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RISSER PLUS SIGN: A NEW GRADING SYSTEM TO CLASSIFY SKELETAL MATURITY IN SCOLIOSIS PATIENTS

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Ossification of the iliac crest is a commonly used classification system to estimate skeletal maturity in managing treatment for patients with scoliosis. The Risser sign has a North American and European variant used in past literature. The Risser Plus system is an 8 point system which combines the two variations into a common system while also assessing the triradiate cartilage (TRC) maturity. The Risser Plus system consists of Risser 0-(open TRC), 0+ (Closed TRC), 1, 2, 3, 3/4, 4 and 5. The primary purpose of this study is to assess the agreement of the Risser Plus system between 6 raters stratified across two continents (3 North American and 3 European)

Method

Intra- rater and inter-rater reliability was determined by 6 raters (3 from NA and 3 from Europe) who assessed 123 pelvic radiographs from the Bracing in Adolescent Idiopathic Scoliosis Trial, all female, average age 13.4 years(range10.1 to 16.5 years). Raters, who were blinded to age or serial x-rays over time, reviewed x-rays at two time points for a total of 1452 readings. Agreement was established by the Krippendorff alpha with bootstrap 95% confidence levels. Intra-rater reliability was assessed with ordinal alpha along with 95% confidence levels with reliability coefficient set at 0.80.

Results

Overall reliability of the 8-point Risser Plus scale did not meet the requirements of the study (alpha=0.78 (0.73-0.83). Inter-rater reliability varied between the first and second readings. The first reading generated insufficient agreement with an overall Krippendorff's alpha of 0.71 (0.63-0.78), whereas the second reading generate sufficient agreement with alpha of 0.86 (0.80-0.90). Intra-rater reliability for the 8-point Risser scale was not sufficient for any rater in the study. Ordinal alpha values ranged from 0.56 to 0.78 and, on average, raters reported the same ratings for both reads only 64% of the time. Graded response modeling determined that reducing the number of categories in the Risser scale had minimal effect on the interrater reliability coefficients but increased intrarater reliability substantially with coefficients ranging from 0.87 to 0.96. Model improvements were also seen when raters with poor discriminant ability or poor intrarater

reliability were removed. The best model overall in terms of reliability criteria was a dichotomous model where the 0- and 0+ categories were collapsed and all ratings 1 or greater were collapsed. 16 readings were identified in which 1 rater recorded a rating that was more than 4 units from the other 5 raters. After removing these values, reliability increased substantially with interrater reliability at alpha 0.85 while intra-rater reliability was still < 0.80 for all raters. Most variability occurred at Risser 2-4.

Discussion

The Risser Plus system showed acceptable reliability when raters could accurately distinguish Risser 0+ from Risser 5. This error can occur on examination of a single radiograph in the absence of relevant clinical data such as age, Tanner stage, or puberty history. Most variability was found with ratings of Risser 2 through 4so that the clinical utility of this section of the scale is in question.

Conclusion

The RIsser Plus system is a reliable scale to classify patients based on skeletal maturity who participate scoliosis treatment research studies.