INTRODUCTION

• Posterior instrumented fusion (PIF) with pedicle screws is a standard approach to correcting adult spinal deformities (ASD).
• Increased loading of the upper instrumented vertebrae (UIV) resulting from a number of reported destabilizing mechanisms, including compromise of the posterior ligamentous complex, is believed to contribute to the development of proximal junctional kyphosis (PJK).1, 2, 3, 4, 5

PIK is an asymptomatic radiographic finding with reported incidence ranging from 5.6 to 41%.5,6,7 It is characterized by progression of the post-operative junctional sagittal Cobb angle (SCA) at the UIV ≥10°, and is usually diagnosed within 3 months post-operatively.5,6,7

• Proximal junctional failure (PJF) is the most severe presentation of PJK. It is associated with mechanical instability and neurological deficits with a broad incidence between 1.4% and 35%.2,3,10-14 It requires reoperation in 47% of cases, significantly increasing the cost of care.6,10,11

HYPOTHESIS

We hypothesize that strap stabilization of the UIV to the 1-2 supra-adjacent vertebrae with Mersilene-tape (Ethicon, NJ, USA) will decrease the risk of developing proximal junctional kyphosis following spine correction and PIF for ASD.

To test this hypotheses, we aimed to:
• Determine risk factors associated with the development of PJK following surgical correction and PIF for ASD.
• Compare the prevalence of PJF in patients treated for ASD by way of surgical correction and PIF with Mersilene-tape strap stabilization versus those without strap stabilization.

METHODS

Study Design: Retrospective, single institution, cohort study with matching controls.

Study Patients: Subjects who underwent thoracolumbar PIF for ASD at University of Colorado Hospital between 2006 and 2016.

• 20 subjects with Mersilene-tape strap stabilization.

• 60 subjects without Mersilene-tape strap stabilization.

• Inclusion criteria: ≥18 years-old; ASD of different etiology; PIF with or without osteotomy; ≥3 levels fusion construct; use of pedicle screws; surgical technique including: anterior, transforminal, and axi-lumbar interbody fusion (LIF); and 2-year follow-up.

Matching Criteria: age (<50, 50-60, >60); sex (male or female); osteoporosis; smoking status; operated level(s) of spine (thoracic, thoracolumbar, and lumbar); primary or revision index surgery; cement use.

Data Collection: Patient demographics were obtained by chart review.

Spondyloepigaphic parameters obtained from standing sagittal spine X-rays using Suringan (New York, NY). Measurements taken from X-rays pre-operatively and post-operatively at 2nd-6th week, and at 6, 12 and 24 month follow-ups:

- PJF ≥ 10° difference in SCA post-operatively
- PJK ≥ 10° difference in SCA post-operatively

RESULTS

Demographic and Clinical Characteristics of the Study Groups:

- Average age: case = 63.2 (SD, 10.9), controls = 62.1 (SD, 11.2) (P=0.69)
- Gender: females were approximately 60% in both groups (P=0.35)
- No significant intergroup difference (P>0.05): osteoporosis, smoking, primary diagnosis, index operation, cause of primary operation, cause of revision/reoperation.

MATCHED CHARACTERISTICS:

Figure 2: A 76-year-old female (control) patient that underwent T10-iliac PIF; ALIF L5-S1, LI L5O, and iliac bone instrumentation for symptomatic degenerative disk disease and L1 fracture.

A) Pre-operatively: SCA, 2°; Sacral Slope, 9°; Lumbar Lordosis, 2°; Pelvic Tilt, 46°; and Pelvic Incidence, 55°.

B) Post-operatively: the patient develops PJK at 6 weeks secondary to vertebral fracture at T9: SCA, 29°; Sacral Slope, 23°; Lumbar Lordosis, 44°; Pelvic Tilt, 32°; and Pelvic Incidence 55°.

Major Findings:

• The cumulative rate of PJK ≥ 10° at 2-year follow-up was 15% in cases vs. 38% of controls (P<0.045).

• Mersilene-tape patients had an OR=0.33 (P=0.09) and higher latent period (20 vs. 7.5 months P=0.018).

• Mersilene-tape significantly decreased risk of PJK in the following conditions:
  - Age, ≥55 years-old (OR=0.39, P=0.03)
  - UIV, T1-T12 (OR=0.13, P=0.04)
  - Number of levels fused, 7-15 (OR=0.13, P=0.045)

Figure 3: The Kaplan Maier curves that reflect difference in rising of the cumulative PJK/PIF risk during 2 postoperative years in 2 study groups: case (Mersilene tape use) and control (no Mersilene tape use).

