Assessment of Chronological Age of Individuals using Radiological and Ultrasonological Means

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ABSTRACT

Introduction: The 5 staged Risser's sign is used to determine the skeletal age by studying the apophysis of the iliac crest of the pelvis. Study was done to evaluate and compare the value of Risser's sign in assessment of chronological age by X ray and Ultrasound.

Material and methods: The study population consisted of 240 patients aged between 12 and 21 years who attended radiology department as referred by physicians for various non-bony pelvis pathologies. All cases underwent X ray and Ultrasonography. All results were graded by Risser's scoring system.

Results: Among the 240 patients, n=105 (43.8%) were male and n=135 (56.2%) were females. Risser's scoring has been estimated for all age groups (12-21yrs). The Risser's scores of 5 evaluated in X ray and USG findings show predominance in X-ray (68.3%) as compared to USG (38.3%) findings. The statistically compared age between actual age and estimated age was more precise in X ray as compared to ultrasound.

Conclusion: Risser's score was found to be useful in estimating the age of adolescents using X ray especially for legal purposes, however more multicenter research are required to warrant the findings.

Keywords: X ray, Ultrasound, Risser's Sign, Age

INTRODUCTION

The extent of skeletal development is an indication of the level of physiological maturation of an individual. The chronological age is determined to consign a skeletal age to a certain developmental condition. The medico-legal age assessment is based on the findings of physical, dental and radiological examination among which radiological examination of various ossification centers of bones form the mainstay of the estimation.[1]

The height and weight of an individual depend not only on hormonal but also on nutritional conditions and genetic factors, which are highly variable. Different ossification centers have been used as maturity indicators as they tend develop regularly in a well-defined order. For determining the age of a person from bones especially in adoloscence, different ossification centers is studied. In elderly people, the closure of skull vault suture, changes in the contour of mandible, union of the sternum, changes in the pubic symphysis, in the region of the glenoid cavity of scapula and the general changes in the bones due to ageing are taken into consideration.[2]

The estimation of age is very important in medico-legal issues. Hence, it is very important, for the forensic authorities, that the age estimates are as accurate as possible. The solution of this problem is important as it is concerned to the right of legal defense of individuals. Several methods are used to evaluate the skeletal maturity that involves different parts of the human skeleton. The methods that have been described by different researchers are based on hand, wrist, foot and knee.[3-6] The above mentioned methods are used for subjects less than 18 years of age.

Oxford and Risser's method is based on the pelvis; Risser's method is the only standard method which is used for determination of skeletal maturity in adolescents over 18 years old. Despite the controversy concerning its accuracy, the Risser's sign is used widely as a basic criterion for building decisions about the onset and type of treatment of spinal deformities during progression in skeletally immature adolescents.[7]

Amongst all the determinants of age, radiological examination of bone ends has shown accuracy and reliability acceptable to medical profession and the legal fraternity. The present study was conducted to determine age of subject by means of radiographic method by assessing the appearance and fusion of ossification centre of iliac crest.

MATERIAL AND METHODS

The prospective comparative study was conducted in the Department of Forensic Medicine and Radio diagnosis, Hind Institute of Medical Sciences and Hospital, Barabanki, UP from January 2016 to January 2017 after approval of Institutional Ethical committee. The study population included 240 outpatients who required radiography as a part of their diagnostics modality for various non-bony pelvis pathologies (intestinal obstruction, intestinal perforation, ureteric calculus, intussusceptions and ovarian pathologies).

Inclusion criteria

Both the males and females between the age group of 12 to 21 years with normal physical development were included.

Subjects having proof of age (in the form of birth certificate, school records, ration card and immunization card) were included.

Exclusion criteria

Subjects having age less than 12 years and more than 21 years were excluded.

Subjects displaying any sign of disease affecting skeletal maturation were excluded.

Subjects with history or any stigmata of previous fractures of bones (of and around the pelvis) were not included.

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Patient's data acquisition

The subjects were explained about the procedure and written informed consent was taken. The data regarding patient's particulars like age, sex, clinical history etc were taken on pre designed proforma.

Methodology

The detailed physical examination was done. The radiography in the form of X-rays and USG were done. The ultra-sonographic scan of individual subject was evaluated with respect to the stage of epiphyseal ossification followed by evaluation of radiographic staging. Risser's staging system was followed in both the cases.

