A commentary by Pablo Castañeda, MD, is linked to the online version of this article.

SCIENTIFIC ARTICLES
OBSERVATIONAL STUDIES

Bracing Outcomes and Risk of Curve Progression in Adolescents with Idiopathic Scoliosis and Autism Spectrum Disorder

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Background: Whether the sensory and behavioral traits of autism spectrum disorder (ASD) affect bracing outcomes in adolescent idiopathic scoliosis (AIS) remains unclear. This study evaluated the impact of ASD on bracing success, curve progression, and patient-reported outcomes in patients with AIS.

Methods: This retrospective study included patients 10 to 18 years of age who were treated for AIS with bracing between 2011 and 2024. A total of 58 patients with ASD were matched in a 1:2 ratio to 116 controls with use of nearest-neighbor matching based on BrAIST-Calc predicted probabilities. Exclusions included non-idiopathic scoliosis, early-onset scoliosis, kyphoscoliosis, a Risser stage of >2, pre-treatment curves of <25° or >40°, and inadequate follow-up. Progression to the surgical threshold was defined as a major curve of ≥45°. Firth logistic regression was used to model the association between ASD and progression to the surgical threshold, adjusting for residual imbalances.

Results: The matched cohort (n = 174; 51% male; 40% White, 25% Hispanic, 21% Black, 10% Asian, and 5% not specified) demonstrated balanced propensity scores (SMD = 0.006). Compared with patients without ASD, those with ASD had higher rates of progression to the surgical threshold (40% versus 20%; p = 0.005), a curve progression of ≥6° (60% versus 38%; p = 0.005), noncompliance (36% versus 22%; p = 0.04), brace-related issues (22% versus 8%; p = 0.006), and surgery being recommended or performed (33% versus 13%; p = 0.002). In the multivariable analysis, ASD (odds ratio [OR], 3.12 [95% confidence interval (CI), 1.32 to 7.35]; p = 0.009), noncompliance (OR, 4.00 [95% CI, 1.65 to 9.71]; p = 0.002), and a greater initial curve magnitude (OR per degree, 1.26 [95% CI, 1.15 to 1.38]; p < 0.001) significantly increased the odds of progression to the surgical threshold. Within the ASD group, Scoliosis Research Society-22 revised (SRS-22r) self-image, management, and total scores improved significantly over time. No significant between-group differences in change scores were observed.

Conclusions: Adolescents with ASD were >3 times more likely to progress to the surgical threshold and had higher rates of noncompliance, brace-related issues, and surgery being recommended or performed. ASD may represent a risk factor for bracing failure, potentially related to sensory or behavioral intolerance. Nonetheless, 60% of patients with ASD avoided progression to the surgical threshold, and within-group improvements in SRS-22r scores were observed. These findings support bracing as a viable treatment option for patients with ASD, although it is likely best paired with individualized care and closer follow-up. Future studies should aim to improve brace tolerance and adherence in this population.

Level of Evidence: Therapeutic Level III. See Instructions for Authors for a complete description of levels of evidence.

Autism spectrum disorder (ASD) is a neurodevelopmental condition characterized by deficits in social communication and interaction, along with restricted, repetitive behaviors[1]. According to the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5), a diagnosis of ASD requires impairment across all communication domains and at

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least 2 restricted behaviors (e.g., stereotyped movements, inflexible routines, fixated interests, abnormal sensory reactivity) and is stratified by the support needs of the patient[1].

The reported prevalence of ASD among 8-year-olds in the U.S. has more than doubled, from 1.1% in 2008 to 2.3% in 2018[2]. This rise may reflect improved awareness, evolving criteria, and better access to services, although the true prevalence may be underestimated due to ongoing diagnostic challenges[3-7]. These trends have prompted investigations into the associations of ASD with immune, gastrointestinal, and neurological conditions[8-11]. The orthopaedic literature on ASD, however, remains limited, with studies focusing on toe walking, spinal fusion, or clinical management[12-14].

