Assessing Risk Factors For Providence Bracing Failure In Adolescent Idiopathic Scoliosis

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INTRODUCTION: The Providence brace (PNB) is a nighttime orthosis designed to prevent curve progression in adolescent idiopathic scoliosis (AIS). The purpose of this study was to investigate risk factors associated with failed PNB treatment.

METHODS: Institutional review board approval was granted prior to the initiation of this study. A retrospective review was conducted of AIS patients treated with the PNB from 2012 to 2024. Eligible patients were 7-17 years old, Risser stage 0-2, with an initial Cobb angle of 15-40° and were premenarchal or ≤1-year postmenarchal. Patients with prior treatment, trauma, non-idiopathic scoliosis, and cervical/cervicothoracic curves were excluded. Extracted data included in-brace (IB) and out-of-brace (OOB) Cobb angles, radiographic variables, comorbidities, and demographic information. Major curve regions were analyzed as thoracic versus lumbar, and apex level was assessed using the following subsets: high thoracic (T1–T3), mid thoracic (T4-T6), low thoracic (T7-T9), thoracolumbar (T10-L1), and lumbar (L2-L5). Treatment failure was defined as ≥6° curve progression, total curve magnitude ≥45°, recommended surgery, brace-type switching, or non-compliance. Statistical analyses included t-tests, and univariate logistic and linear regression models.

RESULTS SECTION: A total of 158 patients (133 females, 25 males) were included and analyzed as two distinct cohorts: PNB treatment failure (35.44%) and PNB treatment success (64.66%). Mean patient age was 11.28 ± 1.60 years, with an average initial Risser score of 0.36 ± 0.65, and an initial OOB Cobb angle of 24.46° ± 4.52. Patients followed up for a mean of 33.47 ± 18.74 months with 6.57 ± 3.25 hours of average nightly brace wear. Significant differences in OOB Cobb angles emerged between successful and failed bracing over the course of PNB treatment (Figure 1). PNB failure was due to curve progression ≥6° (55%), total curve magnitude ≥45° (14%), brace-type switching (28%), and recommended surgery (13%). Area Deprivation Index (ADI) scores were not significantly associated with treatment failure (OR: 1.02, 95% CI: 1.0-1.03, p=0.077). Major curve level and thoracic versus lumbar apex were not predictive of adverse PNB outcomes (all p>0.05). Poor compliance was associated with 68% of treatment failures. Compared to bracing successes, failures had greater initial OOB Cobb angles (25.64° ± 4.84 vs. 23.43° ± 4.07, p=0.004), initial maximum apical vertebral rotation (AVR) (0.57 ± 0.76 vs. 0.15 ± 0.37, p<0.001), and reported significantly fewer hours of nightly brace wear (4.78 ± 3.59 vs. 7.91 ± 2.06, p<0.001). Clinical factors such as brace discomfort (p<0.001), difficulty sleeping (p=0.003), and outgrowing one's brace (p<0.001) were all predictors of failed treatment. Diagnosed anxiety (OR: 8.16, p=0.0017) and 2 concomitant psychiatric comorbidities (OR: 12.08, p=0.008) also predicted treatment failure.

DISCUSSION: PNB failure was significantly associated with both modifiable and non-modifiable risk factors. Well-recognized influences of bracing outcomes such as greater initial Cobb angles and greater AVR were prevalent. Poor brace compliance due to discomfort, difficulty sleeping, and outgrowing one's brace also contributed to a significant proportion of treatment failures. Psychiatric comorbidities, particularly anxiety and multiple diagnoses, also predicted adverse outcomes. Individualized patient counseling, psychiatric evaluation, and early identification of high-risk patients are critical to optimizing PNB treatment. Limitations include this study's retrospective design, single-institution dataset, potential charting inaccuracies, and patient-reported brace wear duration.

SIGNIFICANCE/CLINICAL RELEVANCE: Successful Providence bracing depends not only on curve severity but also on treatment adherence and patient-specific factors. Early identification of patients at risk for poor compliance and psychiatric comorbidities may allow targeted interventions to improve brace tolerance and treatment outcomes.

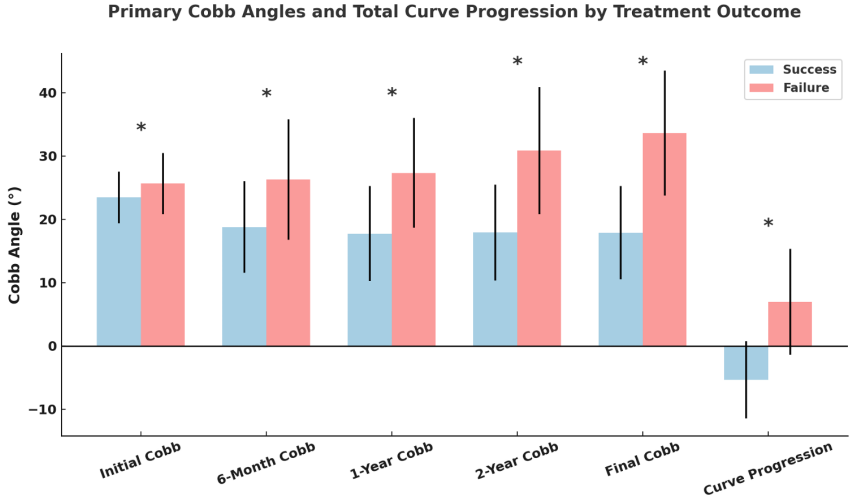

Figure 1. A comparison of initial, 6-month, 1-year, 2-year, and final out-of-brace Cobb angles amongst successful and failed Providence bracing treatments. Total curve progression amongst these populations is also highlighted. *: ($p < 0.05$)