When Does the Global Alignment and Proportion (GAP) Score Fail?: Comprehensive Assessment of Mechanical and Junctional Failure in Patients Meeting Post-Operative Global Alignment and Proportionality Targets

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INTRODUCTION: The GAP score is a new pelvic-incidence-based proportional method of analyzing the sagittal plane that predicts mechanical complications in patients undergoing surgery for adult spinal deformity. Setting surgical goals according to the GAP score may decrease the prevalence of mechanical complications. However, addressing these targets does not always prevent high mechanical complication or revision rates.

METHODS: Surgical ASD patients ≥18 years old with available baseline (BL) radiographic data at baseline (BL) and 2year (2Y) were isolated in the single-center database. Proximal and distal junctional kyphosis and/or failure, rod breakage, and other implant-related complications were considered mechanical complications. Patients improved in GAP [Proportioned (GAP-P), Moderately Disproportioned (GAP-MD), and Severely Disproportioned (GAP-SD)] by 6W were considered Matched. Secondarily, failure rates within each category were established for patients meeting Sagittal Age-Adjusted Score (SAAS) and Roussouly targets by 6W. Backstep logistic regression analysis and CIT analysis then determined factors associated with failure and achieving optimal outcomes.

RESULTS: 331 patients (59.8±15.1 yrs, 78% F, 26.8±5.6 kg/m2) were isolated). By GAP proportionality: 47.8% of patients were considered GAP-P by 6W, 36.1% were considered GAP-MD, and 16.2% were considered GAP-SD by 6W post-op. Overall, 50.0% of patients were considered improved by GAP proportionality. In terms of gross failure rate, 55.2% of the total of patients GAP-matched patients suffered PJK by 2Y despite meeting GAP targets, 8.4% suffered radiographic PJF by 2Y, 16.0% suffered mechanical failure, 25.0% required reoperation, and 29.0% suffered major complication by 2Y. Radiographically, GAP-matched who required reoperation for mechanical failure demonstrated lessened magnitude of correction between BL and 6W in sacral slope (p=.017), PI-LL (p=.006), and C7-S1 SVA (p<.001), but were comparable in ΔT4-T12 kyphosis (p>.05) versus non-matched patients. By 2Y, GAP matched and non-matched patients requiring reoperation were comparable in all radiographic criteria assessed. For patients with mechanical failure by 2Y, 45.8% met 6W SAAS targets (p=.0550, and 35.0% met Roussouly targets (p=.607) versus non-GAP matched patients. Backstep logistic regression revealed that not matching in GAP was predictive of not meeting Smith et al. Best Clinical Outcomes by last follow-up [.167 (.106-.262), p<.001)]. In patients GAP-matched patients, and when accounting for history of osteoporosis and meeting 6W age-adjusted targets, increased BL PI-LL [1.037 (1.005-1.070), p=.024) was predictive of mechanical failure by 2Y.

DISCUSSION AND CONCLUSION: Predictive analysis demonstrates that increased baseline PI-LL, as well as decreased pelvic tilt and operative correction of thoracic kyphosis is significantly associated with increased risk of mechanical failure in patients who improved in GAP proportionality post-operatively. Although improving in GAP proportionality is independently predictive of meeting Best Clinical Outcomes (BCO) by last follow-up, meeting GAP targets alone may not be sufficient to predict post-operative mechanical failure.