Vertebral Growth Modulation in the Porcine Scoliosis Model by Computed Tomographic Analysis

Effect of a Corrective Tether Technique

Benjamin Ungar BA , Virginie Lafage PhD, Frank Schwab MD, Ashish Patel MD, Jean-Pierre Farcy MD

NYU – Hospital for Joint Diseases

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Frank Schwab, MD	**Consultant: Medtronic**

Introduction

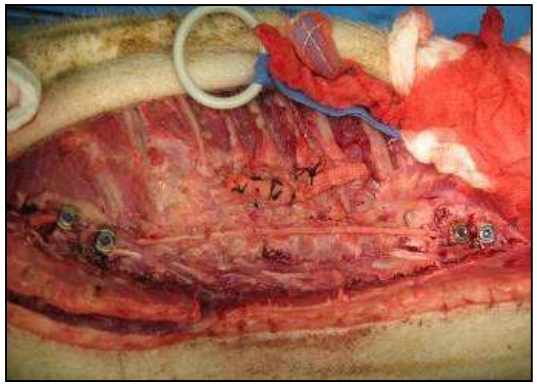
- **Surgical AIS Treatment:**
  - Long Fusion
  - Loss of Segmental Motion
  - Imposed Sagittal Alignment

- **Non-Fusion AIS Correction**
  - Significant Interest
  - Remaining questions
    - Correct a 3D deformity?
    - Favorable growth modulation?
    - Maintain growth?

Braun, Betz, Schmid, Lenke, …

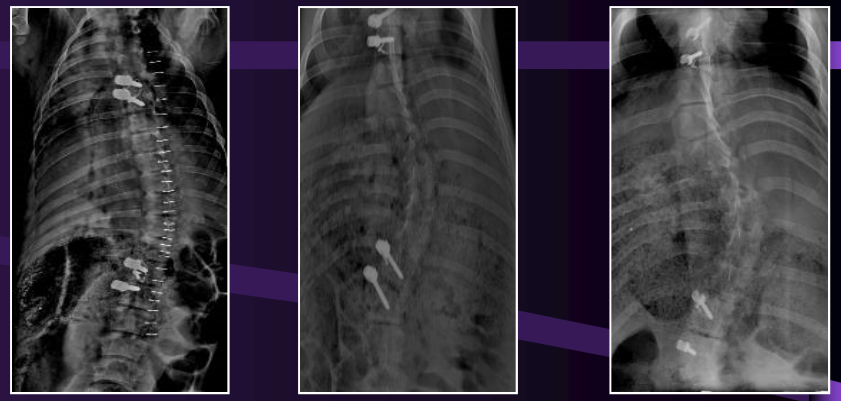
Background: Scoliosis Induction

Scoliosis induction and FU



Scoliosis induction @ 11weeks
=>25° Coronal Cobb

Bi-weekly Xrays until 50° (~6w)

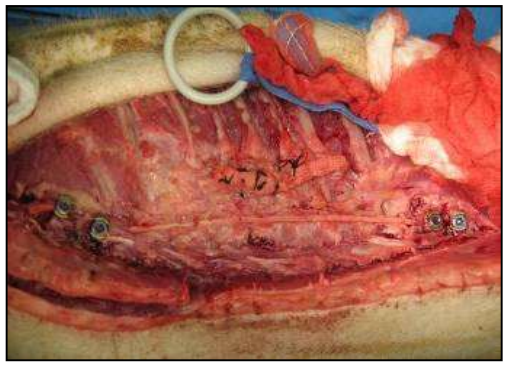


Creation of a 3D deformity
- 50° Cobb
- Flattening of sagittal plane
- Axial Rotation

Deformity maintained
- After removal of tether

Methods: Surgical Procedures and FU

Scoliosis induction and FU



Scoliosis induction @ 11weeks
=>25° Coronal Cobb

Bi-weekly Xrays until 50° (~6w)

Tether Release

N = 5 (TR)

