

Sh. Birang MD¹

I. Associate Professor, Department of Radiology, Loghman Hakim Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

Corresponding Author:

Shirin Birang

Address: Department of Radiology, Loghman Hakim Hospital, Kamali St., South Kargar Ave., Tehran, Iran.

Tel: +98-215-541-1411

Fax: +98-215-541-6170

Email: s1in3r@yahoo.com

Received March 10, 2008;

Accepted after revision August 6, 2008.

Iran J Radiol 2008;5(3):151-154

Estimation of Chronological Age According to Risser's Sign

Background/Objective: Risser's sign, a measure of excursion in the iliac crest apophysis, has been used to evaluate the remaining skeletal growth. The objective of this study was to evaluate the value of Risser's sign in estimation of chronological age in a number of university-affiliated referral hospitals in Tehran, Iran.

Patients and Methods: Our study group consisted of 206 patients aged between 10 and 25 years with a stable hemodynamic condition who were referred due to trauma in regions other than the head and neck. All cases underwent AP spine and proximal pelvis radiographies. All radiographies were graded by Risser's scoring system.

Results: Among our patients, 121 (58.6%) were male and 85 (41.3%) were female. Risser's score of 0, 1, 2, 3, 4 and 5 were seen in 13 (6.3%), 7 (3.4%), 24 (11.7%), 48 (23.3%), 35 (17%), and 79 (38.3%) of the patients, respectively. Risser's score was determined for all age groups. All cases aged over 18 years had a Risser's score ≥ 3 .

Conclusion: Risser's score is useful for the estimation of age in adults especially for legal purposes, though further multicenter studies are required for more comprehensive and precise data of the normal Iranian population.

Keywords: Radiography, Bone Development, Skeletal Maturation, Risser Sign

Introduction

The degree of skeletal development is a reflection of the level of physiological maturation.¹ The chronological age is determined to assign a skeletal age to a certain developmental status. For the evaluation of the developmental status of children and adolescents, a height-weight-age table and bone age chart have been used.²

Height and weight depend on not only hormonal and nutritional conditions but also genetic factors, which are highly variable.

Different ossification centers are used as maturity indicators as they tend to occur and develop regularly in a well-defined order.

Numerous methods are used to assess the skeletal maturity that involves different parts of the skeleton. The methods that have been described by Tanner et al., and Greulich and Pyle are based on the hand and wrist;^{3,4} the Hoerr et al. method, on the foot;⁵ and the Pyle and Hoerr method, on the knee.⁶ The above-mentioned methods are used for subjects less than 18 years of age.

Decisions about epiphysiodesis or spinal arthrodesis as well as predictions of limb-length discrepancy and standing height are influenced by skeletal age and are usually made during puberty.⁷ Oxford and Risser's method is based on the pelvis;^{8,9} Risser's method is the only standard method used for evaluation of skeletal maturity in adolescents over 18 years old.

Despite the controversy concerning its accuracy, the Risser's sign is used widely as a cardinal criterion for making decisions about the onset and type of treatment of spinal deformities during progression in skeletally immature adolescents.^{10,11}

Table 1. Distribution of Different Risser's Scores According to Age Group

Age group (yrs)	Risser's score					
	0	1	2	3	4	5
10–11	7	0	0	0	0	0
12–13	1	3	7	0	0	0
14–15	5	4	13	3	0	0
16–17	0	0	4	27	1	2
18–19	0	0	0	15	22	14
20–21	0	0	0	2	8	13
22–23	0	0	0	0	2	39
24–25	0	0	0	1	2	11

In 1936 Joseph C. Risser proposed the concept of a correlation between ossification of the iliac apophysis, the vertebral end-plate growth, and the potential progression of spinal curves.⁹

Many studies have assessed the reliability of Risser's sign and most of them have found it good.¹²

Since an Iranian standard bone age chart has not still been established for adolescents aged 10–25 years, especially for those over 18 years, for the evaluation of identification, nonage, and management of idiopathic scoliosis; we conducted this preliminary study on this age group in our university-affiliated hospitals.

Patients and Methods

The study group consisted of 10–25-year-old patients referred to our university-affiliated hospitals for trauma in regions other than the head and neck, and had undergone AP spine and proximal pelvis radiographies. All subjects had stable hemodynamic status and normal pelvic radiograph.

After obtaining informed written consent, a physician examined them to determine whether they had any diseases that could affect their biological development and maturity. We excluded those who had congenital, endocrine or other serious diseases or who were under 25 percentile or over 75 percentile in weight and height.

