## Analysis of Cost Utility of Distal Junctional Kyphosis Occurrence after Adult Cervical Deformity Surgery: The Benefit of Prophylaxis and Preoperative Optimization

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INTRODUCTION: Prior studies have examined the predictive factors for DJK and failure following adult spinal deformity surgery. However, there is a lack of research addressing the cost utility and prophylactic efficacy in preventing DJK. This study aims to analyze the cost-effectiveness and utility of preoperative prophylactic measures in preventing the occurrence of DJK after ACD surgery.

METHODS: We retrospectively reviewed operative ACD patients with available 2-year (2Y) follow-up data. Preoperative optimization for osteoporosis was assessed through treatment with an FDA-approved drug (OptO) administered prior to surgery. Additionally, the impact of preoperative rehabilitation (Prehab) was evaluated. The cost analysis was based on average Medicare reimbursement costs, accounting for surgical approach, revision status, complications, and comorbidities (CC), as well as major complications and comorbidities (MCC), according to CMS.gov manual definitions. Reimbursement estimates were standardized using regression analysis of Medicare pay scales for services rendered within a 30-day window. All costs were inflation-adjusted to 2022. For the Quality-Adjusted Life Year (QALY) analysis, utility values were calculated using the EQ-5D, as previously published. Multivariate regression analysis was conducted to identify predictive factors for the development of DJK related to prophylactic measures, adjusting for covariates such as age, baseline deformity, and baseline EQ-5D scores.

## RESULTS:

A total of 136 patients met the inclusion criteria (mean age: 57.1 ± 9.5 years, 60% female, mean BMI: 28.6 ± 6.7 kg/m<sup>2</sup>, mean CCI: 0.58 ± 1.0). Of these, 24 patients (22%) developed DJK, with 6 patients (6%) undergoing revision surgery. Multivariate analysis confirmed that patients who underwent Prehab were more likely to show improvement in the ODI (OR: 0.055 [CI: 0.006-0.476], p = 0.008) at 2 years. However, Prehab and non-Prehab patients exhibited similar ODI Integrated Health State (IHS) recovery rates from baseline to 2 years (p < 0.05). The total cost for Prehab patients was \$59,272 compared to \$72,878 for non-Prehab patients (p < 0.05). The utility gained at 2 years was 0.168 for Prehab patients versus 0.121 for non-Prehab patients (p < 0.05). Cost-effectiveness, determined via cost per QALY, was significantly better for Prehab patients (\$14,463) compared to non-Prehab patients (\$45,515, p < 0.05). For osteoporosis optimization (85.4% of patients), those treated (Opt) had lower odds of 2-year complications (OR: 0.207 [CI: 0.086-0.498], p < 0.001) and lower total costs (\$28,053 vs. \$33,171, p = 0.002) compared to non-optimized patients. The average cost of revision surgery due to DJK within 2 years of the index surgery was  $50,736 \pm 31,467$ , while the average cost of the index surgery was \$44,418. Patients who developed DJK incurred higher average costs (\$58,620 vs. \$44,418). The baseline NDI was similar for both cohorts (57), but by 2 years, the NDI for DJK patients was higher (48 vs. 37, p = 0.026), indicating greater improvement in disability for non-DJK patients. When considering the improvement in NDI and additional cost of QALY by 2 years, the total cost for DJK patients was \$89,259 compared to \$64,973 for those optimized preoperatively.

## DISCUSSION AND CONCLUSION:

Discussion: This study evaluates the cost-effectiveness and utility of preoperative prophylaxis in preventing DJK after ACD surgery. Our findings indicate that preoperative interventions, such as osteoporosis optimization and Prehab, significantly influence postoperative outcomes and costs. Patients who underwent Prehab exhibited lower total costs and higher utility gains at 2 years compared to those who did not receive Prehab. Specifically, the total cost for Prehab patients was \$59,272 compared to \$72,878 for non-Prehab patients. The utility gained at 2 years was 0.168 for Prehab patients versus 0.121 for non-Prehab patients, translating to a cost per QALY of \$14,463 for Prehab and \$45,515 for non-Prehab patients. These findings highlight the economic benefit and enhanced quality of life associated with Prehab. Osteoporosis optimization also proved beneficial. Patients who received FDA-approved osteoporosis treatment (Opt) had significantly lower odds of 2-year complications (OR: 0.207, p < .001) and lower total costs (\$28,053 vs. \$33,171, p =.002) compared to those who were not optimized. This underscores the importance of addressing osteoporosis preoperatively to reduce postoperative complications and costs. The study also found that patients who developed DJK incurred higher costs and had worse outcomes. The average cost for DJK patients was \$58,620 compared to \$44,418 for non-DJK patients. Furthermore, DJK patients showed less improvement in disability as measured by the NDI, with scores of 48 versus 37 for non-DJK patients at 2 years (p = .026). The higher costs associated with DJK, including the average revision surgery cost of \$50,736, emphasize the financial burden and reduced patient-reported outcomes associated with this complication.

Conclusion: The presence of DJK after ACD surgery significantly increases surgical costs and negatively impacts patientreported outcomes, with a greater likelihood of requiring revision surgery. Preoperative optimization, including osteoporosis treatment and prehabilitation, improves cost-effectiveness by reducing the incidence of DJK and associated complications. Although these preoperative interventions may increase initial surgical costs, they provide substantial longterm benefits in terms of cost utility and patient outcomes. Therefore, incorporating preoperative optimization strategies is crucial for enhancing the overall value of ACD surgery.