> ***Adolescents with AIS and ASD were >3 times more likely to reach the surgical threshold and exhibited higher rates of noncompliance, brace-related issues, and surgical recommendation or intervention compared with those without ASD.***

The intersection between orthopaedics and ASD is particularly relevant in adolescent idiopathic scoliosis (AIS), which is defined as a lateral spinal curvature of >10° that does not have an identifiable cause and presents between 10 years of age and skeletal maturity[15]. Bracing is the primary nonoperative treatment and is recommended for curves of >20° or 25° to 40°[16,17]. Brace effectiveness is dose-dependent, with greater adherence having been shown to reduce curve progression[18-20].

As ASD diagnoses rise, orthopaedic surgeons are increasingly likely to encounter patients with both ASD and AIS. Sensory and communication challenges may impair brace adherence, and the varying support needs of this population may further influence the treatment response. This study evaluated the impact of ASD on bracing success, curve progression, and patient-reported outcomes in AIS.

Materials and Methods

Study Design and Participants

This retrospective study was conducted at a single tertiary care center and received institutional review board approval with a waiver of informed consent. Reporting adhered to STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines[21].

Patients who were 10 to 18 years of age with clinical diagnoses of AIS and ASD and who were treated with bracing between 2011 and 2024 were identified. Exclusion criteria included non-idiopathic scoliosis, early-onset scoliosis (including juvenile idiopathic), kyphoscoliosis, pre-treatment curves of <25° or >40°, a Risser stage of >2, missing radiographs, or insufficient follow-up. Figure 1 outlines the selection process.

All brace types were included. To ensure adequate exposure, patients were required to complete ≥12 months of treatment with ≥1 follow-up visit per year until skeletal maturity or surgery. Patients who never obtained a prescribed brace or who were lost to follow-up within <1 year were included separately in an intention-to-treat analysis.

Electronic medical records were reviewed for demographic data, scoliosis and bracing characteristics, and documentation related to ASD diagnosis. Baseline variables included age; sex; body mass index (BMI); Risser stage; curve magnitude; major curve apex; curve direction, classified as typical (convex right thoracic, convex left lumbar, or convex left thoracolumbar) or atypical (any other pattern); and brace type. BMI percentiles were classified as underweight (≤5th percentile), healthy weight (>5th to <85th percentile), or overweight or obese (≥85th percentile).

Diagnostic Criteria

ASD diagnoses were made or confirmed by developmental-behavioral pediatricians or other qualified specialists with use of standardized instruments and clinical evaluation. To ensure accurate classification, DSM-5 support levels (Levels 1, 2, and 3) were abstracted when available or were otherwise recorded as unspecified. These levels are based on clinician judgment and correlate with cognitive and adaptive functioning[1,22]. The levels are as follows:

- Level 1 (requiring support): Patients speak in full sentences but communicate awkwardly, struggle with reciprocal conversation, and may initiate interactions unsuccessfully. They generally function independently but show inflexibility and resistance to change.
- Level 2 (requiring substantial support): Patients engage in limited or brief conversations with reduced reciprocity. Restricted or repetitive behaviors are apparent to a casual observer and interfere with functioning across multiple settings. These deficits often necessitate caregiver support for daily activities.
- Level 3 (requiring very substantial support): Patients use minimal or prompted communication, often nonverbal, with severe deficits in reciprocity. Behavioral rigidity, difficulty adapting to change, or other restricted behaviors are pronounced and pervasive. These deficits substantially limit functioning in all settings, with patients almost entirely dependent on caregivers.

