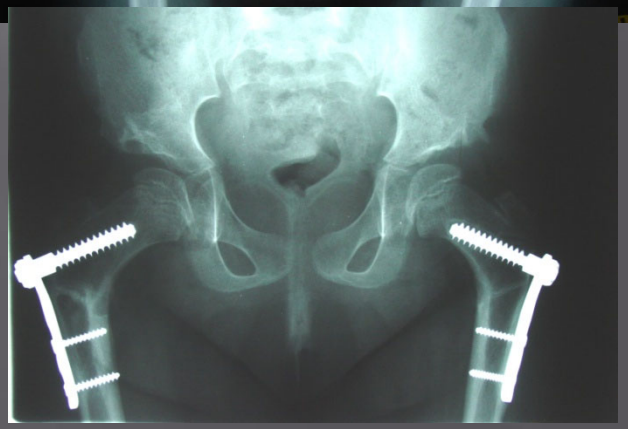
TENSION BASED FUSIONLESS STRATEGIES

2ND INTERNATIONAL CONGRESS ON EOS MONTREAL, CANADA

James W. Ogilvie, MD
Shriners Hospital for Children
Salt Lake City, Utah
Axial Biotech

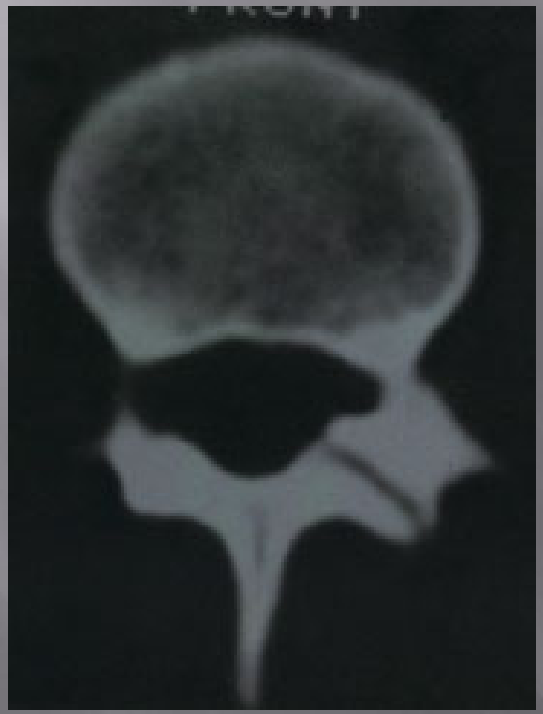
Reconstructive orthopaedics

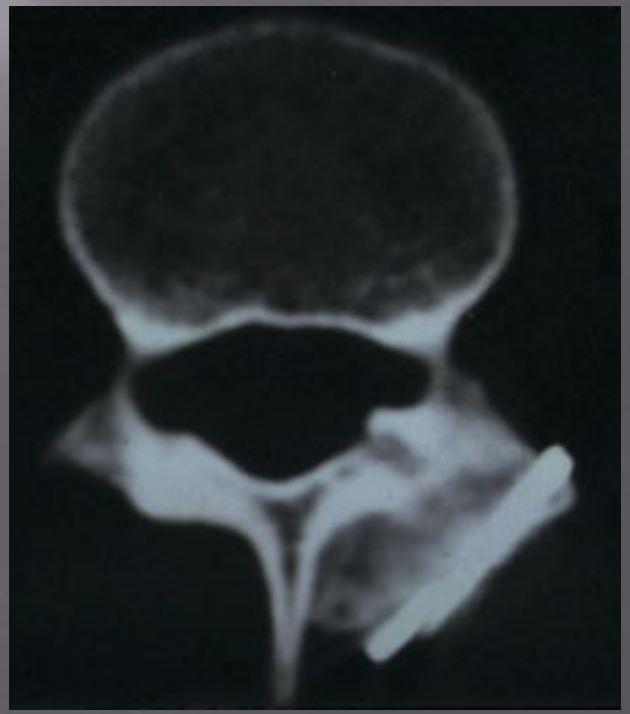
- 4 year old with Hurler syndrome MPS 1-H
- Restoration of Shenton's line
- > 100% femoral head coverage