All radiographies were reported by one radiologist who was blinded to chronological age and gender of the cases. We excluded unclear images.

The iliac wing is divided into quarters and is composed of the following six Risser's grades (Fig. 1): Grade 0, no ossification; grade 1, ossification within

the first quarter (25%) of the crest; grade 2, ossification extending into the second quarter (25%–50%) of the crest; grade 3, ossification into the third quarter (50%–75%) of the crest; grade 4, ossification into the fourth quarter (>75%) to completion of the apophyseal line excursion; and grade 5, fusion of the apophyseal ring to the ilium from the start of the process posteromedially to completion.

Risser's sign is defined by the amount of calcification present in the iliac apophysis and it measures the progressive ossification from the anterolateral part to the posteromedial part.

A Risser's grade 5 means the iliac apophysis has fused to the iliac crest after 100% ossification.

Data were analyzed by SPSS® ver 11.5 for Windows®.

Results

Out of 206 patients included in this study, 121 (58.6%) were male and 85 (41.3%) were female.

In our study, Risser's grade 0, 1, 2, 3, 4 and 5 were observed in 13 (6.3%), 7 (3.4%), 24 (11.7%), 48 (23.3%), 35 (17%), and 79 (38.3%) of patients, respec-

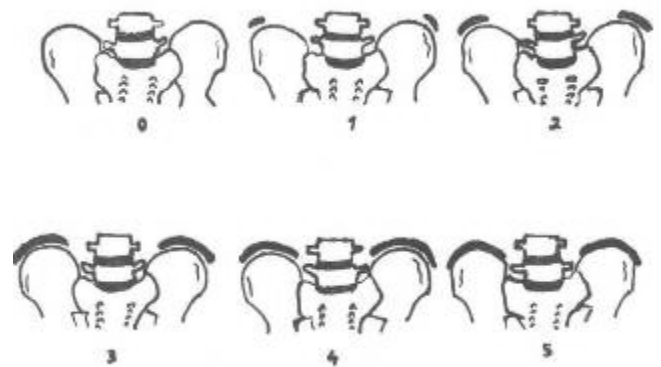


Fig. 1. Risser's grading system.

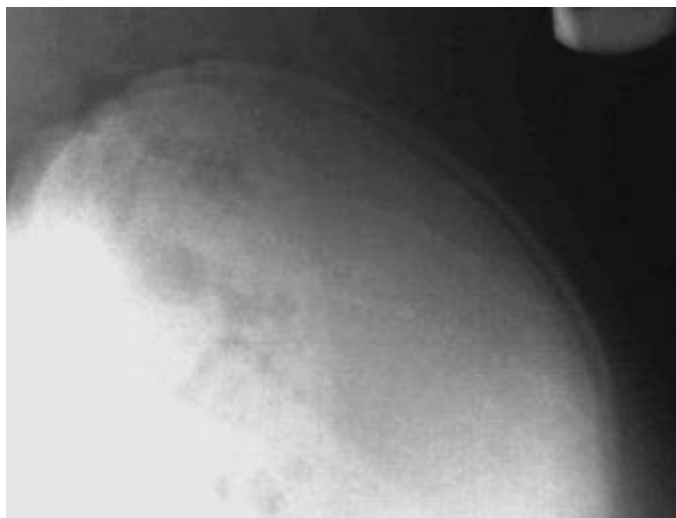


Fig. 2. A15-year-old man with Risser's grade 3.

tively (Fig. 2). All participants over 18 years had a Risser's grade ≥ 3 . In each group the distribution of different Risser scores were assessed (Table 1).

All participants who had a Risser's grade < 2 were younger than 16 years.

Discussion

The significance of bone age in the evaluation of adolescent's physical development was shown to be as important as the chronological age.¹³

Determination of skeletal age is also useful in evaluation of those with idiopathic scoliosis to determine the remaining growth and the risk for curve progression.

In addition, determination of skeletal maturity is an important method in evaluation, follow up and timing of therapy in growth disorders.¹⁴

Evaluation of bone age is frequently performed in children with growth abnormalities, to confirm clinical suspicion, to predict adult height, or to evaluate the effect of endocrine treatment.

The onset and progression of pubertal development are highly variable in different populations and may be affected by many factors such as socioeconomic, genetic, and environmental factors.^{13,15}

Racial, socioeconomic and environmental differences between Iranians and other populations may cause differences in skeletal maturation.