Brace Fabrication and Compliance

Braces were selected by the treating surgeon, custom-fabricated by independent orthotists, and externally fitted. Clinical and radiographic evaluation occurred within 1 to 2 weeks after brace

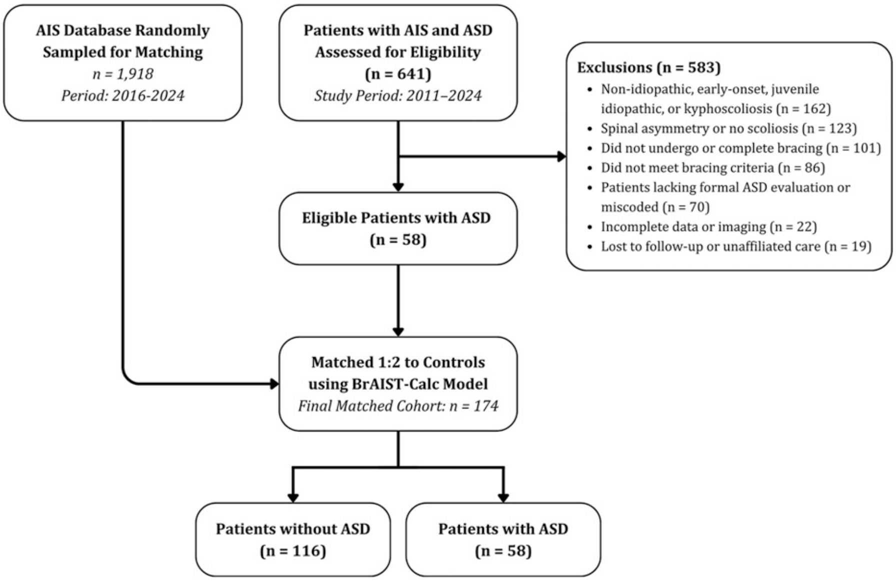

Fig. 1

Flow diagram of the patient inclusion, exclusion, and matching process. Adolescents with adolescent idiopathic scoliosis (AIS) and comorbid autism spectrum disorder (ASD) were identified using International Classification of Diseases, 10th Revision (ICD-10) codes and assessed for eligibility. After applying the exclusion criteria, 58 eligible patients with AIS and ASD were identified and matched, on the basis of the BrAIST-Calc model results, in a 1:2 ratio to 116 patients who had AIS without ASD, yielding a final matched cohort of 174 patients. The most common reasons for exclusion were non-idiopathic scoliosis (n = 134), spinal asymmetry or no scoliosis (n = 123), not undergoing or completing bracing (n = 101), lacking a formal evaluation of ASD by specialists at our institution or being miscoded as having ASD (n = 70), not meeting bracing criteria (e.g., skeletal maturity or curves of <25° or >40°) (n = 86), kyphoscoliosis or juvenile idiopathic scoliosis (n = 28), incomplete data or imaging (n = 22), and being lost to follow-up or treated outside our institution (n = 19).

fabrication, with follow-up performed every 3 to 6 months to assess fit, tolerance, and curve progression.

Compliance was assessed via caregiver or patient report according to institutional practice. Noncompliance was defined as brace wear for <12 hours per day (for full-time use) or <5 nights per week (for nighttime use) as reported at ≥2 consecutive visits, or as disuse for ≥12 consecutive months. The latter definition captured prolonged noncompliance due to skeletal maturity or scheduling variability.

Brace-related issues included behavioral outbursts, sensory or anxiety-related complaints, and physical complications. General discomfort was excluded unless accompanied by physiological or behavioral sequelae.

Bracing Outcomes

Patients were followed until brace discontinuation at skeletal maturity, progression to the surgical threshold, or surgery. Progression to the surgical threshold was defined as a coronal curve of ≥45°. Secondary outcomes included ≥6° of progression and a surgical recommendation or intervention.

Intention-to-Treat Sensitivity Analysis

A sensitivity analysis was performed using an intention-to-treat approach. This analysis included patients with ASD who met the inclusion criteria but did not obtain a brace or who discontinued treatment before 12 months, provided that they had ≥1 follow-up visit and sufficient data for the outcomes to be assessed using the same criteria as the primary analysis.

