A Novel Weave Tether Technique for Proximal Junctional Kyphosis Prevention in 71 Adult Spinal Deformity Patients: A Preliminary Case Series Assessing Early Complications and Efficacy

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BACKGROUND: Proximal junctional kyphosis (PJK) rates may be as high as 69.4% after adult spinal deformity (ASD) surgery. PJK is one of the greatest unsolved challenges in long-segment fusions for ASD and remains a common indication for costly and impactful revision surgery. Junctional tethers may help to reduce the occurrence of PJK by attenuating adjacent-segment stress.

OBJECTIVE: To report our experience and assess early safety associated with a novel "weave-tether technique" (WTT) for PJK prophylaxis in a large series of patients.

METHODS: This single-center retrospective study evaluated consecutive patients who underwent ASD surgery including WTT between 2017 and 2018. Patient demographics, operative details, standard radiographic measurements, and complications were analyzed.

RESULTS: A total of 71 patients (mean age 66 ± 12 yr, 65% women) were identified. WTT included application to the upper-most instrumented vertebrae (UIV) + 1 and UIV + 2 in 38(53.5%) and 33(46.5%) patients, respectively. No complications directly attributed to WTT usage were identified. For patients with radiographic follow-up (96%; mean duration 14 ± 12 mo), PJK occurred in 15% (mean 1.8 ± 1.0 mo postoperatively). Proximal junctional angle increased an average 4° (10° to 14°, $P = .004$). Rates of symptomatic PJK and revision for PJK were 8.8% and 2.9%, respectively.

CONCLUSION: Preliminary results support the safety of the WTT for PJK prophylaxis. Approximately 15% of patients developed radiographic PJK, no complications were directly attributed to WTT usage, and the revision rate for PJK was low. These early results warrant future research to assess longer-term efficacy of the WTT for PJK prophylaxis in ASD surgery.

KEY WORDS: Junctional tethers, Adult spinal deformity surgery, Proximal junctional kyphosis, Early complications

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Proximal junctional kyphosis (PJK) is a commonly recognized radiographic finding reported in up to 69.4% of patients treated with long-segment spinal instrumentation for adult spinal deformity (ASD).[1-5] Though patients may experience no clinical symptoms secondary to the development of PJK, others may progress in severity to proximal junctional failure (PJF), which is associated with structural failures and clinical sequelae such as pain, ambulatory difficulties, focal neurologic deficit, as well as higher rates of reoperation.[6-8] Literature cites PJF as one of the most common indications for reoperation in patients with spinal fixation, reporting PJF as the primary indication for revision surgery in up to 55% of cases.[9-13]

Given the potential clinical impact on patient outcomes and increased economic

ABBREVIATIONS: ASD, adult spinal deformity; **EBL,** estimated blood loss; **PI-LL,** pelvic incidence and lumbar lordosis; **PT,** pelvic tilt; **PJA,** proximal junctional angle; **PJF,** proximal junctional failure; **PJK,** Proximal junctional kyphosis; **SVA,** sagittal vertical axis; **TK,** thoracic kyphosis; **UIV,** upper-most instrumented vertebrae; **WTT,** weave-tether technique

burden that accompanies reoperation and clinical management of PJK and related junctional spinal disorders, physicians have been proposing strategies to minimize the postoperative occurrence of PJK.[14-16] Among these strategies, junctional tethers have been proposed given their potential ability to decrease segmental range of motion, intradiscal pressure, and posterior ligament complex forces at the proximal junction.[17-19] Proper intraoperative use of junctional tethers for PJK prophylaxis may serve to attenuate abrupt changes in spinal range of motion and adjacent-segment stress commonly seen at the junction between instrumented and noninstrumented levels following spinal fixation.[18,19] In 2019, a novel junctional weave-tether technique (WTT) was introduced, and using finite element analyses, the WTT was demonstrated to effectively mitigate adjacent-segment stress in long-segment spinal fixation.

Our objective was to report our experience with the WTT, assess its safety by identifying WTT-associated complications, and to report preliminary results with rates of PJK at early follow-up.

METHODS

We present a single-center, retrospective case series of consecutive patients treated with the novel WTT for ASD at the University of Virginia Health System between August 2017 and September 2018 by the senior operating surgeons, CIS and JSS. Informed consent was not required for this case series, as this was a retrospective review of existing, deidentified medical data. The present study was approved by the University of Virginia Institutional Review Board.