Therefore, it is expected that there should be some differences of skeletal maturation among different populations.^{14,16}

The Risser's sign evaluates the size and configuration of the iliac apophysis and is commonly used to evaluate skeletal maturity in patients who have idiopathic scoliosis because it is usually visible and also correlated with the growth of the spine and progression of the curve.^{17,18} It is convenient, as another film is not required for analysis. Several studies have evaluated the reliability of this sign and most of them found it reliable.^{19,20}

The iliac apophyseal capping is the last visible center of ossification that appears before the smaller and less visible ischial tuberosity on an AP radiography of the proximal pelvis.¹⁰

In our study, we found that none of our cases younger than 16 years of age had Risser's grade 0 and all over 18 had a Risser's grade ≥ 3 .

We think that these preliminary results would be useful for the estimation of age in adults especially for legal purposes.

When the results of this study and the previous reports were assessed, we felt that some modification of the Risser's atlas for each population (e.g., Iranians) may be necessary for obtaining better results.

One limitation of this study was the small sample size we studied. Another limitation was that we performed this study only in Tehran.

In conclusion, although we evaluated normal Risser's scores in our cases, further multicenter studies are necessary for the assessment of Risser's staging standard levels in Iranians.

References

1. Styne DM. The physiology of puberty. In: Brook CGD, editor. *Clinical paediatric endocrinology*. Blackwell Science, Oxford, 1995. p. 234-52.
2. Todd TW. *Atlas of skeletal maturation: Part 1 Hand*. London, Kimpton: 1937.
3. Tanner JM, Whitehouse RH, Marshall WA, Healy MJR, Goldstein H. *Assessment of skeletal maturity and prediction of adult height (TW2 method)*. Academic, London: 1975.
4. Greulich WW, Pyle SI. *Radiographic atlas of skeletal development of the hand and wrist*. Stanford: University Press; 1959.
5. Hoerr NL, Pyle SI, Francis CC. *Radiographic atlas of skeletal development of the foot and ankle: a standard of reference*. Springfield, IL: Charles C. Thomas; 1962.
6. Pyle SI, Hoerr NL. *Radiographic atlas of skeletal development of the knee*. Springfield, IL: Charles C. Thomas; 1955.
7. Diméglio A, Charles YP, Daures JP, de Rosa V, Kaboré B. Accuracy of the Sauvegrain method in determining skeletal age during puberty. *J Bone Joint Surg Am* 2005 Aug;87(8):1689-96.

8. Acheson RM. The Oxford method of assessing skeletal maturity. *Clin Orthop* 1957;10:19-39.
9. Risser JC, Ferguson AB. Scoliosis: its prognosis. *J Bone Joint Surg* 1936;18:667-70.
10. Bitan FD, Veliskakis KP, Campbell BC. Differences in the Risser grading systems in the United States and France. *Clin Orthop Relat Res* 2005 Jul;(436):190-5.
11. Asuhiro I. The accuracy of Risser staging. *Spine* 1995;20:1868-71.
12. Moseley CF. Leg length discrepancy and angular deformity of the lower limbs. In: Morrissy RT, Weinstein SL, editors. *Pediatric Orthopaedics*. Philadelphia: Lippincott-Raven; 1996. p. 849-901.
13. Büyükgebiz A, Eroglu Y, Karaman O, Kinik E. Height and weight measurements of male Turkish adolescents according to biological maturation. *Acta Paediatr Jpn* 1994;36:80-3.
14. Koc A, Karaoglanoglu M, Erdogan M, Kosecik M, Cesur Y. Assessment of bone ages: is the Greulich-Pyle method sufficient for Turkish boys? *Pediatr Int* 2001 Dec;43(6):662-5.
15. Wheeler MD. Physical changes of puberty. *Endocrinol Metab Clin North Am* 1991;20:1-14.
16. Loder RT, Estle DT, Morrison K, Eggleston D, Fish DN, Greenfield ML. Applicability of the Greulich and Pyle skeletal age standards to black and white children of today. *Am J Dis Child* 1993;147:1329-33.
17. Sanders JO, Herring JA, Browne RH. Posterior arthrodesis and instrumentation in the immature (Risser-grade-0) spine in idiopathic scoliosis. *J Bone Joint Surg Am* 1995 Jan;77(1):39-45.
18. Risser JC. The iliac apophysis: an invaluable sign in the management of scoliosis. *Clin Orthop* 1958;11:111-19.
19. Dhar S, Dangerfield PH, Dorgan JC, Klenerman L. Correlation between bone age and Risser's sign in adolescent idiopathic scoliosis. *Spine* 1993;18(1):14-9.
20. Scoles PV, Salvagno R, Villalba K, Riew D. Relationship of iliac crest maturation to skeletal and chronological age. *J Pediatr Orthop* 1988;8:639-44.