Risk Factors for Pelvic Fixation Failure in Pediatric Patients With Spinal Muscular Atrophy, Cerebral Palsy, and Marfan Syndrome Over a Twenty-Year Retrospective Study

Zaid Shaker Elsabbagh, Henry Stewart, William Gabriel Elnemer, Paul D Sponseller

INTRODUCTION:
Pelvic fixation is frequently utilized in long spinal constructs for pediatric patients with neuromuscular and syndromic scoliosis to improve stability, maintain balance, and prevent distal junctional failure. Despite its utility, fixation failure remains a significant complication, particularly in patients with compromised bone quality or altered biomechanics. Although widely used, risk factors contributing to pelvic fixation failure in these vulnerable populations remain poorly defined. This study aimed to identify clinical and radiographic predictors of pelvic fixation failure in pediatric patients with spinal muscular atrophy, cerebral palsy, and Marfan syndrome.
METHODS: We performed a retrospective chart review of pediatric patients (<18 years or skeletally immature) who underwent spinal fusion with pelvic fixation from 2004 to 2024 at a single academic center. Data collected included demographics, diagnosis, ambulatory status, construct type, and radiographic parameters. Pelvic fixation failure was defined radiographically as lucency greater than 2 mm around pelvic screws. Subgroup analyses were performed on patients undergoing posterior spinal fusion and on those undergoing primary surgery. Statistical significance was defined as $p<0.05$.
RESULTS: A total of 117 patients were included (cerebral palsy: 40; Marfan syndrome: 54; spinal muscular atrophy: 23). Pelvic fixation failure occurred in 25 patients (21.4%), with the highest rate observed in spinal muscular atrophy (43%, $p=0.011$). Failure was associated with younger age, elevated body mass index, greater preoperative Cobb angle, increased pelvic obliquity, and fewer levels fused (all $p<0.05$). These associations remained significant in subgroup analyses restricted to posterior spinal fusion and primary fusion procedures. Diagnosis trended toward significance in the most restrictive subgroup ($p=0.050$), suggesting a potential underlying biological component.

DISCUSSION AND CONCLUSION: Pelvic fixation failure is more common in pediatric patients with spinal muscular atrophy. Higher body mass index, pelvic obliquity, and shorter fusion length are consistent risk factors that should inform preoperative planning and construct design.