Patients included in this series were those diagnosed with ASD (minimum age of 18 yr) and treated with long-segment spinal instrumentation extending into the thoracic spine and the WTT. Spinal deformity was defined as the presence of at least one of the following: C7-S1 sagittal vertical axis (SVA) $\geq$ 5 cm, pelvic tilt (PT) $\geq$ 25°, thoracic kyphosis (TK) $\geq$ 60°, coronal Cobb angle $\geq$20°, and mismatch between pelvic incidence and lumbar lordosis (PI-LL) $\geq$ 10°. PJK, was defined as a proximal junctional angle (PJA) >10° and 10° greater than the corresponding preoperative measurement.[3]

Data Collection, Radiographic Parameters, and Statistical Analysis

Demographic, surgical, and clinical characteristics were extracted from the medical record. Intraoperative and postoperative complications were collected from the medical record and operative reports and subsequently analyzed to evaluate for direct complications associated with the use of junctional tethers in this cohort of patients.

Sagittal and coronal spinopelvic measurements were assessed from preoperative, early postoperative (approximately 6 wk following surgical treatment), and final postoperative full-length standing radiographs (14 × 36-inch films). The spinopelvic parameters studied in this series included PI, PT, TK, LL, SVA, PI-LL mismatch (PI-LL), and PJA. PJA was measured as the sagittal Cobb angle from the caudal endplate of the upper-most instrumented vertebrae (UIV) to the superior endplate of the second vertebral body above the UIV.[3]

Paired sample *t*-tests were used to evaluate differences between pre- and postoperative radiographic parameters, and a Fisher's exact test was performed to evaluate differences in the postoperative occurrence of PJK among patients treated with tethers to UIV + 1 vs UIV + 2.

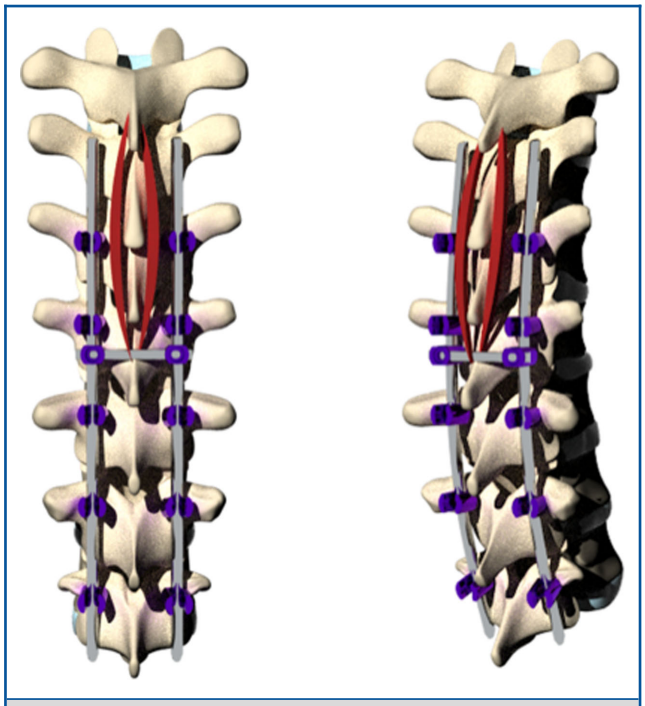

FIGURE 1. *Sample model with spinal fixation and tether to UIV + 2.*

Surgical Procedure and WTT

All patients underwent surgical intervention under general endotracheal anesthesia in prone positioning on a Jackson table with somatosensory-evoked, motor-evoked potential, and EMG monitoring. Following spinal fixation, the WTT is applied. A hole is created at the base of the UIV + 1 and UIV-1 spinous processes using a high-speed drill. A polyethylene-terephthalate tape is woven through the interspinous ligament through the hole at the UIV-1 spinous process and back through the hole and interspinous ligament. The tether is then passed through the tether connector and the tensioning and torqueing slot of the tensioning tower (NuVasive VersaTie System). This technique is then repeated on the contralateral side, and the tether is secured to the top of the tower and tightened securely (Figure 1).[20]

Routine postoperative care was performed for all patients based on institutional protocol, and most patients presented in this case series underwent routine postoperative imaging with long-cassette standing radiographs.