Reconstructive spine surgery

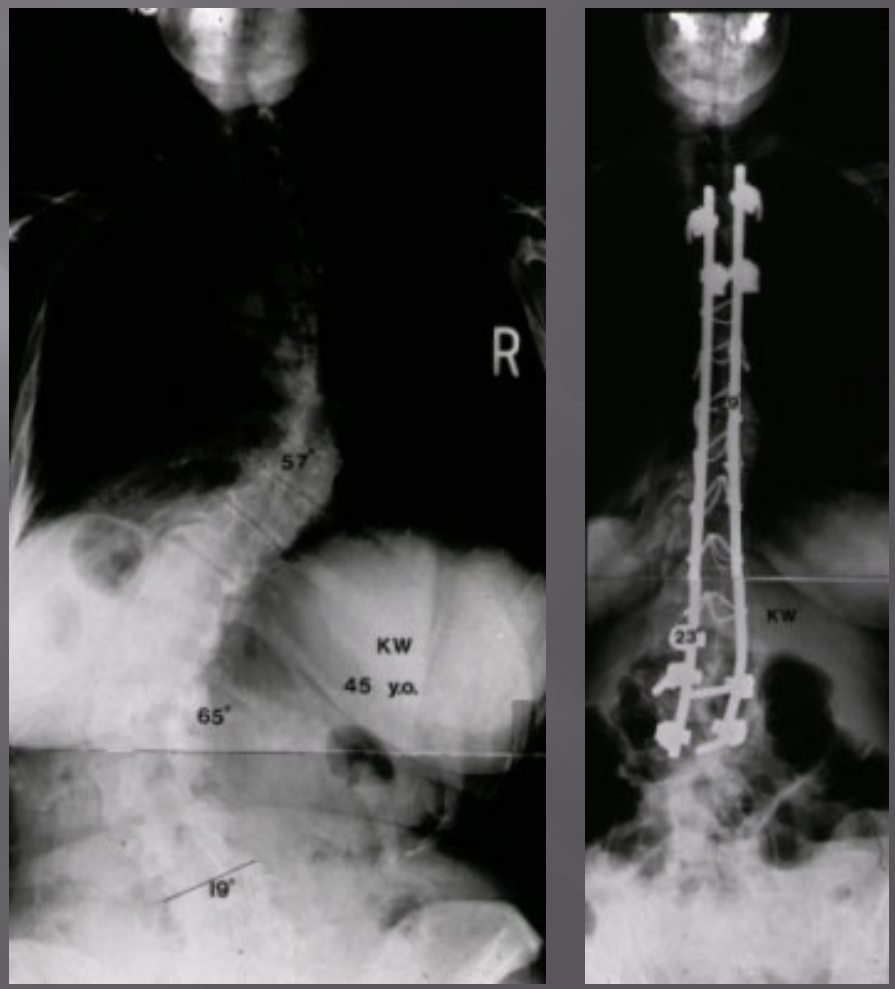
- Reconstruction implies reconstitution or preservation of normal anatomy
- Examples: pars repair of spondylolysis





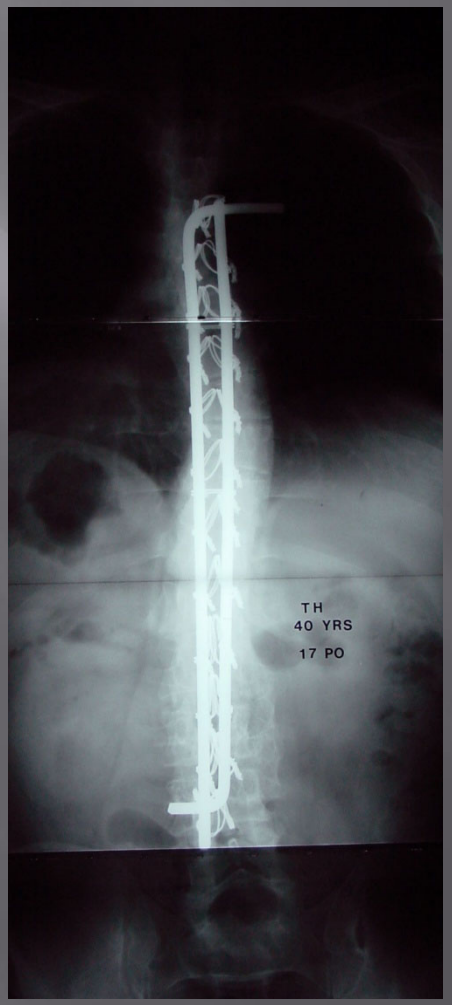
Salvage

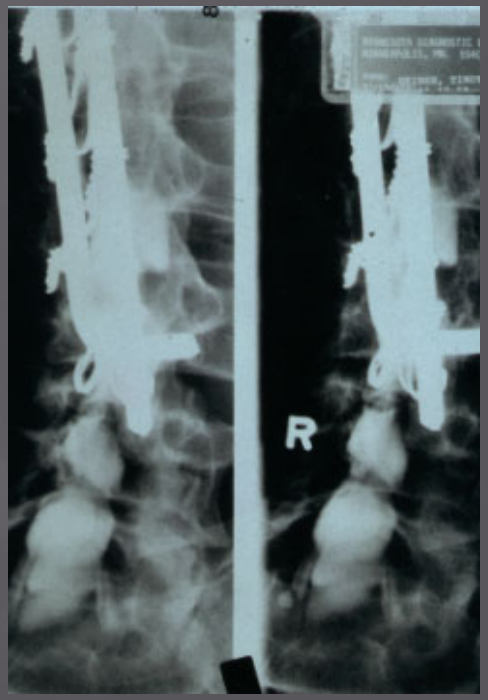
- 45 year old female
- Painful scoliosis
- Anterior-posterior fusion
- Improved quality of life, less pain, better self image