Scoliosis Research Society-22 revised (SRS-22r) Questionnaire

SRS-22r scores were abstracted at baseline (within 6 months after brace initiation) and ≥2 years after brace initiation. Patients with data at either time point were included in cross-sectional analyses; inclusion in paired analyses required questionnaire completion at both time points. The proportion of patients achieving the minimum clinically important difference (MCID) and the proportion achieving the minimum detectable measurement difference (MDMD) were also calculated[23-25].

Matching Procedure

Patients with ASD were matched 1:2 to randomly selected controls (patients without ASD who met the study criteria) from an institutional database with use of greedy nearest-neighbor matching without replacement, based on BrAIST-Calc estimated probabilities of success (defined as reaching skeletal maturity with a major curve of ≤45°) without treatment[26]. Balance was assessed using standardized mean differences (SMDs), with an SMD of <0.10 considered acceptable[27] (see Appendix for details).

Statistical Analysis

Continuous variables were compared using independent-samples t tests or Mann-Whitney U tests, and categorical variables were compared using Pearson chi-square or Fisher exact tests. Results are reported as mean differences or differences in proportions, with 95% confidence intervals (CIs). Significance was set at $p \leq 0.05$.

Firth penalized logistic regression was used to model the association between ASD and curve progression to the surgical threshold, reducing small-sample bias and separation[28]. Covariates were selected using the Akaike information criterion and the Bayesian information criterion. The concordance statistic (c-statistic) was used to assess model discrimination, and odds ratios (ORs) with 95% CIs were reported. BrAIST-Calc model input variables with post-matching SMDs of ≥0.10 were retained to adjust for residual imbalances[27]. The BMI percentile was used to standardize for developmental stage.

Inverse probability of treatment weighting (IPTW) was performed on the full eligible cohort (58 patients with ASD and 359 potential controls) on the basis of a propensity score incorporating BrAIST-Calc model input variables. The weighted model used the same covariates to assess robustness.

Matching, weighting, and regression analyses were performed in SAS (version 9.4; SAS Institute); other analyses were conducted in IBM SPSS Statistics (version 29). Details are provided in the Appendix.

Results

Study Sample and Baseline Characteristics

Of 641 patients screened, 58 patients with ASD met the inclusion criteria and were matched 1:2 to 116 controls (final cohort: n = 174; mean age [and standard deviation], 12.8 ± 1.5 years; 51% male). Race and ethnicity distributions were 40% White (n = 70), 25% Hispanic (n = 43), 21% Black (n = 36), 10% Asian (n = 17), and 5% not specified (n = 8).

Table 1. Baseline Characteristics of the Matched ASD and Non-ASD Groups*

Characteristic	ASD Group (N = 58)	Non-ASD Group (N = 116)	SMD†
BrAIST-Calc predicted probability of success without treatment‡ *(%)*	37 ± 24 (3 to 94)	37 ± 24 (3 to 93)	0.006
Age *(yr)*	12.9 ± 1.3 (11 to 16)	12.8 ± 1.6 (10 to 16)	0.04
Male sex *(no. of patients)*	35 (60%)	53 (46%)	0.29§
BMI percentile	51 ± 31 (<1 to >99)	45 ± 33 (<1 to >99)	0.17§
Pre-treatment Risser stage *(no. of patients)*			0.03
Stage 0	34 (59%)	68 (59%)	
Stage 1	12 (21%)	25 (22%)	
Stage 2	12 (21%)	23 (20%)	
Pre-treatment curve magnitude *(deg)*	31 ± 4 (25 to 40)	30 ± 5 (25 to 40)	0.12§
Weight classification# *(no. of patients)*			0.03
Healthy weight	41 (71%)	81 (70%)	
Overweight to obese	11 (19%)	23 (20%)	
Underweight	6 (10%)	12 (10%)	
Major curve apex *(no. of patients)*			0.52§
Thoracic	27 (47%)	65 (56%)	
Lumbar	12 (21%)	34 (29%)	
Thoracolumbar	19 (33%)	17 (15%)	
Curve direction *(no. of patients)*			0.21§
Atypical	13 (22%)	17 (15%)	
Typical	45 (78%)	99 (85%)	
Brace type *(no. of patients)*			0.38§
Boston	49 (84%)	95 (82%)	
Providence	3 (5%)	14 (12%)	
Rigo-Chêneau	6 (10%)	5 (4%)	
Milwaukee	0 (0%)	1 (1%)	
Charleston	0 (0%)	1 (1%)	