Risser's staging[8]

The steps of ossification and fusion of the iliac apophysis are classified into six stages (Risser's Stages 0–5), the higher numbers of the score relating to the progression towards skeletal maturity.

Stage 0: signifies no ossification center is seen in the apophysis, whereas

Stage 1: 25% iliac apophysis ossification, Anterior Superior iliac spine (anterolateral) seen in prepuberty or early puberty.

Stage 2: 50% iliac apophysis ossification extends halfway across iliac wing seen immediately before or during growth spurt.

Stage 3: 75% iliac apophysis ossification. Indicates slowing of growth.

Stage 4: 100% ossification, with no fusion to iliac crest. Indicates slowing of growth

Stage 5: Represents complete ossification and fusion of the iliac apophysis.

The two can be distinguished by age**;** an adolescent with Risser's score 5 will not show any open growth plates in the long bones. *Risser's 0* grading will still have open growth plates in most of the long bones.

STATISTICAL ANALYSIS

The results are presented by using Microsoft excel 2007. The one way analysis of variance with Tukey's post hoc tests was used to compare the predicted age among different actual age groups. The unpaired t-test was used to evaluate the predicted age between male and female. The p-value <0.05 was considered to be statistically significant. All the data analysis was done by using SPSS 16.0 version.

RESULTS

A total of 240 subjects aged between 12-21 years were included in the study. More than half of the subjects were between 20-21 years (62.5%) followed by 18-19 (24.6%), 16-17 (5.8%), 12-13 (3.8%) and 14-15 (3.3%) years. The females n=135 (56.2%) are more as compared to the males n=105 (43.8%). The age distributions of the subjects were depicted in Table 1.

The Risser's scores evaluated in X ray and USG findings show predominance in X-ray (68.3%) as compared to USG (38.3%) findings. The finding of Risser's score for X ray and USG is tabulated in Table 2.

The comparison of Risser's scores with actual age on X-ray and USG findings is shown in Table 3. Among the X-ray findings the highest score was found in the age group of 20-21 years (4.93±0.34) and lowest was in 12-13 years (1.11±0.33). The ANOVA revealed that there was significant (p=0.0001) difference. The post-hoc analysis showed that there scores was found to be significantly (p<0.01) different in all the pairs of age

Age in years	No of Subjects (n=240)	Percentage (%)
12-13	9	3.8
14-15	8	3.3
16-17	14	5.8
18-19	59	24.6
20-21	150	62.5
Total	240	100

Table-1: Actual age distribution of study subjects

Age Group	Risser's score											
	0		1		2		3		4		5	
	X-ray	USG	X-ray	USG	X-ray	USG	X-ray	USG	X-ray	USG	X-ray	USG
12-13	0	0	03	05	00	03	00	00	00	00	00	00
14-15	0	0	06	06	02	05	04	01	00	00	00	00
16-17	0	0	00	00	02	16	12	15	01	09	05	03
18-19	0	0	00	00	00	06	17	12	11	29	36	36
20-21	0	0	00	00	00	00	02	01	17	40	123	53
Total	00	00	09	11	04	30	35	29	28	78	164	92
Percentage	00	00	3.8	4.6	1.7	12.5	14.6	12.1	11.7	32.5	68.3	38.3

Table-2: Distribution of Risser's scores according to age group in X-ray and USG findings

Age in years	Risser's Scores (X ray) (Mean±SD)	Risser's Scores (USG) (Mean±SD)
12-13	1.11±0.33[a]	1.66±0.86[a]
14-15	2.37±0.74[a]	3.00±1.19[a]
16-17	3.42±0.64[a]	3.28±1.26[a]
18-19	4.01±0.79[a]	3.86±1.18[a]
20-21	4.93±0.34[a]	4.11±1.02[a]
p-value[1]	0.0001*	0.0001*

Table-3: Comparison of Risser's scores with actual age X-ray and USG finding

Age group	Mean±SD		
	Actual age	Predicted age	
		X-ray	USG
12-13	12.33±0.50	13.76±0.56	17.53±0.67
14-15	14.88±0.35	15.87±1.24	18.56±0.93
16-17	16.36±0.49	17.63±1.08	18.79±0.98
18-19	18.49±0.50	18.62±1.33	19.23±0.91
20-21	20.45±0.49	20.15±0.57	19.43±0.79
Total	19.24±2.05	20.15±0.57	19.24±0.92

Table-4: Statistical measures of age (Mean±SD) distribution among the all the subjects

groups on X-ray finding.

