Persistent Lower Extremity Compensation for Sagittal Imbalance following Surgical Correction of Complex Adult Spinal Deformity: A Radiographic Analysis of Early Impact

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INTRODUCTION: Achieving ideal spinopelvic realignment during adult spinal deformity (ASD) corrective surgery does not always produce ideal outcomes. Little is known whether compensation in the lower extremities (LE) plays a role in this disassociation. We analyzed lower extremity compensation following complex adult spinal deformity corrective surgery, its effect on outcomes, and whether correction can alleviate these mechanisms.

METHODS: We included surgical complex ASD patients with six-week (6W) data; 6W outcomes: SAAS (Sagittal Age-Adjusted Score), and PJK/PJF. LE parameters assessed were Sacrofemoral Angle (SFA), Knee Flexion Angle (KA), Ankle Flexion Angle (AA). Compensation designated as the upper tertile at 6W for each parameter. Multivariate analysis controlling for frailty, baseline PT, and history of total knee arthroplasty / total hip arthroplasty (TKA/THA) evaluated outcomes between groups. Patients compensating/not compensating postoperatively were propensity-score matched (PSM) for BMI, frailty, and T1PA to evaluate outcomes.

RESULTS: A total of 210 patients (22% previous THA/TKA, Levels fused: 13.1±3.8) included. At baseline, 59% were compensating in LE: 32% at the hips, 39% knees, 36% ankles. After correction, 61% were compensating in at least one LE joint. Patients with remaining compensation after correction suffered higher rates of PJF, spine-related and neurological complications, and reoperation(all $p<.01$). Overcorrection in SAAS did not eliminate compensation at any joint (all $p>.1$). However, undercorrection less often relieved compensation (OR: 0.2,[0.04-0.9]). PSM revealed patients compensating in LE postoperatively were more often undercorrected in age-adjusted PT, PI-LL, T1PA, and disproportioned in GAP parameters (all $p<.05$). Patients matched in SAAS but compensating in LE were more likely to develop PJK (OR: 4.1,[1.3-21.8]) and PJF (8% vs. 0%;$p=.035$) than those SAAS-matched without LE compensation.

DISCUSSION AND CONCLUSION: Perioperative lower extremity compensation was often the product of undercorrecting complex adult spinal deformity. Even in the setting of age-adjusted realignment, compensation in the lower extremities was associated with global undercorrection and junctional failure. Consideration of the lower extremities during surgical planning is vital to avoid adverse outcomes in the perioperative course following complex adult spinal deformity surgery.