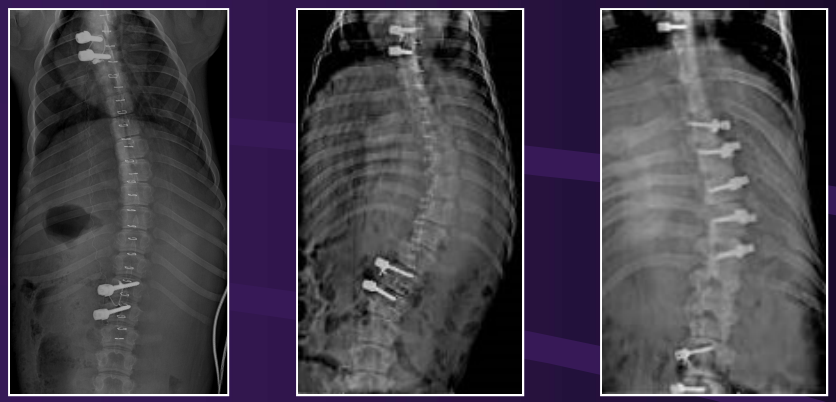
Anterior Correction

N = 5 (AC)

FU 20wks with Bi-weekly Xrays

Existing Porcine Scoliosis Model

Scoliosis induced at ~11 weeks of age

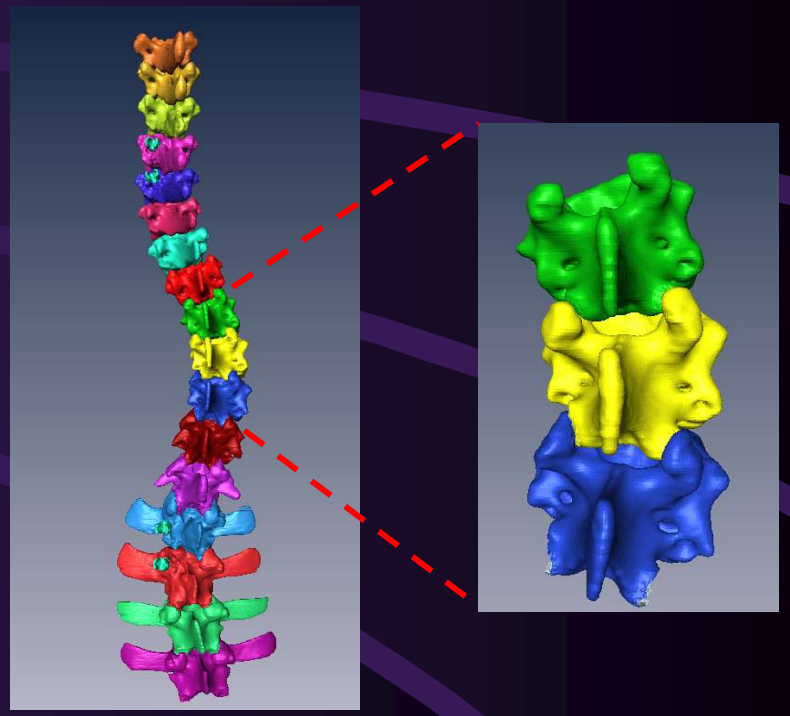


- **Anterior Tether**
  - Progressive correction
  - Coronal Cobb: 24° vs. 49°
  - Sagittal Kypho: 21° vs. 16°

Study Objective

Using Detailed CT Reconstruction

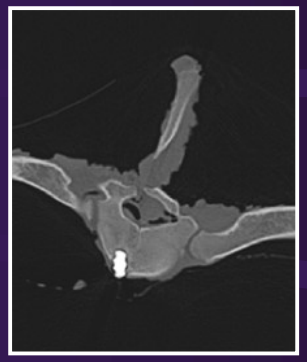
Investigate the impact of a **corrective tether** on vertebral body **morphology** and the **apical** segment



Methods: CT Reconstruction Protocol

Euthanasia

20 Wks FU

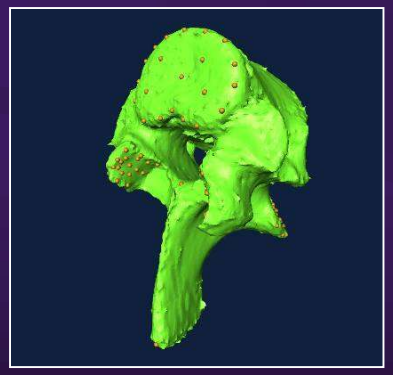


CT-scans

Fine Cut (0.6mm, contiguous)

