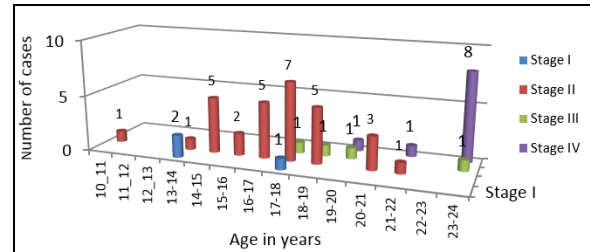


Figure-1: Female cases at different stages of fusion in different age groups

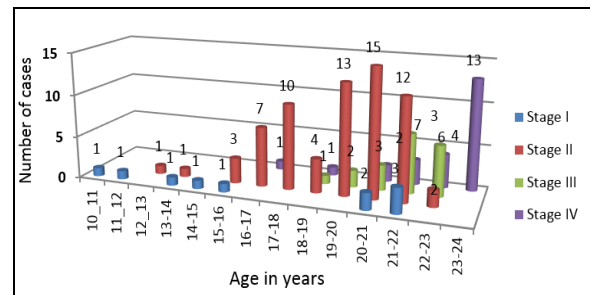


Figure-2: Male cases at different stages of fusion in different age groups

Table-2: Variations in age groups for different stages of ischial tuberosity epiphysis

Extent and appearance of fusion	Age group (years)														Total
	10–11	11–12	12–13	13–14	14–15	15–16	16–17	17–18	18–19	19–20	20–21	21–22	22–23	23–24	
	Cases (%)	Cases (%)	Cases (%)	Cases (%)	Cases (%)	Cases (%)	Cases (%)	Cases (%)	Cases (%)	Cases (%)	Cases (%)	Cases (%)	Cases (%)	Cases (%)	
Stage I	1 (7.6)	1 (7.6)	0 (0)	3 (23)	1 (7.6)	1 (7.6)	0 (0)	1 (7.6)	0 (0)	0 (0)	2 (15.3)	3 (23)	0 (0)	0 (0)	13 (100)
Stage II	1 (1)	0 (0)	1 (1)	2 (2)	5 (5.1)	5 (5.1)	12 (12.2)	17 (17.3)	9 (9.1)	13 (13.2)	18 (18.38)	13 (13.2)	2 (2)	0 (0)	98 (100)
Stage III	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (4.3)	2 (8.6)	3 (13)	3 (13)	7 (30.4)	6 (26)	1 (4.3)	23 (100)
Stage IV	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (2.9)	0 (0)	1 (2.9)	1 (2.9)	2 (5.8)	4 (11.7)	4 (11.7)	21 (61.7)	34 (100)

DISCUSSION

In this study, the earliest appearance of epiphyseal centres of ischial tuberosity was observed in females between 10–11 years of age while latest at 21–22 years, with the maximum number of 7 subjects in age group of 17–18 years. In males, earliest appearance was at 12–13 years while latest at 22–23 years, maximum number of 15 cases were in age group of 20–21 years followed by 13 cases in 19–20 years. This observation is almost similar in case of females subjects while different in male subject in the studies conducted by, Flecker⁸ and Dasgupta⁹ Sankhyan S *et al*¹⁰ and SS Bhise and SD Nanadkar¹¹. According to SS Bhise and SD Nanadkar the centres appeared at 15–17 years in females and 16–17 years of age in males.

At age of 23–24 years, all the cases showed complete epiphyseal Centre while earliest union was seen at 19–20 years in females and 16–17 years in males. According to SS Bhise and SD Nanadkar the earliest complete union occurred at 19 years in females which is in accordance with present study while the male showed the complete epiphyseal Centre at 20 years which differs from this study,¹¹ William Bilkey *et al* conducted two separate studies on females and males in north eastern region of India, according to him ischial tuberosity has completed fourth degree epiphyseal Centre by the age of 21 years in females and by 22 years in males.^{5,12} This result differs from the present study. Some other studies have shown the earliest union in females at 17 years and males at 18 years.⁷

We had a maximum number of 52 cases in between the age group of 20–22 years. Out of these, there were 31 cases where epiphyseal centres had just appeared, 10 were in late phase of union, while 6 cases showed complete union of epiphysis. Still there were 5 cases where no epiphyseal centres had appeared even at this late age. These observations differ from many of the other studies which can be justified due to the geographical differences, genetics factors, socioeconomic status and changes in climate which may play a role in determining the age of epiphyseal centre of ischial tuberosity.

CONCLUSION

From the present study, it can be concluded that the earliest appearance of epiphyseal centre in males

occurred at 12–13 years and in females at 10–11 years. While complete union was observed in both sexes at 23–24 years. According to our data it can be observed that there is a vast variation in age group of different stages of union especially in stage II. The study thus provides some guidance in establishing age but cannot be taken as a sole parameter for age determination and must be correlated with other age determining parameters.

AUTHORS' CONTRIBUTION

HS conceived the idea and designed the study. SN collected, analyzed and interpreted the data. NW helped in drafting the article, critical revision and final approval of the version to be published.

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