Reliable Prediction of Postoperative Shoulder Balance, defined by RSH, through Clavicle Angle and Concordant T1 Tilt in Adolescent Idiopathic Scoliosis (AIS) Patients

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INTRODUCTION: Shoulder imbalance following Posterior Spinal Fusion (PSF) is a significant concern. This study aimed to identify radiographic predictors of shoulder balance by analyzing X-rays of control patients with no spinal deformities and X-rays of patients with Adolescent Idiopathic Scoliosis (AIS) who underwent PSF.

METHODS:
An analysis of 243 control and 419 AIS patients. The study measured Radiographic Shoulder Height (RSH), with less than 20 mm considered normal. T1 tilt and clavicle angle (CA) in the same orientation as RSH were defined as concordant. The study was divided into multiple parts:

Part I: X-rays of control patients were evaluated, with T1 tilt and CA recorded to determine "normal" and "abnormal" values. Kruskal-Wallis tests were performed to analyze the results.

Part II: Preoperative, postoperative, and final follow-up X-rays of AIS patients who underwent PSF were measured. Spearman's correlation was used to assess the correlation between radiographic parameters and RSH. Fisher's exact test was used to evaluate the distribution of abnormal postoperative RSH.

Part III: X-rays from multiple surgeons were evaluated to predict RSH, and Fisher's exact test was used to evaluate the distribution of abnormal postoperative RSH.

RESULTS:
Part I: 243 control patients were evaluated. 224 had normal RSH and 19 were abnormal. CA (1.5 vs 5.0), T1 tilt (2.4 vs 5.0), and First Rib Angle (2.3 vs. 5.4) were significantly different between the two groups ($p<0.001$).

Part II: In 419 AIS patients, there was a significant difference in post operative and final CA for Normal versus Abnormal RSH (1.9 vs 5.3; 2.0 vs 2.8), ($p<0.001, <0.001$). Those who had normal post-op CA had a greater than 90% likelihood of normal post-op RSH. This was similar for MSH. We found that over time, RSH continues to normalize. 73.8% of patients that had abnormal post-op RSH have normal final RSH. At final follow-up, those with normal post-operative CA had a 90% likelihood of having normal final RSH. Additionally, irrespective of normality in post-op T1 tilt, 85+% patients had a normal final RSH.

Part III: In 127 patients, restoring CA below 3 degrees yielded normal RSH at postop in all cases. Restoring concordant T1 tilt below 4 degrees yielded normal RSH at postop in nearly all cases.

DISCUSSION AND CONCLUSION: We found that restoring CA < 3° yields normal RSH postoperatively. In addition, when T1 is concordant, restoring it to < 4 degrees can yield normal RSH. Additionally, over time RSH will continue to normalize.