Long term effects of spinal fusion

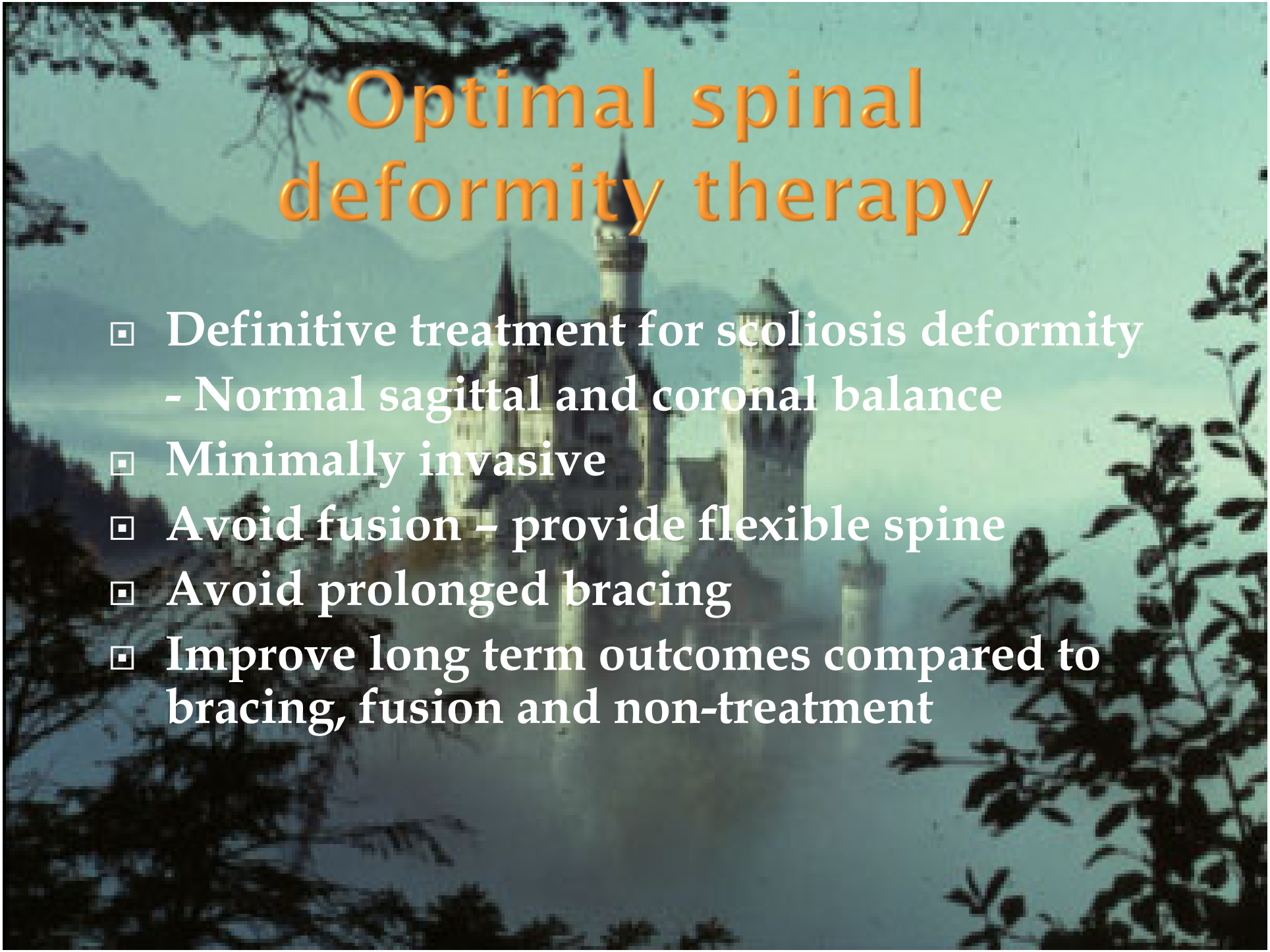
- 40 year old male
- Scoliosis fusion 17 years previously
- Now with painful lumbar spine
- Neuro claudication





Spinal deformity surgery

- Salvage
- Costly
- Invasive
- Long term adjacent motion segment degeneration
- Current state of the art



Optimal spinal deformity therapy

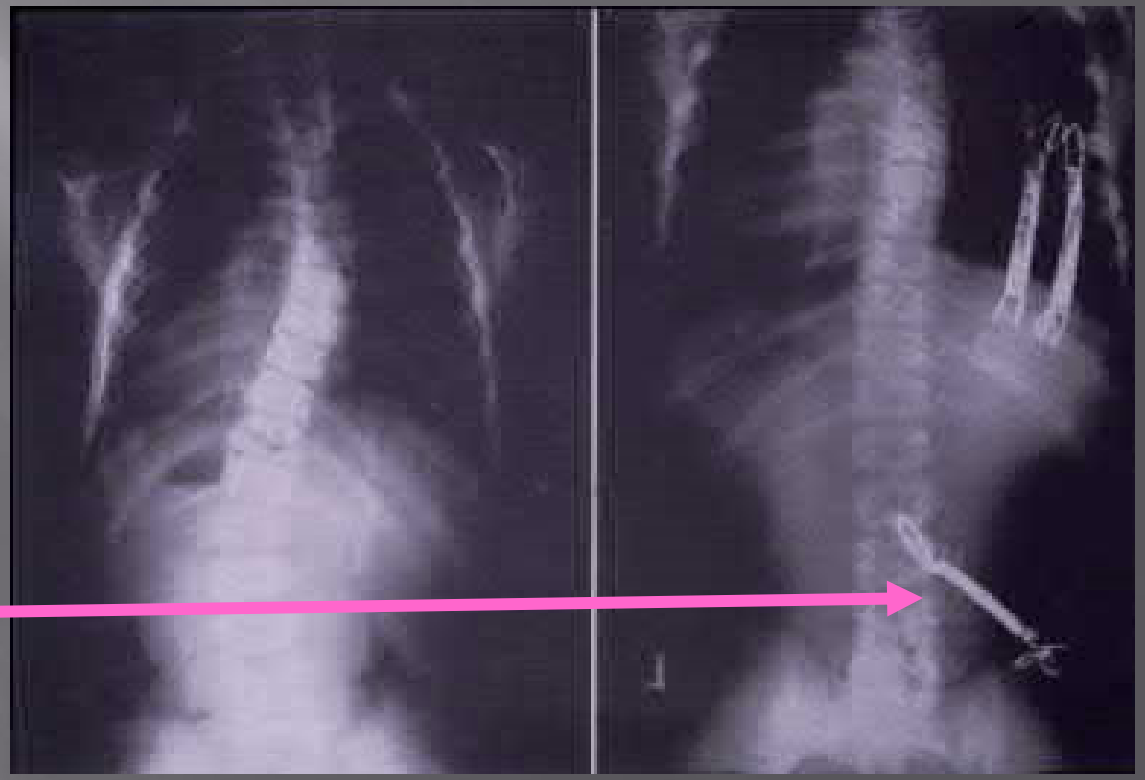
- Definitive treatment for scoliosis deformity
  - Normal sagittal and coronal balance
- Minimally invasive
- Avoid fusion – provide flexible spine
- Avoid prolonged bracing
- Improve long term outcomes compared to bracing, fusion and non-treatment