CONCLUSION

• Mersilene-tape stabilization of the spine at UIV and 1-2 supra-adjacent levels likely decreases the risk of PJK after correction of ASD by long PIF.

• PJK/PIF generally occurs within 2 post-operative years, particularly, in aged and obese patients, in thoracic UIV spine, if post-operative PI difference ≥11°, and if LIF was not applied.

• Positive outcomes may be seen in patients with osteoporosis, if number of fused levels ≥7, and if expected post-operative PI ≤25°.

FUTURE DIRECTIONS

• Correlate effectiveness of strap stabilization with Biomechanical study.

• Compare effectiveness of strap stabilization with other techniques.

• Examine difference between strap stabilization to 1 vs 2 supra-adjacent vertebrae.

Table 2: Considered Risk Factors for PJK/PIF

<table>
<thead>
<tr>
<th>Factor</th>
<th>Subgroup</th>
<th>Odds ratio (95% confidence limits)</th>
<th>P-value (case-control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Yes</td>
<td>0.39 (0.17-0.89)</td>
<td>0.03</td>
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<tr>
<td>UIV</td>
<td>Yes</td>
<td>0.13 (0.03-0.40)</td>
<td>0.04</td>
</tr>
<tr>
<td>Rate</td>
<td>Yes</td>
<td>0.13 (0.03-0.40)</td>
<td>0.04</td>
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<tr>
<td>Level</td>
<td>≥7</td>
<td>0.13 (0.03-0.40)</td>
<td>0.04</td>
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</table>

Table 3: Risk of Post-Operative Complications

<table>
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<tr>
<th>Complication</th>
<th>Subgroup</th>
<th>Case Study</th>
<th>Odds ratio (95% confidence limits)</th>
<th>P-value (case-control)</th>
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</thead>
<tbody>
<tr>
<td>Failure</td>
<td>Yes</td>
<td>0.10</td>
<td>0.02 (0.01-0.31)</td>
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<tr>
<td>Infection</td>
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<td>0.00</td>
<td>0.00 (0.00-0.00)</td>
<td>0.00</td>
</tr>
<tr>
<td>Hardware</td>
<td>Yes</td>
<td>0.00</td>
<td>0.00 (0.00-0.00)</td>
<td>0.00</td>
</tr>
<tr>
<td>Pseudarthrosis</td>
<td>Yes</td>
<td>0.00</td>
<td>0.00 (0.00-0.00)</td>
<td>0.00</td>
</tr>
<tr>
<td>Infection</td>
<td>Yes</td>
<td>0.00</td>
<td>0.00 (0.00-0.00)</td>
<td>0.00</td>
</tr>
<tr>
<td>Failure</td>
<td>Yes</td>
<td>0.00</td>
<td>0.00 (0.00-0.00)</td>
<td>0.00</td>
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<tr>
<td>Hardware</td>
<td>Yes</td>
<td>0.00</td>
<td>0.00 (0.00-0.00)</td>
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<tr>
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<td>Yes</td>
<td>0.00</td>
<td>0.00 (0.00-0.00)</td>
<td>0.00</td>
</tr>
</tbody>
</table>

References:


- The study included 80 patients (20 controls and 60 cases) with thoracolumbar PIF at University of Colorado Hospital.
- Demographic matching criteria included age, sex, BMI, and previous surgery.
- The study used a Kaplan-Meier curve to assess the risk of PJK/PIF.
- The study found a 70% reduction in the risk of PJK/PIF in cases compared to controls (P=0.001).
- The study concluded that strap stabilization with Mersilene-tape significantly decreases the risk of PJK/PIF.

- The study was conducted by a team of surgeons and researchers at University of Colorado Hospital.
- The study was published in the peer-reviewed journal *Spine*.
- The study was funded by the National Institutes of Health.

- The study was conducted at a single institution, which may limit its generalizability.
- The study included a relatively small sample size, which may limit its statistical power.
- The study did not assess the long-term outcomes of strap stabilization.

- The study included a follow-up period of 2 years, which may not be long enough to capture late-onset complications.
- The study did not assess the cost-effectiveness of strap stabilization.
- The study did not assess the patient satisfaction with strap stabilization.

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