*ASD = autism spectrum disorder, SMD = standardized mean difference, BMI = body mass index. Values are given as the mean ± standard deviation, with the range in parentheses, or as the count, with the percentage in parentheses. †For multicategory nominal variables, the absolute maximum SMD is reported. SMDs were calculated using pooled proportions to compute the standardized difference. ‡Computed from the BrAIST-Calc model and expressed as the percentage likelihood of reaching skeletal maturity with a curve magnitude of <45° without bracing. §SMD ≥0.1, indicating potential imbalance. #BMI classification based on U.S. Centers for Disease Control and Prevention growth charts for age and sex. Underweight was defined as the ≤5th percentile, healthy weight was defined as the >5th to <85th percentile, and overweight to obese was defined as the ≥85th percentile.

Table 2. Comparison of Bracing Characteristics and Outcomes Between Patients with and without ASD*

Variable	ASD Group (N = 58)	Non-ASD Group (N = 116)	Difference† (95% CI)	P Value‡
Brace duration *(yr)*	2.3 ± 0.8 (1.0 to 5.1)	2.4 ± 0.9 (1.2 to 5.6)	−0.1 (−0.4 to +0.2)	0.37
In-brace correction *(%)*	42 ± 26 (−15 to 100)	44 ± 24 (0 to 100)	−2 (−10 to +6)	0.56
Brace-related issues *(no. of patients)*	13 (22%)	9 (8%)	+15 (+3 to +26)	**0.006**
Noncompliance *(no. of patients)*	21 (36%)	25 (22%)	+15 (0 to +29)	**0.04**
Post-treatment curve magnitude *(deg)*	41 ± 16 (14 to 90)	35 ± 13 (9 to 71)	+7 (+2 to +11)	**0.008**
Progressed to the surgical threshold *(no. of patients)*	23 (40%)	23 (20%)	+20 (+5 to +34)	**0.005**
Curve progression *(no. of patients)*				
≥6° of progression	35 (60%)	44 (38%)	+22 (+7 to +38)	**0.005**
≤5° of progression	23 (40%)	72 (62%)	—	—
Surgery recommended or performed *(no. of patients)*	19 (33%)	15 (13%)	+20 (+6 to +33)	**0.002**

*ASD = autism spectrum disorder, CI = confidence interval. Values are presented as the mean ± standard deviation, with the range in parentheses, or as the count, with the percentage in parentheses. †The absolute difference in proportions or means between the groups (ASD − non-ASD), expressed in percentage points for categorical variables. ‡P values were derived from the chi-square test, t test, or Mann-Whitney U test, as appropriate.

Matching achieved balance in the BrAIST-Calc predicted probability of success without treatment (a mean of 37% in both the ASD and non-ASD groups; SMD = 0.006). Residual imbalance was noted in sex (60% versus 46% male), pre-treatment curve magnitude (mean, 31° versus 30°), and BMI percentile (mean, 51st versus 45th), as detailed in Table 1.

Brace-Related Issues and Compliance

Brace-related issues were more frequent in patients with ASD than in those without ASD (22% versus 8%; p = 0.006), primarily due to behavioral or sensory intolerance (n = 8). Other issues in the ASD group included skin rash (n = 3), neuropathic symptoms (n = 1), and axillary abscess (n = 1). In the control group, issues included skin rash or infection (n = 6), neuropathic symptoms (n = 2), and brace-related psychological distress (n = 1). The noncompliance rate was 36% in the ASD group and 22% in the control group (p = 0.04).