Ambrose Paré (1510-1590)

- First orthosis made by armorer.
- Patterned brace after the King's cuirasse

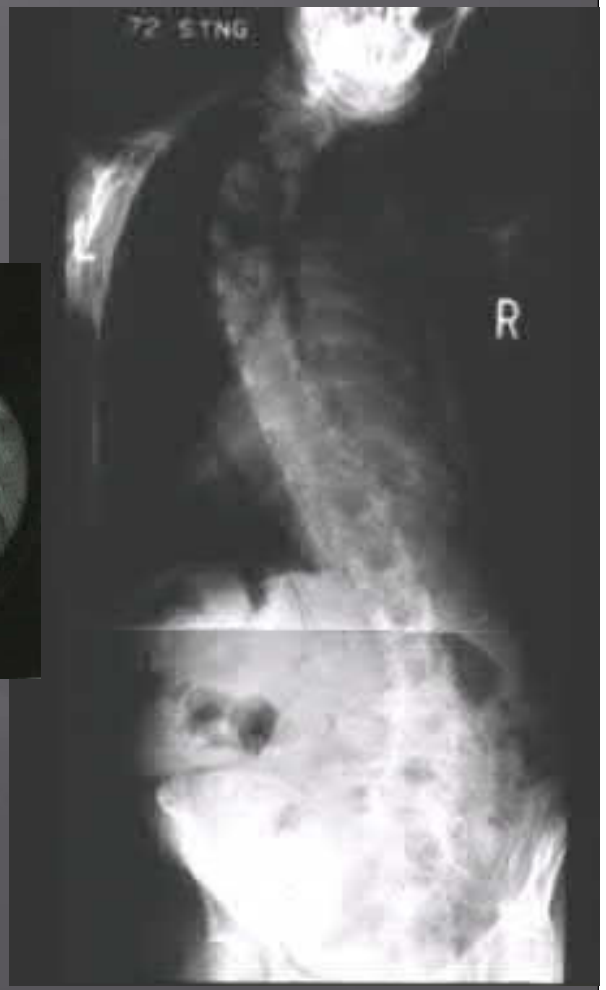
Asymmetrical tether

- Adam Gruca
  JBJS 1950



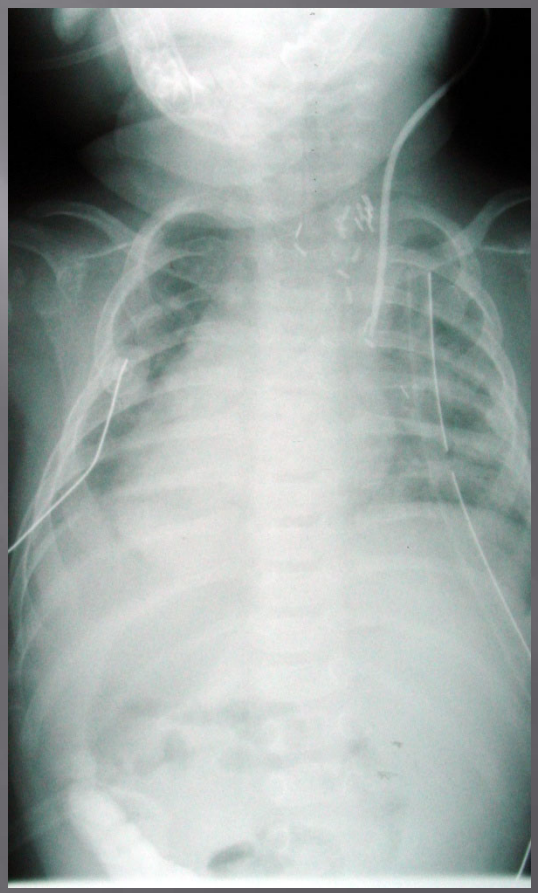
Asymmetrical tether alters spinal growth

