Failures of the Tethering Technique: How and Why?

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NOT FDA APPROVED DEVICE
What is Failure?

- Clinical outcome
  - Avoiding a fusion
  - HRQoL
- Radiographic
  - Improved but under what value
    - Coronal 35°?
- Complications
  - Reoperations?
- *Need longer follow-up*
**Animal studies: Abundant**

**Human: Few but increasing**
- Crawford CH, Lenke LG: Growth modulation by means of anterior tethering resulting in progressive correction of JIS. JBJS 92A:202-9, 2010
- Samdani *et al*: Anterior VBT for immature AIS: one-year results on the first 32 patients. Eur Spine J 2015;24:1533-9
- Miyanji F: Results of VBT at 2 years. IMAST 2017
Successes and Failures Following Spinal Growth Tethering for Scoliosis: A Retrospective Look 2 to 4 Years Later

Newton et al: SRS 2016

- 17 consecutive patients
  - Risser 0, mean age 11 years, mean thoracic scoliosis 52º
  - 2-4 years of follow-up
- 9/17 were considered to have a successful outcome (reduction of thoracic Cobb to < 30º)
- Good initial correction but inconsistent midterm outcomes
  - Revision surgery required for approx. 50% of patients
Reoperations

- Approximately 10-15%
  - Overcorrection
    - Younger patient, usually triradiates open
    - Technique related
  - Undercorrection
    - Curve too stiff and/or not enough growth
- Adding on
  - Usually if tethered short of CSVL
Too Much Growth: Overcorrection

Pre-op  Immediate post-op  1 year  2 years  2 years after tether cut
Curve Too Stiff

75

45

48

24 months
Newton Observed Failed PET Cord in 8/17 (47%)

- 2 confirmed at reoperation
- 6 suspected based on change in screw angulation

P Newton et al, SRS 2016
Not All Broken Tethers Are Failures

P Newton et al, SRS 2016
Patient R.L.

- 12-year-old boy with AIS
  - Risser 0, triradiates open, Sanders 3
  - 49° right thoracic curve
  - Bends to 28°
  - Inclinometer 12°
- Age at surgery 12 years
  Height 145 cm

- Current age 16 years
  Height 175 cm

- Grows 30 cm = 13.6 inches
WHO Not to Tether

- Patient too skeletally immature
- Family
  - Do they understand all options?
    - Not FDA approved
    - No long-term data
- Expectations
  - Residual deformity
- Not enough growth
Did Not Grow Enough?
The First 100 Consecutive Anterior Vertebral Body Tethering Procedures for Immature Adolescent Idiopathic Scoliosis at a Single Institution: Outcomes and Complications in the Early Postoperative Period

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Complications:
- 5% with transient thigh pain/numbness
- 2% converted to open procedure
- 1% prolonged atelectasis
- 1% unresolved intercostal neuralgia
- No neurologic deficits

Conclusion:
- 49% initial coronal Cobb correction
- 33% initial rib prominence reduction
- Progressively faster operative times and lower EBL
- No major, few minor complications
Complications

- Lumbosacral plexus
  - Posteriorly placed screws
  - Peel psoas back
- Three chest tube reinsertions
  - Delayed effusions
  - Now leave chest tube in two days
- One infection
  - Salmonella
- One patient excessive blood loss
  - Lumbar tether
  - Aortic branch
WHY Consider Anterior Growth Modulation?

- Adjacent level degeneration later
- Maybe better sagittal compensation
- Hypothetically, mobile spine better than fused spine


Look at improvement in cervical lordosis
Trunk Motion Pre- / Post-op

PSF

Pre-op

6m post-op

VBT

Pre-op

6m post-op
Thoracic PSF vs. VBT

12 year old T2-T11
Preoperative
54 degrees
6 months post-op

13 year old T5-T12 Tethering
Preoperative
48 degrees
6 months post-op
Thoracic Fusion vs. Tether Trunk Motion Analysis

Pre/post Fusion T2-T11

Pre/post Tethering T5-12
Thoracolumbar Fusion vs. Tether

Preoperative
65 & 75 degrees

6 months post-op

Preoperative
55 & 40 degrees

6 months post-op
23 & 23 degrees
Fusion vs. Tethering
Trunk Motion Analysis

Pre/post Fusion T5-L4

Pre/post Tethering T5-L4
Conclusions

- Failures of tethering most commonly occur in mature patients and in those with stiff curves.
- Reoperation rate is higher than with fusion, but perhaps not all should be considered failures.
- Cord breakage common and will lead to loss of correction if segment has not modulated.
- Promising technique with evolving indications.