RESULTS

Patient Population and Surgical Characteristics

Overall, 71 consecutive patients treated at the University of Virginia Health System between August 2017 and September 2018 were identified (mean age 66.1 ± 11.8 yr; average body mass index 27.6 ± 7.3; 64.8% female). Of these 71 patients, 21 (29.6%) presented with an additional diagnosis of osteopenia or

osteoporosis. Approximately 48% of patients reported a history of prior spinal fusion. Most (n = 68 [96%]) patients had available radiographic follow-up (mean follow-up duration 13.8 ± 11.8 mo). The remaining patients were lost to follow-up or did not obtain full-length (14 × 36-inch films) radiographs postoperatively.

Etiology of spinal deformity included: de novo degenerative (n = 43 [60.6%]), idiopathic (n = 17 [23.9%]), and iatrogenic (n = 11 [15.5%]) deformity. Operative data included: mean instrumented fusion length (11.8 ± 3.0 levels), use of iliac screw fixation (93.0%), upper (35.2%) vs lower thoracic (64.8%) UIV, 3-column osteotomy (9.9%), use of transforaminal lumbar interbody fusion (69.0%), mean estimated blood loss (EBL, 2.5 ± 1.7 L), average operative duration (5.4 ± 1.3 h), and mean hospital length of stay (8.1 ± 4.3 d). Of 71 patients, 62 (87.3%) were also treated with Smith-Peterson osteotomies. WTT included application to UIV + 1 and UIV + 2 in 53.5% and 46.5%, respectively. Additional patient demographic data and surgical characteristics are presented in Table 1.

Radiographic Outcome Measurements

Baseline preoperative, postoperative, and final sagittal radiographic parameters extracted from full-length, long-cassette radiographs are presented in Table 2. Overall, patients experienced significant postoperative improvements in sagittal spinopelvic measurements: (PT 29.5° to 22.7°, $P < .0001$; PI-LL 22.4° to 4.7°, $P < .0001$; SVA 6.7 to 4.0 cm, $P = .0465$). However, there was a modest but significant increase in PJA postoperatively when compared to baseline measurements (14.5° vs 10.3°, $P = .0015$).

Postoperative Development of PJK, Reoperation Rates, and Other Complications

Of 68 patients with radiographic follow-up, 10 (14.7%) developed PJK, 6 (60%) of which presented with symptomatic PJK, reporting symptoms such as low back and midthoracic pain and weakness. A summary of symptoms reported by patients who developed symptomatic PJK is presented in Table 3. Overall, 2 (2.9%) patients underwent reoperation for PJF, or severe PJK, both of whom presented with symptomatic PJK. There were no statistically significant differences between postoperative PJK rates among patients treated with tethers to UIV + 1 (15.8%) when compared to those treated with tethers to UIV + 2 (12.1%).

When comparing the differences in perioperative characteristics between patients tethered to UIV + 1 vs UIV + 2, there were no significant differences in operative duration (UIV + 1 340.2 ± 80.6 min vs UIV + 2 317.3 ± 67.8 min, $P = .213$), EBL (UIV + 1 2.4 ± 1.5 L vs UIV + 2 2.7 ± 2.0 L, $P = .533$), length of hospital stay (UIV + 1 7.9 ± 3.7 d vs UIV + 2 8.2 ± 5.1 d, $P = .736$), or proportion of patients discharged to inpatient rehabilitation postoperatively (UIV + 1 [63.9%] vs UIV + 2 [80.6%], $P = .129$).

TABLE 1. Demographics and Index Surgical Data for All Patients Treated With Junctional Tethers Between August 2017 and September 2018[a]