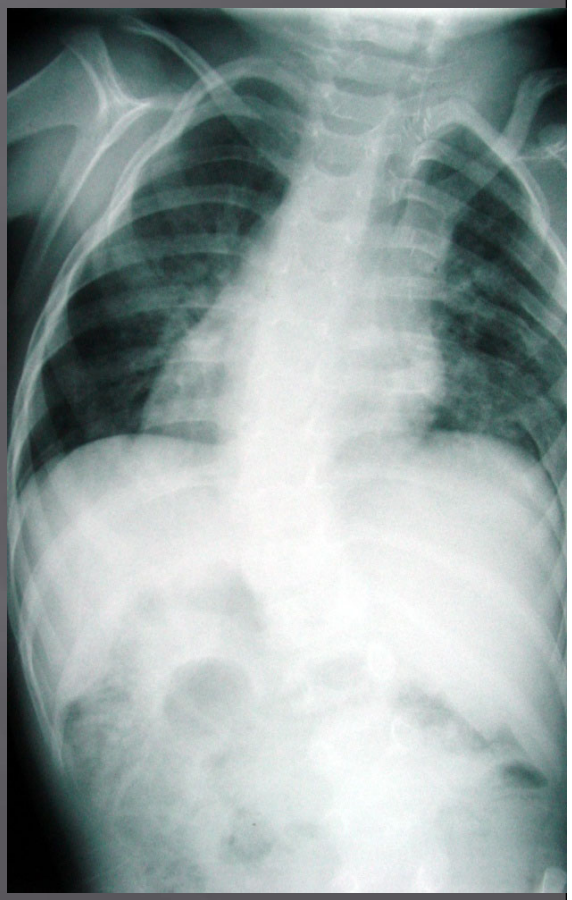
- 72 yr. old ♂
- Empyema age 11
- Right sided tether caused left thoracic curve

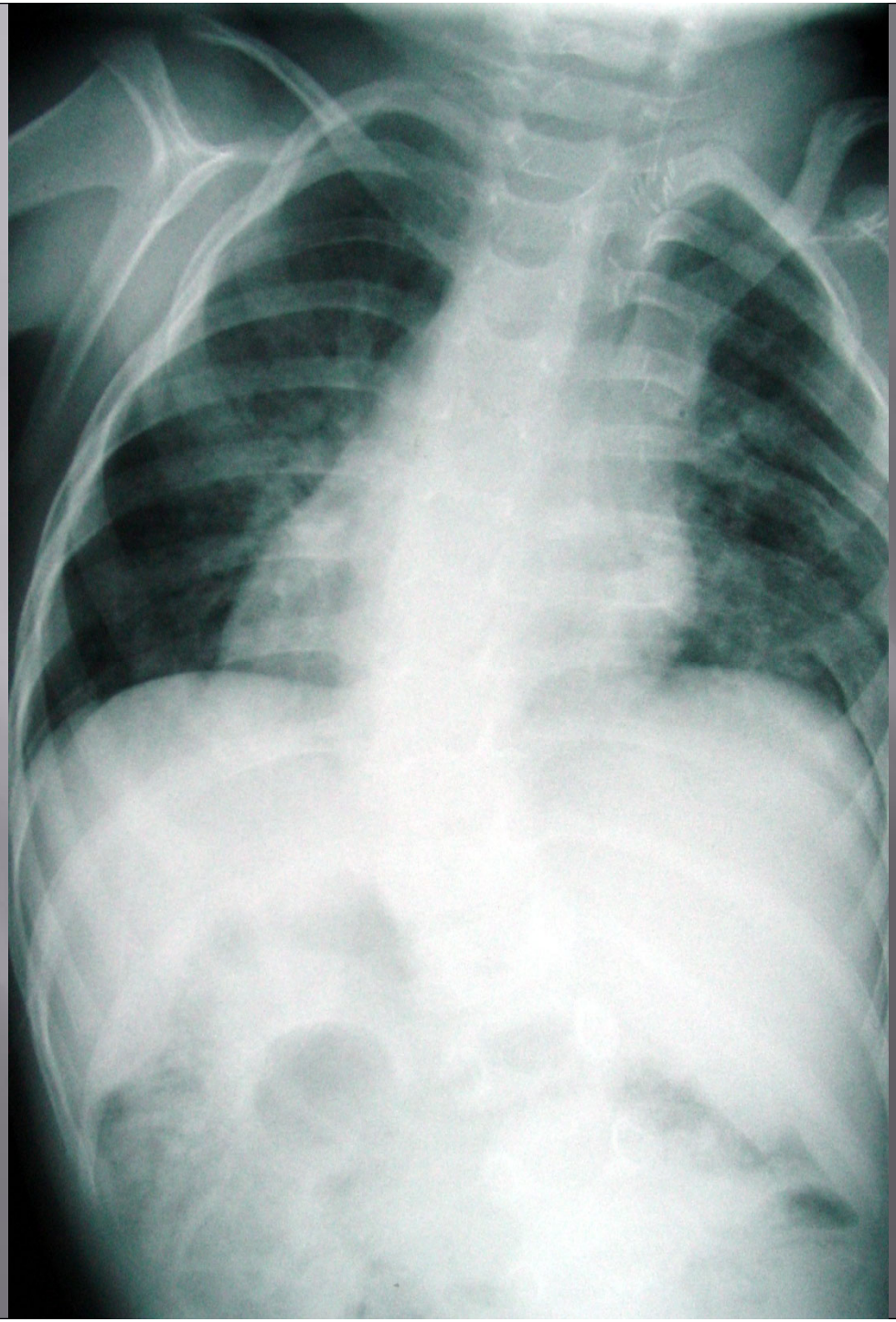


Newborn with VATER

- No congenital spine deformity
- Normal neuro exam
- 5 thoracotomies in 3 years for TE fistula







