

# Systematic Isolation of Key Parameters for Evaluating Anteroposterior Shoulder Radiographs

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**INTRODUCTION:** The proximal humerus ossification system (PHOS) is a new skeletal maturity system (SMS) that is uniquely useful in the treatment of scoliosis. Integration of an additional medial fusion parameter increases PHOS's ability to predict likelihood of progression to a surgical curve magnitude, but decreases the proportion of readable posteroanterior (PA) shoulder XR. We sought to improve accuracy, readability, and reliability of PHOS by integrating new radiographic parameters.

**METHODS:**

Utilizing the prospectively collected, historical Bolton-Brush longitudinal growth study, demographic factors (age + sex), PHOS, and four novel radiographic parameters were evaluated on serial peripubertal shoulder radiographs, using Greulich and Pyle (GP) skeletal age from corresponding hand radiographs for comparison. Stepwise linear regression and generalized estimating equations were used to identify ideal radiographic and demographic parameters for estimating skeletal maturity based on 90% of final height (a corollary of peak height velocity). The accuracy of 5 SMS were compared: GP, PHOS, PHOS + demographics, PHOS + demographics + medial fusion, and PHOS + demographics + novel radiographic parameters (expanded PHOS).

**RESULTS:**

In this study, 368 peripubertal radiographs from 79 patients (41 girls and 38 boys) were included. The PHOS + demographics SMS estimated skeletal maturity with a mean discrepancy of 0.51-year and was more accurate than GP alone (0.67-year, p<.001) or PHOS alone (0.73-year, p<.001). The addition of medial fusion resulted in similar accuracy in skeletal maturity estimation (0.50-year, p=.07). The expanded PHOS system, which included novel radiographic parameters, estimated skeletal maturity with better accuracy than PHOS + demographics (0.48 vs. 0.51-year, p=.002).

**DISCUSSION AND CONCLUSION:**

Integration of demographic information into PHOS leads to greatly improved skeletal maturity estimation accuracy with minimally increased time and effort applying the system. For quick clinical use in skeletal maturity estimation, PHOS + demographics may be sufficient. However, utilization of the expanded PHOS may yield more accurate results.

**Table 1. Comparison of Skeletal Maturity Estimation Accuracy**

	<b>GP</b>	<b>PHOS</b>	<b>PHOS + Age + Sex</b>	<b>PHOS + Age + Sex + Medial Fusion</b>	<b>Expanded PHOS</b>
<b>Average Discrepancy (years)</b>	0.67	0.73	0.51	0.50	0.48
<b>StDev</b>	0.51	0.55	0.39	0.39	0.39
<b>p value</b>	<.001	<.001	-	0.07	<b>0.002</b>
<b>Number of Outliers*</b>	127	101	37	39	33
<b>% Outliers</b>	34.1%	27.2%	9.9%	10.5%	8.9%
<b>P value:</b>	<.001	<.001	-	0.69	0.48
<b>R<sup>2</sup></b>	0.74	0.70	0.85	0.853	0.862

Outlier = skeletal maturity estimation >1 year off from true skeletal maturity