

# **Radiographic Predictors of Functional and Pain Outcomes in Scheuermann's Kyphosis: A ROC-Based Minimal Clinically Important Difference (MCID) Analysis**

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## **INTRODUCTION:**

Scheuermann's Kyphosis (SK) is a structural spinal deformity that often necessitates surgical correction to improve sagittal balance and alleviate pain and functional impairments. The primary goal of such interventions is to achieve meaningful improvements in patient-reported outcomes such as pain relief and functional ability. Radiographic parameters, including Pelvic Incidence-Lumbar Lordosis (PI-LL) mismatch, Thoracic Kyphosis (TK), Lumbar Lordosis (LL), and T1 Pelvic Angle (TPA), are critical in guiding surgical planning and evaluating the success of corrective surgery. However, the relationship between changes in these parameters and patient-reported outcomes remains variable, warranting further investigation into their clinical relevance. This study aimed to evaluate the clinical significance of key radiographic parameters in SK correction by calculating the Minimal Clinically Important Difference (MCID) using the Receiver Operating Characteristic (ROC) curve method. The analysis sought to determine the radiographic thresholds that best predict patient-reported improvements in function and pain, based on Oswestry Disability Index (ODI) and Visual Analog Scale (VAS) scores at 2 years postoperative follow up. We hypothesized that more stringent corrections in radiographic parameters, particularly in PI-LL mismatch and TK, would be predictive of significant improvements in patient-reported outcomes, while parameters such as LL and TPA might have weaker associations with clinical improvements.

**METHODS:** A retrospective analysis of 40 patients who underwent surgical correction for SK was conducted. Key radiographic parameters, including PI-LL mismatch, TK, LL, and TPA, were analyzed at the final follow-up. The MCID was calculated using the ROC curve method, with thresholds defined by the patient-reported outcomes of functional improvement (ODI) and pain relief (VAS). The Area Under the Curve (AUC) was used to assess the predictive power of each radiographic parameter. Comparisons were made with established literature standards to evaluate whether the cohort required more stringent corrections to achieve clinically meaningful outcomes.

**RESULTS:** The cohort consisted of 52.2% male with a mean age of 19.7 years, a mean BMI of 24.8, and Sanders Score of 7.23. The analysis revealed that PI-LL mismatch and TK were the strongest predictors of patient-reported improvements. For PI-LL mismatch, the ROC-based MCID threshold was  $6.0^\circ$ , more stringent than the commonly accepted threshold of  $\leq 10^\circ$  in the literature. The final PI-LL mismatch values ranged from  $-7.0^\circ$  to  $8.0^\circ$  in the cohort. The AUC for PI-LL mismatch was 0.68 for ODI, indicating that it was a fair predictor of functional improvement. In contrast, its AUC for VAS was 0.54, suggesting it had poor predictive value for pain relief. TK demonstrated a significant association with pain relief, with an ROC-based MCID threshold of  $0.40^\circ$  and an AUC of 0.69 for VAS, making it a fair predictor of pain improvement. However, its predictive value for functional improvement was limited, as evidenced by an AUC of 0.51 for ODI. LL had ROC thresholds of  $47.0^\circ$  for ODI and  $48.0^\circ$  for VAS, with AUC values of 0.54 and 0.60, respectively, indicating poor predictive ability for both functional and pain improvements. Similarly, TPA showed limited predictive power, with ROC thresholds of  $-3.0^\circ$  for ODI and  $9.0^\circ$  for VAS, and corresponding AUC values of 0.61 and 0.54. These results suggest that while LL and TPA are important for overall sagittal balance, their direct impact on patient-reported outcomes in this cohort was minimal.

**DISCUSSION AND CONCLUSION:** The ROC-based MCID analysis identified PI-LL mismatch and TK as the most clinically significant predictors of improvement in patients undergoing surgical correction for SK. Stricter corrections in PI-LL mismatch and TK were associated with better patient-reported outcomes, particularly in terms of functional improvement and pain relief, respectively. In contrast, LL and TPA, while essential for sagittal alignment, were poor predictors of meaningful clinical improvements. These findings suggest that surgical planning for SK should prioritize achieving tighter corrections in PI-LL mismatch and TK to maximize patient outcomes. Surgeons should focus on these parameters during preoperative planning and intraoperative correction to enhance patient outcomes, as LL and TPA showed limited predictive value for clinical improvement in this cohort.