Bracing Outcomes

As shown in Table 2, the ASD group had a higher mean post-treatment curve magnitude than the non-ASD group (41° versus 35°; p = 0.008). Brace duration and in-brace correction were similar between the groups. A greater proportion of patients in the ASD group than in the non-ASD group reached the surgical threshold (40% versus 20%; p = 0.005), had a curve progression of ≥6° (60% versus 38%; p = 0.005), and had surgery recommended or performed (33% versus 13%; p = 0.002).

Bracing Outcomes by ASD Support Level

A DSM-5 support level was documented for 74% (n = 43) of the 58 patients with ASD; 41% (n = 24) of the patients in the ASD group were Level 1, 24% (n = 14) were Level 2, 9% (n = 5) were Level 3, and 26% (n = 15) were unspecified. Progression to the surgical threshold occurred in 29% (n = 7) of Level 1, 50% (n = 7) of Level 2, 80% (n = 4) of Level 3, and 33% (n = 5) of unspecified-level patients. Surgery was recommended or performed in 25% (n = 6) of Level 1, 50% (n = 7) of Level 2, 60% (n = 3) of Level 3, and 20% (n = 3) of unspecified-level patients. Noncompliance was reported for 29% (n = 7) of Level 1, 50% (n = 7) of Level 2, 60% (n = 3) of Level 3, and 27% (n = 4) of unspecified-level patients.

Multivariable Analysis

ASD (OR, 3.12; 95% CI, 1.32 to 7.35; p = 0.009), noncompliance (OR, 4.00; 95% CI, 1.65 to 9.71; p = 0.002), and greater pre-treatment curve magnitude (OR per degree, 1.26; 95% CI, 1.15 to 1.38; p < 0.001) significantly increased the odds of progression to the surgical threshold (Table 3). The model

Table 3. Multivariable Logistic Regression for the Odds of Progression to the Surgical Threshold*

Variable	OR (95% CI)†	P Value
AIS with ASD	3.12 (1.32 to 7.35)	**0.009**
AIS without ASD	Reference	
Male sex	0.90 (0.38 to 2.13)	0.76
Female sex	Reference	
BMI percentile‡	1.00 (0.98 to 1.01)	0.23
Pre-treatment curve magnitude, in degrees	1.26 (1.15 to 1.38)	**<0.001**
Noncompliant with bracing	4.00 (1.65 to 9.71)	**0.002**
Compliant with bracing	Reference	

*OR = odds ratio, CI = confidence interval, AIS = adolescent idiopathic scoliosis, ASD = autism spectrum disorder, BMI = body mass index. †Values were derived from the Firth penalized logistic regression model. ‡Age- and sex-adjusted percentile values.

demonstrated excellent discrimination (c-statistic, 0.85) and was significant (likelihood ratio $\chi^2 = 59.8$; degrees of freedom = 5; $p < 0.001$). Male sex and BMI percentile were retained for clinical relevance and to adjust for residual imbalance but were not significant factors.

IPTW analysis supported the association between ASD and progression to the surgical threshold, with excellent covariate balance and model discrimination (c-statistic, 0.85; see Appendix Fig. A1 and Tables A1 and A2).

Intention-to-Treat Sensitivity Analysis

An additional 28 patients with ASD were included in the intention-to-treat sensitivity analysis, yielding a cohort of 86 patients with ASD. Of these, 44% (n = 38) progressed to the surgical threshold, 64% (n = 55) had a curve progression of ≥6°, and 38% (n = 33) had surgery recommended or performed.

SRS-22r Questionnaire

Of the 174 patients, 137 (79%) had SRS-22r data available for the cross-sectional analysis. Baseline scores were collected at a mean of 3.0 ± 1.0 months after bracing (range, 0 to 7.1 months), and follow-up scores were collected at a mean of 34.2 ± 12.4 months after bracing (range, 22.9 to 75.5 months). At both time points, patients with ASD reported significantly lower scores than patients without ASD across multiple domains, including function, self-image, mental health, and total score. Management scores did not differ significantly between the groups. Full comparisons are provided in Table 4.