Variable	Tethers (N = 71)
Age, yrs.	66.1 ± 11.8
Female sex	46 (64.8)
BMI, kg/m^2	27.6 ± 7.3
ASA Score	3 (2-3)
Osteopenia/Osteoporosis	21 (29.6)
History of Prior Spinal Fusion	34 (47.9)
Diagnosis	
Idiopathic	17 (23.9)
De Novo degenerative	43 (60.6)
Iatrogenic	11 (15.5)
Uppermost instrumented vertebra	
Upper thoracic spine (T2-T8)	25 (35.2)
Lower thoracic spine (T9-T11)	46 (64.8)
Iliac fixation	66 (93.0)
No. of Levels Fused	11.8 ± 3.0
No. of patients with Smith-Peterson osteotomies	62 (87.3)
0-1 osteotomies	10 (14.1)
2-4 osteotomies	35 (49.3)
5-9 osteotomies	24 (33.8)
≥ 10 osteotomies	2 (2.8)
No. of patients with PSO/VCR	7 (9.9)
No. of patients with transforaminal lumbar interbody fusion	49 (69.0)
L3-4	9 (8.3)
L4-5	28 (39.4)
L5-S1	41 (57.7)
Techniques to reduce complications	
Junctional tethers	71 (100)
UIV + 1	38 (53.5)
UIV + 2	33 (46.5)
Intraoperative tranexamic acid	69 (97.2)
Local intrawound vancomycin powder	68 (95.8)
Total EBL, L	2.5 ± 1.7
Operative duration, hrs.	5.4 ± 1.3
Length of stay, d	8.1 ± 4.3
Patients discharged to rehab	50 (70.4)
Follow-up, mos.	13.8 ± 11.8

ASA = American Society of Anesthesiologists; UIV = uppermost instrumented vertebra
Values are expressed as the number (%) of patients or mean ± SD.
[a]Three patients had no radiographic follow-up.

Other than PJK, the most common complication was gastrointestinal ileus (n = 8 [11.3%]). Other complications included: wound dehiscence (n = 1 [1.4%]), hematoma/seroma (n = 2 [2.8%]), pleural effusion (n = 1 [1.4%]), deep vein thrombosis (n = 1 [1.4%]), pneumonia (n = 1 [1.4%]), deep wound infection (n = 1 [1.4%]), urinary tract infection (n = 1 [1.4%]), durotomy (n = 4 [5.9%]), rod breakage (n = 1 [1.7%]), and pseudarthrosis (n = 1 [1.7%]). A summary of complications is presented in Table 4. Neurological, implant, and radiographic complications were assessed only from patients with at least one radiographic follow-up.

TABLE 2. Radiographic Measurement Outcomes in Patients With at Least One Radiographic Follow-up (N = 68)[a]

Sagittal plane parameters	Tethers (N = 68)
PJA (°)	
Baseline	10.3 ± 7.5
Immediate postop	14.5 ± 7.4
P value	**.0015**
Change following surgery	4.2 ± 7.9
Final	17.2 ± 9.0
P value comparing final to immediate postop	.0515
TK (°)	
Baseline	38.2 ± 21.7
Immediate postop	49.6 ± 11.8
P value	**.0002**
Change following surgery	11.4 ± 18.3
Final	51.1 ± 12.2
P value comparing final to immediate postop	.4074
LL (°)	
Baseline	31.5 ± 25.1
Immediate postop	49.0 ± 9.6
P value	**<.0001**
Change following surgery	17.5 ± 22.6
Final	47.6 ± 10.4
P value comparing final to immediate postop	.4011
PI-LL mismatch (°)	
Baseline	22.4 ± 25.1
Immediate postop	4.7 ± 11.0
P value	**<.0001**
Change following surgery	−17.7 ± 22.4
Final	6.1 ± 10.6
P value comparing final to immediate postop	.3919
PT(°)	
Baseline	29.6 ± 10.7
Immediate postop	22.7 ± 7.9
P value	**<.0001**
Change following surgery	−6.8 ± 8.7
Final	24.3 ± 8.4
P value comparing final to immediate postop	.2233
SVA (cm)	
Baseline	6.7 ± 6.2
Immediate postop	4.0 ± 9.1
P value	**.0465**
Change following surgery	−2.7 ± 9.9
Final	4.5 ± 9.0
P value comparing final to immediate postop	.8111
Pelvic Incidence (°)	
Baseline	53.9 ± 10.2
Immediate postop	53.6 ± 10.1
P value	.8803
Change following surgery	−0.3 ± 1.6
Final	53.7 ± 10.5
P value comparing final to immediate postop	.9011

[a]Mean values are presented ± SD. Bold type indicates statistical significance. LL = lumbar lordosis; PI = pelvic incidence. PT = pelvic tilt.