In case of USG findings the highest score was found in the age group of 20-21 years (4.11±1.02) and lowest was in 12-13 years (1.66±0.86). The ANOVA revealed that there was significant (p=0.0001) difference in the score among the age groups on USG finding. The post-hoc analysis showed that there scores was found to significantly (p<0.01) different in all the pairs of age groups on USG finding.

The regression equations for predicting the age by X-ray and USG was calculated. Among the regression equations, X-ray has higher coefficient of determination (R^2=0.84) than USG (R^2=0.44) among all the subjects irrespective of gender. The coefficient of determination was higher for females on both X-ray (R^2=0.92) and USG (R^2=0.55). The males have coefficient of regression in X-ray (R^2=0.76) and USG (R^2=0.29)

The comparison between mean predicted age and actual age groups is shown in Table 4. The predicted mean age was observed to be close to actual age on X-ray among all the subjects. However, the predicted mean age was observed to be distant from actual age on USG among all the subjects.

DISCUSSION

The connotation of bone age in the evaluation of adolescent's physical development was proved to important as the chronological age of the individual in the past. Estimation of age is an important task for the forensic medicine experts especially in developing countries, when birth records are often not well maintained. Though the general development including height, weight, and secondary sexual character are helpful, but eruption and development of teeth are quite reliable data for estimation of age. Changes in bones especially time related appearance and fusion of different ossification centers in growing periods are also valuable indices for assessing the age.

In the present study, the percentage of male subjects was higher in the age group of 18-19 years (Male-81.4%, Female-18.6%). However, females were higher in other age groups. It was found in the present study that the fusion of iliac crest occurs at 18-19 years in males and at 20-21 years in females which is a higher age range than that of Flecker (1942)[9] findings who observed the complete fusion at the age of 18 years in males and at the age of 15-16 years in females. The findings of this are very much in accordance with that of Shah (1991)[10] [Gujarat] and Kumar et al (2004)[11] (Kanpur) findings.

Skeletal age of the subjects was determined by the appearance of the iliac apophysis of the pelvis. On a pelvic X-ray the apophysis appears laterally, and move towards the spine as the person approaches adolescence. Risser′s sign is a gauge of the growth missing in the spine, where 5 stages have been described by the study of Schmidt et al[12]; he analyzed the applicability of ultrasonography for the assessment of apophyseal ossification of the iliac crest in the subjects. The stages 1-5 typically appear from age 14-16 for girls and 15-18 for boys. In the present study, the highest score 5 was predominant in both X-ray (68.3%) and USG (38.3%) findings. The score was found be in increasing order with age. The score was significantly (p=0.001) higher among females (4.59±0.93) than males (4.13±1.11) on X-ray finding. Birang et al[12] found the Risser's score of 0-5 in his study among 206 patients [121 (58.6%) males and 85 (41.3%) females], in 13 (6.3%), 7 (3.4%), 24 (11.7%), 48 (23.3%), 35 (17%), and 79 (38.3%) of the subjects respectively. Risser's score was determined for all age groups over 18 years and found to be ≥3.

In this study, among the regression equations, X-ray has higher coefficient of determination (R^2=0.84) than USG (R^2=0.44) among all the subjects as well as in male and females. In the present study, the predicted mean age was observed to be close to actual age on X-ray among all the subjects. However, the predicted mean age was observed to distant from actual age on USG among all subjects. There was high significant (p=0.0001) correlation between actual age and predicted age on X-ray among all the subjects including male and female. However, the correlation of actual age and predicted age was mild to moderate on USG among all the subjects including male and females. Rao et al (2016)[1] demonstrated that the regression formulae derived (among females) for age group 14-17 years has the highest coefficient of determination which implies that the age calculated by the regression formula derived for the age group is the nearest possible value to the age calculated by the standard method.

CONCLUSION

To conclude, the study evaluated normal Risser's scores in the studied cases by both the methods, further the predicted mean age was observed to be close to actual age on X-ray among all the subjects but the variation from actual age was more on USG in comparison to X-ray which is statistically proven. The study is limited to less number of ossification centers as well as the age group of the subjects, so more multicentre study is warranted to add on to the findings of this study.

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