Table 4. Cross-Sectional Comparison of SRS-22r Domain Scores Between Patients with and without ASD*

Domain	Time Point†	Mean Difference‡ (95% CI)	P Value§
Function	Baseline	−0.27 (−0.52 to −0.02)	**0.04**
	Follow-up	−0.27 (−0.51 to −0.04)	**0.02**
Pain	Baseline	−0.28 (−0.49 to −0.07)	**0.01**
	Follow-up	−0.21 (−0.50 to +0.09)	0.16
Self-image	Baseline	−0.38 (−0.63 to −0.14)	**0.002**
	Follow-up	−0.30 (−0.59 to 0.00)	**0.05**
Mental health	Baseline	−0.34 (−0.61 to −0.07)	**0.01**
	Follow-up	−0.45 (−0.79 to −0.11)	**0.01**
Management	Baseline	−0.24 (−0.56 to +0.08)	0.15
	Follow-up	−0.07 (−0.46 to +0.32)	0.72
Subtotal	Baseline	−0.32 (−0.53 to −0.12)	**0.003**
	Follow-up	−0.31 (−0.56 to −0.06)	**0.01**
Total score	Baseline	−0.31 (−0.51 to −0.11)	**0.003**
	Follow-up	−0.29 (−0.54 to −0.04)	**0.02**

*SRS-22r = Scoliosis Research Society-22r, ASD = autism spectrum disorder, CI = confidence interval. †Initial scores were available for 44 patients with ASD and 89 patients without ASD. Follow-up scores were available for 39 patients with ASD and 85 patients without ASD. ‡Mean differences in SRS-22 scores between the groups (ASD − non-ASD) at each time point. §P values are from cross-sectional analyses comparing the groups at each time point with use of 2-sided independent t tests.

Of the 174 patients, 120 (69%) had paired data available for the change-score analyses. Within-group comparisons showed significant improvements in self-image, management, and total score among patients with ASD and in management and total score among patients without ASD (see Appendix Table A3). Between-group differences in the change scores were not significant (see Appendix Table A4). MCID and MDMD data are reported in Appendix Table A5.

Discussion

This study evaluated whether adolescents with AIS and comorbid ASD experience different bracing outcomes compared with matched controls without ASD. ASD was associated with higher rates of curve progression to the surgical threshold, noncompliance, and brace-related issues. Nonetheless, bracing was effective for many patients with ASD: 60% avoided progression to the surgical threshold, exceeding the BrAIST-Calc-derived estimate of a 37% success rate without treatment, and within-group improvements in SRS-22r scores were observed. A sensitivity analysis that included early treatment discontinuation showed similar results (56% of patients without progression to the surgical threshold), despite one-third of the patients not completing treatment. Although ASD may increase the risk of bracing failure, many patients with ASD still benefit from bracing although they may require more intensive, individualized support.

Bracing was effective, with 74% of the matched cohort avoiding progression to the surgical threshold. While not directly comparable, this finding aligns with the results of prior bracing studies[19,29-32], including those by Weinstein et al.[19] and Nachemson and Peterson[29], who reported bracing success rates of 72% and 74%, respectively. In the present study, 60% of patients in the ASD group avoided progression to the surgical threshold, which may reflect adherence challenges rather than a reduced physiological response. The results of the subgroup analysis may support this interpretation, as the rates of progression to the surgical threshold appeared to increase with the DSM-5 support level. Although limited by the sample size, these findings suggest that patients who require greater support may be more vulnerable to bracing failure and could benefit from tailored goals and earlier shared decision-making.

Both noncompliance and ASD were associated with a >3-fold increase in the odds of curve progression to the surgical threshold. Although noncompliance was more common in the ASD group, interaction testing showed that noncompliance and ASD each contributed independently to the risk of bracing failure. This finding aligns with prior evidence that adherence predicts bracing success, regardless of other patient factors[18-20]. Current guidelines recommend multidisciplinary collaboration in order to optimize brace fit, to support adherence, and to monitor tolerance[16], all of which may be especially important for patients with neurodevelopmental conditions.