TABLE 3. Postoperative Development of PJK and Revision Surgery for PJF (%)[a]

	Tether (N = 68)
Overall PJK (%)	
Yes	10 (14.7)
Symptomatic[†]	6 (8.8)
Revision for PJF (%)	2 (2.9)
Asymptomatic	4 (5.9)
No	58 (85.2)
Cases of symptomatic PJK[†]	Symptoms
1	PJF. UIV three-column fracture. Revised.
2	Severe midthoracic pain.
3	Midthoracic pain radiating to periumbilical region.
4	Severe midthoracic pain.
5	Increased neck pain in the setting of T3 UIV. Bilateral scapular pain and muscle spasms.
6	PJF. Weakness in LLE. Revised.

LLE = left lower extremity.
[a]Percentage calculated from patients with at least one radiographic follow-up (N = 68).

DISCUSSION

As the proportion of elderly individuals in the United States continues to rise, the volume of cases of ASD advances significantly.[21] In a 2005 study by Schwab and colleagues, the incidence of ASD in the population of individuals over the age of 65 was reported to be as high as 68%.[22,23] PJK is cited as one of the most common complications reported in patients treated with long-segment spinal fixation for ASD, and symptomatic cases of PJK and PJF have been associated with significant neurologic deficit and increased rates of reoperation among those with higher severity of deformity/instability.[3,14] PJF is also a form of junctional pathology associated with structural failure and elevated mechanical instability, often presenting as vertebral body fracture and compression deformities, loss of disc height and facet joint degeneration, implant failure, or disruption of the posterior osseo-ligamentous complex.[8] An example of this occurrence is demonstrated in the case presented in Figure 2A and 2B. This patient presented with a PJA angle increase of approximately 31 degrees on postoperative imaging, as well as an anterior compression fracture at the UIV. A case successfully treated with the WTT may be found in Figure 2C and 2D.

Given the potential severity of this complication, it is important to understand the pathophysiology behind the development of postoperative PJK in patients surgically treated for ASD and evaluate various mechanisms that may be used to prevent its occurrence. Though the pathophysiology of PJK and PJF in patients who undergo operative management for ASD remains unclear, literature suggests that this phenomenon may be multifactorial in nature.[24,25] Risk factors such as patient age, poor bone quality, posterior spinal ligament disruption,

TABLE 4. Rates of Complications

Complication category	Number of complications (%)		
	Early (≤6 wk)	Delayed (>6 wk)	Combined
Radiographic[a]	2 (2.9)	9 (13.2)	11 (16.2)
PJK	2 (2.9)	8 (11.8)	10 (14.7)
Pseudarthrosis	0 (0.0)	1 (1.7)	1 (1.7)
Neurological[a]	6 (8.8)	3 (4.4)	9 (13.3)
Motor deficit	0 (0.0)	2 (2.9)	2 (2.9)
Postoperative delirium	5 (7.4)	0 (0.0)	5 (7.4)
Sensory deficit	0 (0.0)	1 (1.7)	1 (1.7)
Pseudomeningocele	1 (1.7)	0 (0.0)	1 (1.7)
Gastrointestinal	8 (11.3)	0 (0.0)	8 (11.3)
Ileus	8 (11.3)	0 (0.0)	8 (11.3)
Operative	4 (5.9)	0 (0.0)	4 (5.9)
Dural tear	4 (5.9)	0 (0.0)	4 (5.9)
Wound (excluding infection)	2 (2.8)	1 (1.4)	3 (4.2)
Dehiscence	0 (0.0)	1 (1.4)	1 (1.4)
Hematoma/seroma	2 (2.8)	0 (0.0)	2 (2.8)
Cardiopulmonary	2 (2.8)	1 (1.4)	3 (4.2)
Pleural effusions	1 (1.4)	0 (0.0)	1 (1.4)
Deep vein thrombosis	1 (1.4)	0 (0.0)	1 (1.4)
Pneumonia	0 (0.0)	1 (1.4)	1 (1.4)
Infection	2 (2.8)	0 (0.0)	2 (2.8)
Deep wound infection	1 (1.4)	0 (0.0)	1 (1.4)
Urinary tract infection	1 (1.4)	0 (0.0)	1 (1.4)
Implant[a]	0 (0.0)	1 (1.7)	1 (1.7)
Rod breakage	0 (0.0)	1 (1.7)	1 (1.7)

[a]Complications assessed only from patients with at least one radiographic follow-up (N = 68).

and fusion to the sacrum have been identified; however, most authors agree that a potential mechanism behind the postoperative development of PJK is the sudden change in rigidity between instrumented and non-instrumented levels.[18,26] An important consideration among these risk factors is bone mineral density (BMD); in the present case series, 21 (29.6%) patients presented with osteopenia/osteoporosis. Of these patients, 5 (23.8%) developed PJK. There was no significant difference in the development of PJK among this subset of tethered patients with low BMD when compared to those with BMD within normal range (23.8% low BMD vs 11.9% normal BMD; $P = .264$).

