# Which Complications When? Individualized Complications Calculator for Adult Spinal Deformity Surgeries

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INTRODUCTION: The adult spinal deformity (ASD) patient population is notably diverse, making the prediction of intraoperative and perioperative complications challenging. Recent quality improvement initiatives have focused on detailing patterns of complications, aiming to enhance prevention and optimization strategies effectively.

METHODS: We analyzed 840 operative ASD patients with complete baseline (BL) and two-year (2Y) follow-up data in a retrospective cohort study using a prospectively enrolled database. Descriptive statistics were utilized to evaluate patient data, focusing on the timing and type of complications encountered. Regression analyses were conducted to identify significant predictors of intraoperative and perioperative complications, as defined and categorized by AO Spine Klineberg et al. 2020.

RESULTS:

A total of 523 patients met the inclusion criteria for this study, with a mean age of 60.2±14.2, mean BMI of 27.1±5.7, mean Charlson Comorbidity Index (CCI) of 1.63±1.7, and a mean modified Adult Spinal Deformity Frailty Index (mASD-FI) of 6.4±4.9. Surgical details revealed an average operative time of 415.9±175.1 minutes, average estimated blood loss (EBL) of 1580.9±1388.6 mL, and an average of 11.0±4.5 levels fused per patient. Of these, 1.5% (8 patients) experienced a major intraoperative complication, while 9.8% (51 patients) experienced a minor intraoperative complication. Before discharge, 3.4% (18 patients) endured a major perioperative complication, and 5.7% (30 patients) had minor perioperative complications. Perioperative complications significantly predicted increased length of stay (LOS) with an odds ratio (OR) of 2.8 ($p<.001$). Age was a significant predictor of both intra- and peri-operative complications, while baseline comorbidities did not predict intraoperative complications. However, histories of clotting, kidney disease, and osteoporosis significantly heightened the risk of perioperative complications.

Specifically, perioperative renal complications, including renal failure, were notably higher among patients with diabetes (100% vs. 6.7%, $p<.001$) or heart disease (100% vs. 10.4%, $p<.004$). Furthermore, patients with heart disease, hypertension, kidney disease, and osteoporosis had higher incidences of perioperative motor deficits (40.0% vs. 10.3%, $p=0.032$; 80.0% vs. 33.2%, $p=0.028$; 60.0% vs. 2.7%, $p<.001$; 60.0% vs 18.3%, $p=0.017$, respectively). Those with pre-existing lung disease or peripheral vascular disease were more likely to experience deep vein thrombosis (DVT) at rates of 33.3% vs. 4.6%, $p=0.020$ and 33.1% vs. 2.1%, $p<.001$, respectively.

DISCUSSION AND CONCLUSION:

The results from our study underscore the complex interplay between patient characteristics and surgical outcomes in ASD surgery. The notable diversity in complications, especially perioperative ones, highlights the importance of a tailored approach to patient management based on individual risk factors.

Firstly, the significant predictors of increased LOS identified were perioperative complications, with an odds ratio of 2.8. This finding is consistent with literature suggesting that perioperative complications can substantially impact hospital resource utilization and patient recovery time. The relationship between age and the incidence of both intra- and peri-operative complications also emphasizes the need for heightened vigilance and possibly more conservative management strategies in older ASD patients.

Our study found that baseline comorbidities such as clotting disorders, kidney disease, and osteoporosis significantly increased the risk of perioperative complications but were not predictors of intraoperative complications. This may suggest that while certain comorbidities do not directly affect the surgical procedure itself, they play a crucial role in the patient's ability to recover and cope with the stress of surgery. These findings could guide preoperative screening and optimization, potentially reducing the risk of adverse outcomes.

Specifically, the high rate of perioperative renal complications in patients with diabetes or heart disease (100% vs. 6.7% and 10.4%, respectively) calls for a proactive approach in managing these patients. This could include more stringent intraoperative monitoring of renal function and postoperative care tailored to mitigate renal stress.

Additionally, the greater incidence of perioperative motor deficits in patients with comorbidities such as heart disease, hypertension, kidney disease, and osteoporosis highlights the multifaceted challenges in managing ASD. These conditions may exacerbate the strain on the neuromuscular system already imposed by surgery, suggesting that these patients might benefit from both preoperative neurological assessments and enhanced postoperative rehabilitation.

Moreover, the significantly higher rates of DVT in patients with preexisting lung disease and peripheral vascular disease underline the necessity for aggressive prophylactic measures in these high-risk groups. Implementing more aggressive

anticoagulation protocols or mechanical prophylaxis might reduce the incidence of such thrombotic events, which are critical complications that can extend hospitalization and increase morbidity.

In conclusion, our study highlights the critical need for comprehensive preoperative evaluation and personalized surgical planning in ASD surgery. By understanding the specific risks associated with various comorbid conditions, surgeons can better anticipate complications and refine their surgical approach to optimize patient outcomes. Future research should focus on longitudinal outcomes to further elucidate the impact of managing these risk factors on long-term surgical success and patient quality of life.

| Factor Associations | | |
|---|---|---|
| **BL Factor** | **OR [CI 95%]** | **Significance** |
| Intraoperative Complications | | |
| Age | 1.03 [1.00-1.06] | 0.048 |
| Smoker | 3.32 [1.21-9.10] | 0.020 |
| Perioperative Major Complications | | |
| Age | 1.07 [1.01-1.15] | 0.036 |
| Blood Clot | 7.99 [1.56-40.9`] | 0.013 |
| Kidney Disease | 17.2 [3.89-76.1] | 0.001 |
| Osteoporosis | 4.33 [1.41-13.3] | 0.010 |
| **Predictive Patterns** | | |
| **BL Factor** | **Type of Complication** | **Risk** |
| Heart Disease | • Excessive Intraoperative Bleeding | 4.3x [1.43-3.11], p=0.009 |
| Kidney Disease | • GI Complications<br>• Neurological Deficits | 15.5 [1.3-190.5], p=0.033<br>72.0 [6.3-826.2], p<.001 |
| Osteoporosis | • Neurological Deficits | 10.3 [1.02-104.3], p=0.048 |
| Lung Disease | • DVT | 58.8 [2,6-1323.1], p=0.010 |