Strategies to support patients with ASD include structured caregiver engagement, sensory-adapted environments, and tailored education to reduce distress and improve participation[33,34]. Occupational or behavioral therapy may further address sensory and behavioral barriers[33,35,36]. Additional approaches, including desensitization, integrated care models, and adaptable brace materials, may warrant investigation[33].

Bracing may disproportionately affect the quality of life of patients with ASD, who face heightened sensory and social challenges[37] and may be more vulnerable to functional and body-image impacts[38,39]. In the present study, despite having lower SRS-22r scores across multiple domains at baseline and follow-up, the ASD group demonstrated within-group improvements in scores that were comparable to those in the control group. These findings suggest similar improvement from baseline between patients with and without ASD and a potential perceived benefit for patients with ASD. Approximately one-third and one-half of patients with ASD included in the paired SRS-22r analysis met the MCID and MDMD thresholds for total score, respectively, although interpretation is limited by unclear benchmark validity in bracing populations. Furthermore, the SRS-22r may not capture ASD-specific experiences, particularly in patients who require greater support, whose questionnaires may be completed by caregivers[40]. Bracing may improve the quality of life of certain patients with ASD, but further study is needed to establish clinical relevance and to determine appropriate measurement tools for neurodivergent populations.

This study has several limitations. Its retrospective design and modest sample size introduce potential bias and limit generalizability. Brace-related issues and compliance were abstracted from clinical documentation and thus may have been subject to reporting bias. Objective sensors (e.g., temperature or force) were not routinely used, potentially overestimating adherence in AIS populations[41]. Although these devices provide valuable data and are typically flush-mounted in order to minimize tactile discomfort, broader use remains limited by cost, fabrication logistics, and the need for data management. Sensor-based monitoring may pose unique challenges in the ASD population, in whom the validation and feasibility of such monitoring remain unstudied and warrant investigation. While objective data may strengthen rigor, prior studies have reported moderate to high caregiver-reported adherence to structured interventions among children with ASD[42-44], suggesting that the reported adherence in this population may reasonably reflect treatment compliance in ASD.

Matching reduced confounding, although some residual imbalance remained. Conditional logistic regression yielded unstable estimates due to limited within-stratum variation. A modest imbalance in BMI persisted; however, weight classification was balanced, and the clinical relevance of BMI to bracing outcomes remains inconclusive.

To isolate AIS, patients with scoliosis-associated conditions (e.g., Marfan syndrome) were excluded, improving internal consistency but potentially introducing selection bias by omitting more complex phenotypes. Twenty-six percent of patients with ASD lacked documentation of the DSM-5 support level, limiting the stratified analysis. Although subgroup findings are described, ASD was modeled as a binary variable, potentially obscuring phenotypic variability. Missing SRS-22r data reduced the paired sample size and may have introduced attrition bias. Surgical decisions were surgeon-dependent, but a surgical threshold of ≥45° was applied to reduce variability and to enhance internal consistency. Larger prospective studies are needed to validate these findings and to refine bracing strategies for adolescents with ASD.

Conclusions

Adolescents with AIS and ASD were >3 times more likely to reach the surgical threshold and exhibited higher rates of noncompliance, brace-related issues, and surgical recommendation or intervention compared with those without ASD. ASD may represent an independent risk factor for bracing failure, potentially mediated by sensory or behavioral intolerance. Nonetheless, 60% of patients with ASD avoided progression to the surgical threshold, exceeding the estimated 37% success rate without treatment. These findings support bracing as a viable treatment option for patients with ASD, although it is likely best paired with individualized care and closer follow-up. Future research should aim to improve brace tolerance and adherence in this population.

Appendix

eA Supporting material provided by the authors is posted with the online version of this article as a data supplement at jbjs.org (http://links.lww.com/JBJS/I981). ■

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