Fibrotic chest wall

Rib synostoses

Progressive scoliosis

Mechanical Modulation: Concave Enhancement and Convex Inhibition

- External fixator applied compression to rat tail motion segments (vertebrae)
- Loaded vertebrae grew at 68% of control growth
- Distracted vertebrae grew at 114% of control growth

Stokes, et al. *Spine* 1996

Stapled rat epiphyses

- ^{3}H-thymidine decrease at two weeks after stapling
- Loss of columnar organization in growth plate
- Polysaccharide synthesis and accumulation not affected

Erlich, et al *JBJS* 1972

Asymmetrical tether alters spinal growth

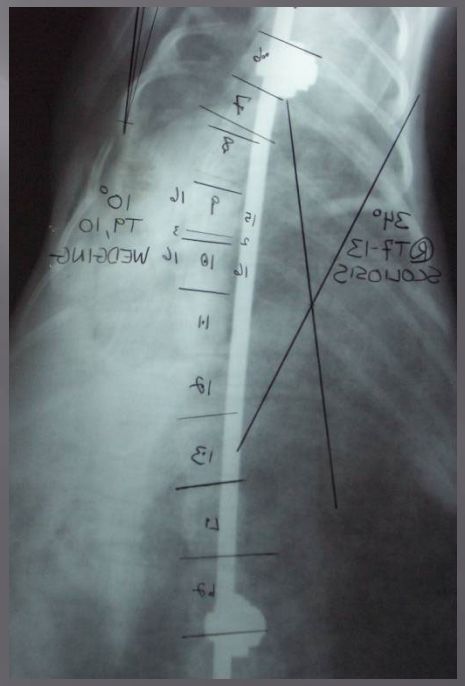
- Spinal tethering in juvenile goats
- Angular change in vertebral body dimensions

Braun, et al. SRS 2001

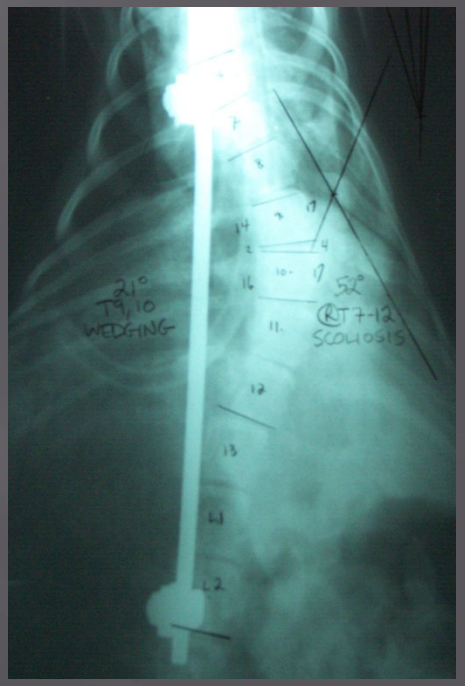
Tethering

- Initial Wedging: 10.3 º
- Final Wedging: 20.6 º
- Increase: +10.3 º

(P = 0.001)