3D Reconstruction

Amira



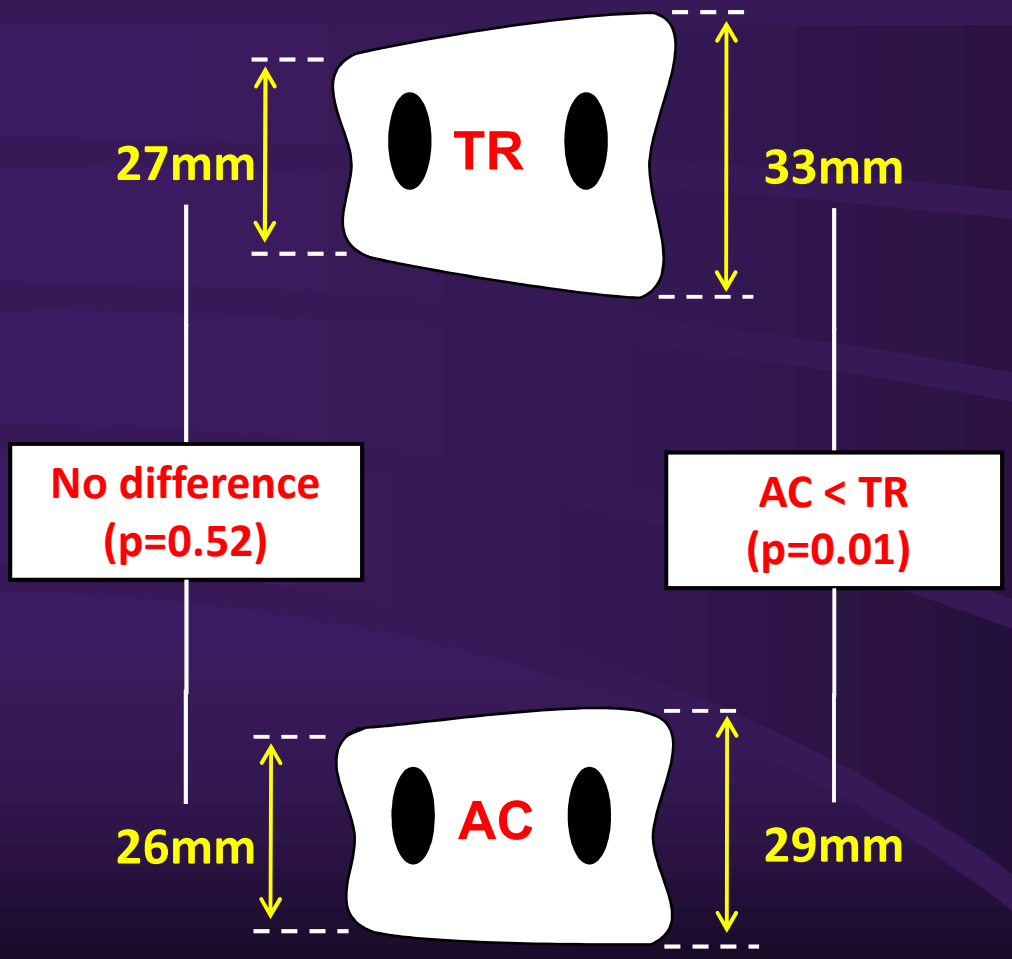
Amira Analysis:

Application of 121 Standardized points

<u>Anterior Correction vs Tether Release</u>

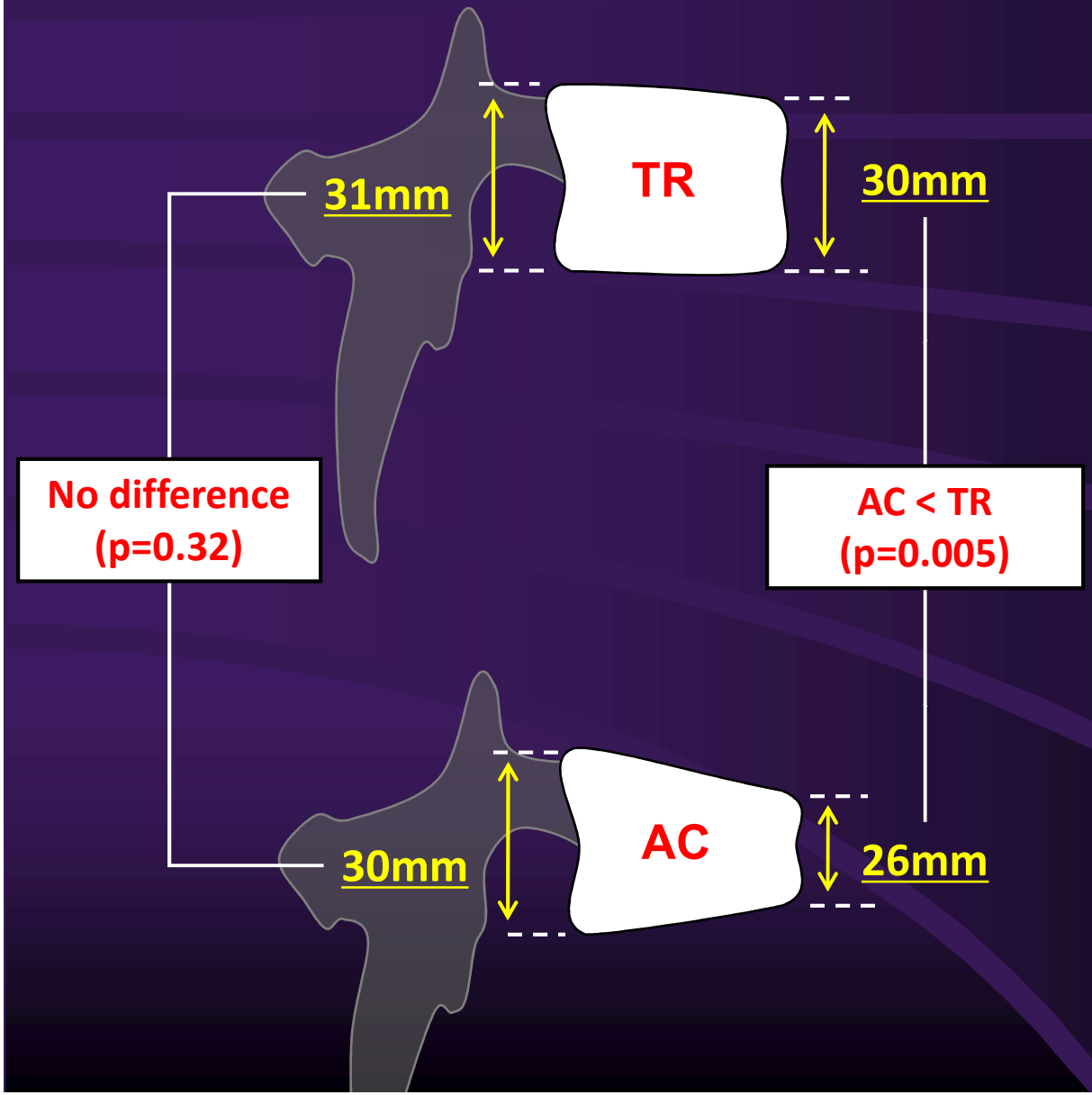
Vertebral Wedging, Vertebral/Disc Height, Axial Rotation

Coronal Plane Individual morphology



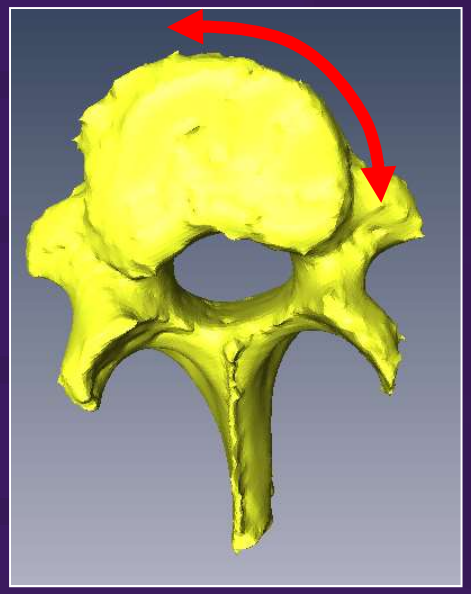
- **Concave Body Height**
  - Similar
- **Convex Body Height**
  - Reduction in AC
- **Body Wedging**
  - Reduction in AC
- **Disc Wedging**
  - Similar