The main goal of implementing junctional tethers in long-segment pedicle screw fixations is the reduction of adjacent-segment stress sustained in long-segment constructs used in the treatment of ASD.[19] Biomechanical finite element analyses conducted by Bess and colleagues[18] suggest that junctional tethers allow for a significant reduction in the segmental range of motion above the instrumented levels, reducing abrupt changes at the junction between instrumented and non-instrumented levels. In this study, WTT to UIV + 2 most effectively dampened adjacent-segment stress above the level of fixation, with a mean segmental range of motion at levels between T9-T12 of between 5 and 26% for UIV + 1, and 5 and 31% for UIV + 2.

In the present case series, 14.7% of patients developed postoperative radiographic PJK, representing a substantial reduction in comparison to the previously reported rates of up to 69.4% among ASD patients who underwent operative deformity correction.[3,4,12,27-30] Symptomatic PJK or revision for PJK were low: 8.8% and 2.9%, respectively. Though finite element analyses found a greater level of stability and more gradual transition from the fusion construct to normal motion with posterior tethers to UIV + 2, there was no significant difference in rates of postoperative PJK development between patients treated with a tether to UIV + 1 when compared to those treated with a tether to UIV + 2 among the patients presented in this series.[18] When evaluating differences in perioperative characteristics between patients tethered to UIV + 1 vs UIV + 1, there were no significant differences in EBL, length of hospital stay, operative time, or rates of discharge to rehabilitation, despite UIV + 2 traditionally being a more invasive procedure requiring higher level of dissection with a larger incision and increased operative time.

This is a pilot series reporting preliminary results with the intention of assessing early safety; it is possible that a larger cohort with longer follow-up may further elucidate the comparative efficacy of UIV + 1 vs UIV + 2 tethers. No complications were identified that were directly attributed to WTT usage, and the overall findings are supportive of its potential benefit in