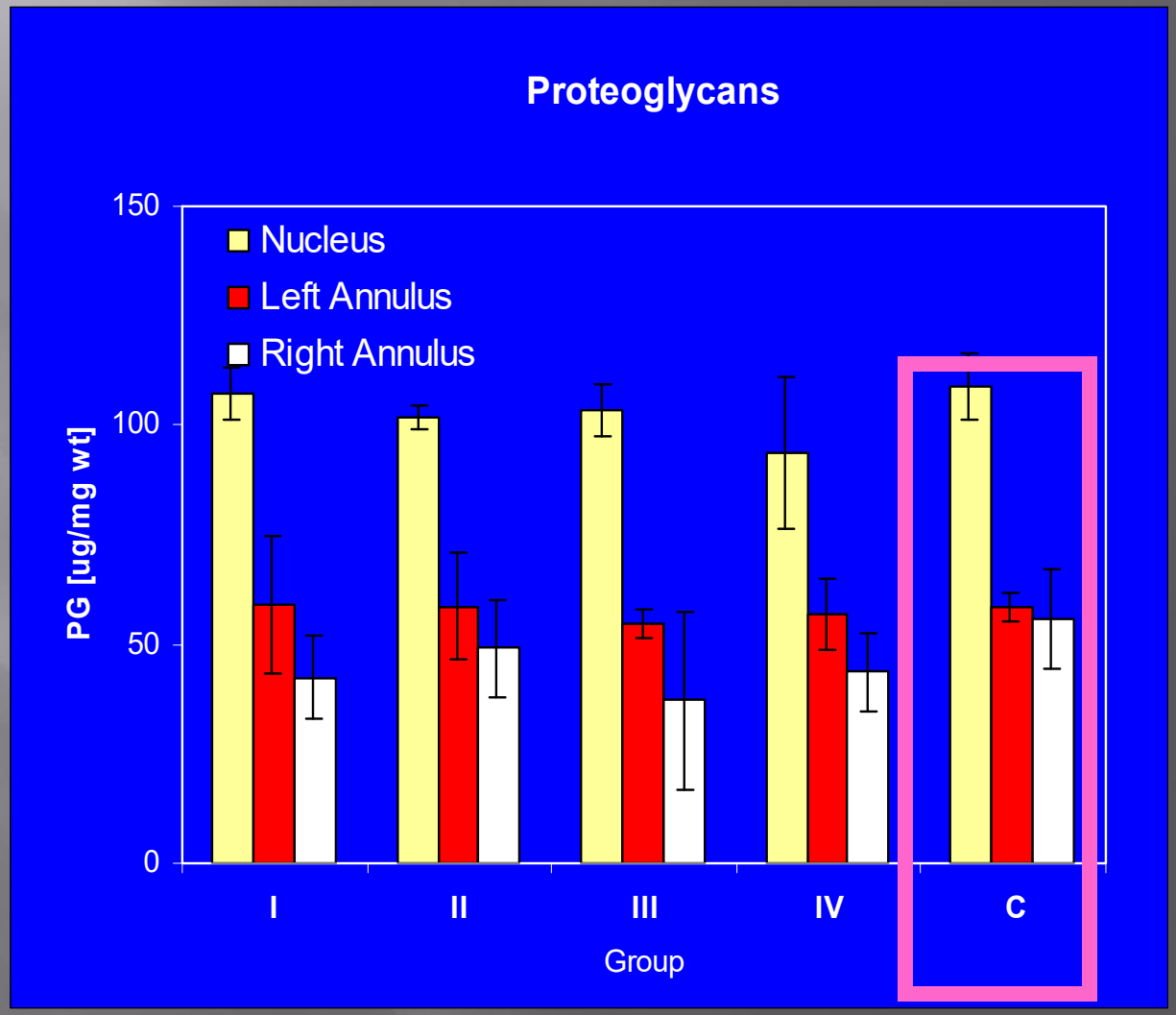


Initial 10 º



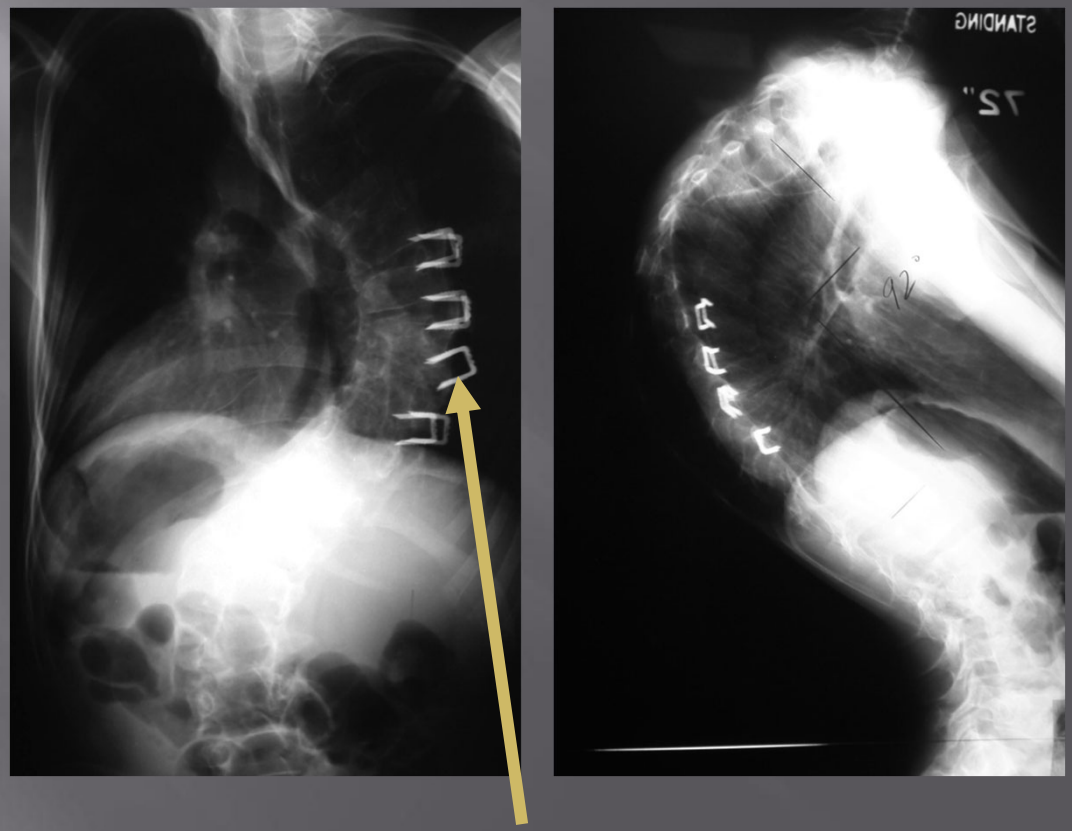
Final 21 º

Disc Biochemistry



Convex scoliosis stapling: 1994

- Minimally invasive
- Four apical levels
- Brace for two months then no bracing



What went wrong?