Sagittal Plane Individual morphology



- **Post. Body Height**
  - Similar
- **Ant. Body Height**
  - Reduction in AC
- **Body Wedging**
  - Increased in AC
- **Disc Wedging**
  - Similar

Growth modulation and Surface / Volume



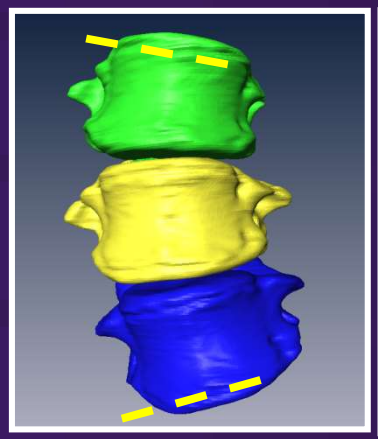
- **Area of significant growth modulation**
  - Anterior Correction << Tether Release
  - Corresponds to Staple placement
- **Vertebral Bodies**
  - AC Larger volumes => 18.3cm^3 vs 17.7cm^3
  - AC Larger surfaces => 56.2cm^2 vs 44.2cm^2
- **Endplates**
  - AC Larger endplates => 5.5cm^2 vs 5cm^2

Placement of anterior tether doesn't inhibit growth
Radial growth?

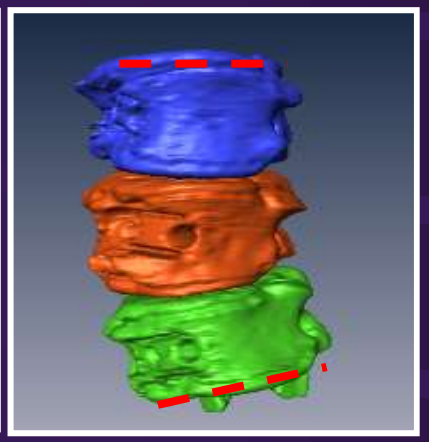
Results: Apical Cobb (3 VB's)