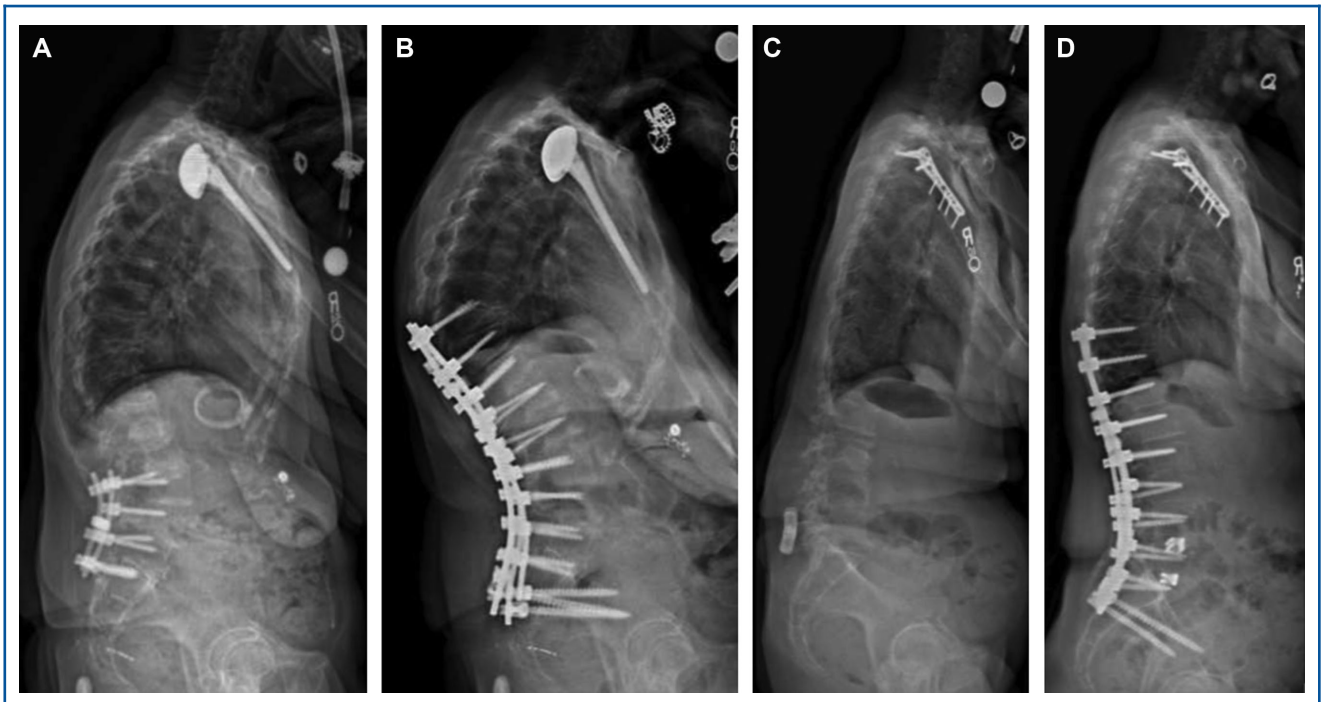

FIGURE 2. *Preoperative* **A** *and postoperative* **B** *sagittal standing long-cassette radiographs of a 71-yr-old woman with ASD treated with the WTT obtained approximately 11 mo apart. The PJAs were 4.7º and 35.2º, respectively. Imaging demonstrates an anterior compression fracture of the T10 vertebral body with exaggerated focal kyphosis. Preoperative* **C** *and postoperative* **D** *sagittal standing long-cassette radiographs of a 66-yr-old woman with ASD treated with the WTT system obtained approximately 35 mo apart. The PJAs were 6.33º and 13.71º, respectively.*

reducing PJK for patients treated with long-segment spinal instrumentation.

Limitations

The retrospective nature of this case series introduces important disadvantages concerning the availability, consistency, and accuracy of data in the medical record. Limitations of this study also include the lack of a control arm for comparison to a no-tether cohort, for example, or to other posterior tethering techniques to evaluate the comparative efficacy of the WTT technique in patients. The patients in this case series also presented with a relatively short average follow-up duration of approximately 14 mo. Although a longer follow-up duration is appropriate to evaluate the long-term efficacy of WTT in preventing the development of postoperative PJK, a review of available literature revealed that a vast majority of PJK cases are evident within the first 3 mo following operative management.[26]

CONCLUSION

PJK continues to represent a common complication associated with long-segment spinal fixation for ASD, and can result in significantly decreased patient outcome scores and increased rates of reoperation. The use of junctional tethers and WTT appears to be a safe adjunct to traditional spinal fixation and may assist in mitigating the development of postoperative PJK in this subset of patients. In this single-center, retrospective case series of 71 operative ASD patients treated with WTT, no complications were identified that were directly attributed to WTT usage. Approximately 15% of patients developed radiographic PJK, and the rates of symptomatic PJK or revision for PJK was 8.8% and 2.9%, respectively. These early results warrant future research to elucidate the long-term efficacy of WTT as a method of junctional tether application for PJK prophylaxis in ASD surgery.

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Disclosures

Dr Smith reports being a consultant for and receiving royalties from NuVasive. Dr Shaffrey reports being a consultant for NuVasive, direct stock ownership in NuVasive, and patent holder with NuVasive. The other authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article. Dr Smith also reports being a consultant for and receiving royalties from Zimmer Biomet; being a consultant for and receiving study group research grants from DePuy Synthes; being a consultant for Stryker and Carlsmed; having stock ownership in Alphatec; receiving fellowship funding and research support from AOSpine; and receiving fellowship funding from the Neurosurgery Research and Education Foundation (NREF). Dr Shaffrey also reports being a

consultant for Medtronic and SI Bone, and patent holder with Medtronic and Zimmer Biomet.

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COMMENT

PJK is one of the key issues that continue to plague patients undergoing fusions for deformity correction. The consequences include requirements for rostral extension of fusion.

The WTT shows promise in reducing PJK in adult deformity surgery by reducing the revision rate for PJK without leading to direct complications attributed to the WTT usage. While this technique shows promise, the enthusiasm must be tempered by the fact that this study was conducted as a single center retrospective case series of 71 patients. A larger multi-center prospective trial will be beneficial to validate the efficacy of this technique. Also, longer term follow-up of 2-3 yr is preferable to monitor for the efficacy of the technique and validate the results of this study. We congratulate the authors for their insights into prevention of PJK.

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