Coronal

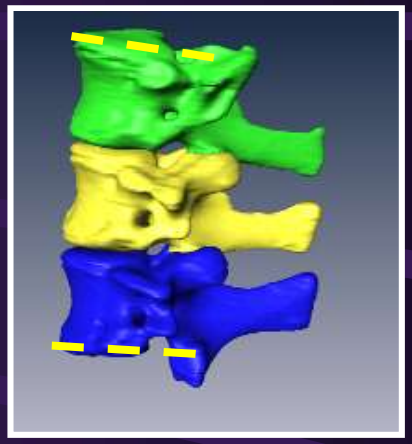
Sagittal



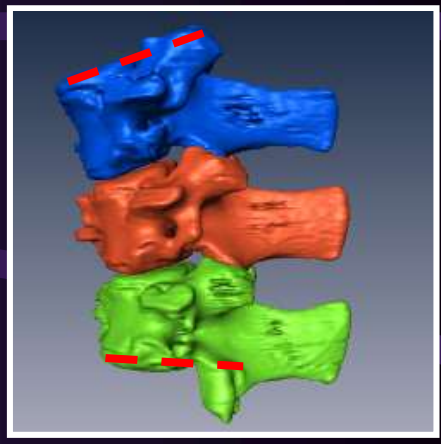
Tether Release



Anterior Correction



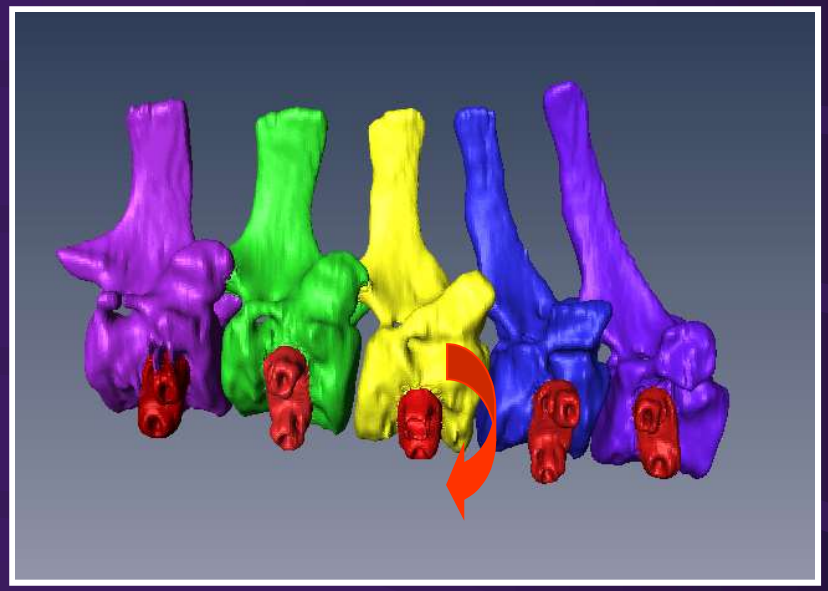
Tether Release



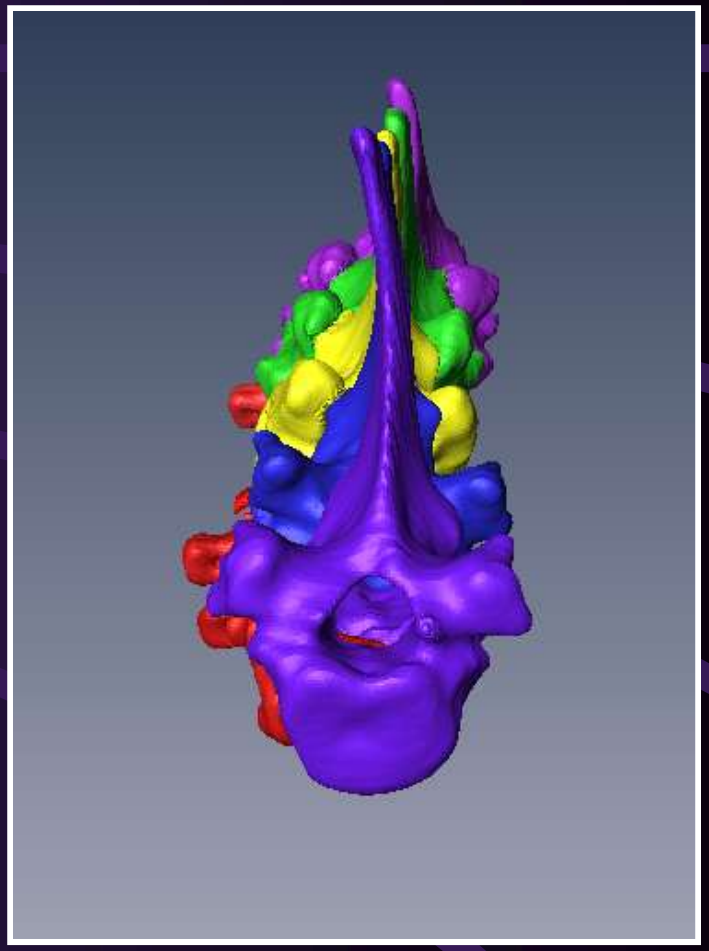
Anterior Correction

Tether Release	Anterior Correction	Tether Release	Anterior Correction
33°	19°	8°	22°

Results: Axial Rotation Correction



25% Reduction in
Apical Axial Rotation



Anterior Correction Tether

- **Coronal plane: deformity correction**
  - **Individual vertebral morphologic changes**
    - Reduction in Convex Height
    - Correction of Coronal Wedging
- **Sagittal plane: kyphosing effect**
  - **Regional Reduction in Anterior Body Height**
- **Axial Plane: Deformity correction**
  - **Correction of Apical Rotation**
- **Total growth uninhibited**

Tether based growth modulation can permit guided 3D correction of deformity

References

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2. Patel A, Schwab F, Lafage V, et al. *Progressive spinal deformity correction via and anterior based tether in a porcine scoliosis model: a detailed radiographic analysis.* IMAST Toronto, CA, 2010.

3. Braun JT, Hoffman M, Akyuz E, et al *Mechanical modulation of vertebral growth in the fusionless treatment of progressive scoliosis in an experimental model.* Spine 2006;31:1314-20.

4. Crawford CH, 3rd, Lenke LG. *Growth modulation by means of anterior tethering resulting in progressive correction of juvenile idiopathic scoliosis: a case report.* J Bone Joint Surg Am 2010;92:2002-9.