- Staple dislodgment
- Progression outside stapled segments
- Wrong patient population:
  Idiopathic vs. syndromic
- Severity level?
  Heuter-Volkmann principle

Staple dislodgment

- Shaped Memory Alloy (SMA) NiTi
- 4° C configuration

  Martensite: monoclinic crystal

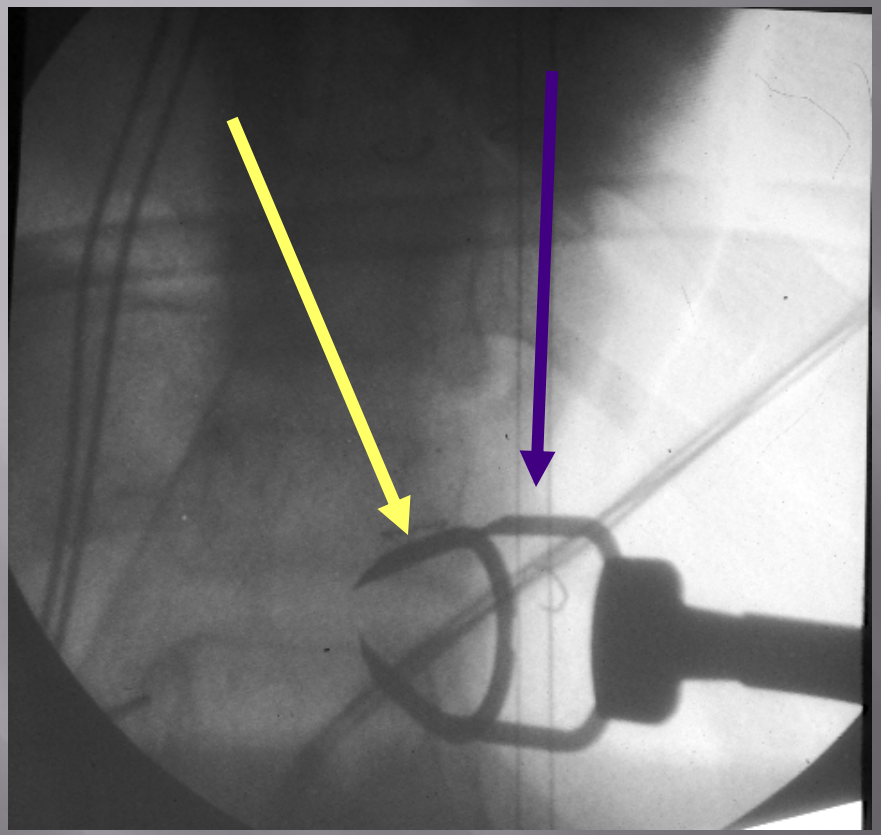
Staple dislodgment

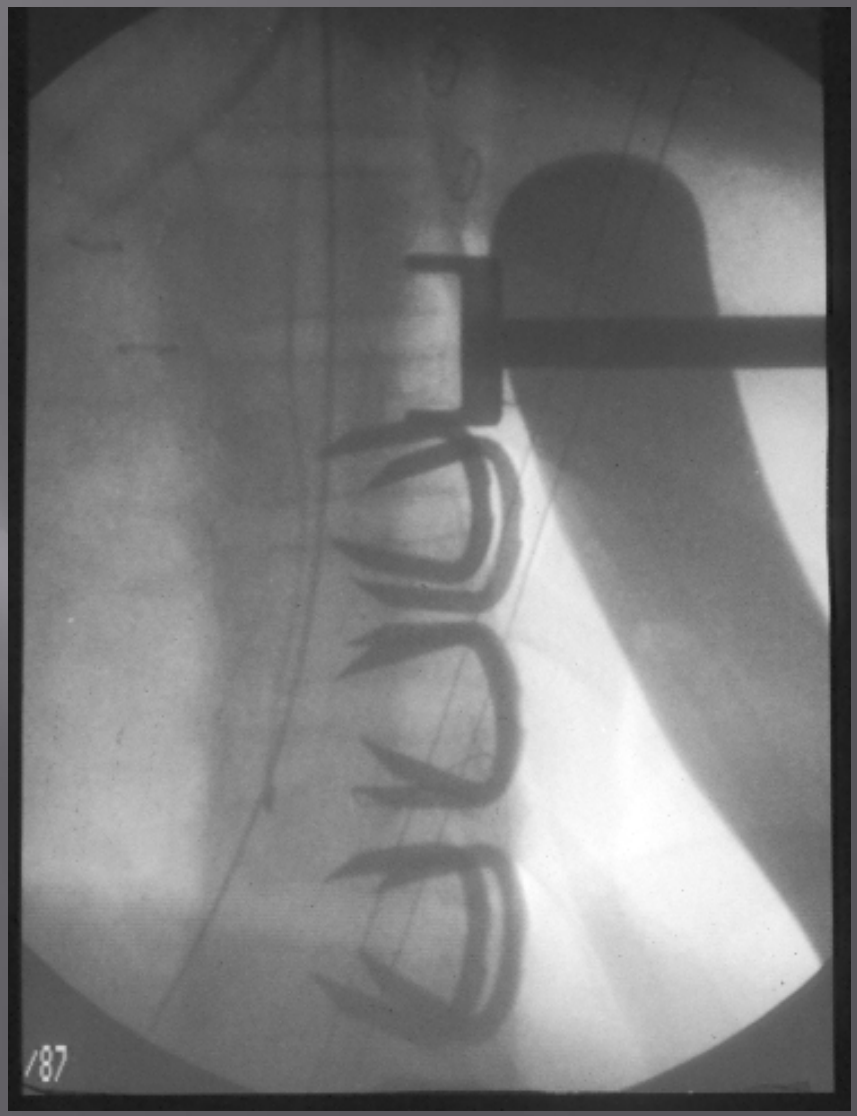
- Shaped Memory Alloy (SMA)
- 4° C configuration
- 35° C configuration

  Austenite: body centered cubic crystal

Staple dislodgment

- Shaped Memory Alloy (SMA) NiTi
- 4° C configuration
- 35° C configuration
- No staple dislodgment in subsequent trials

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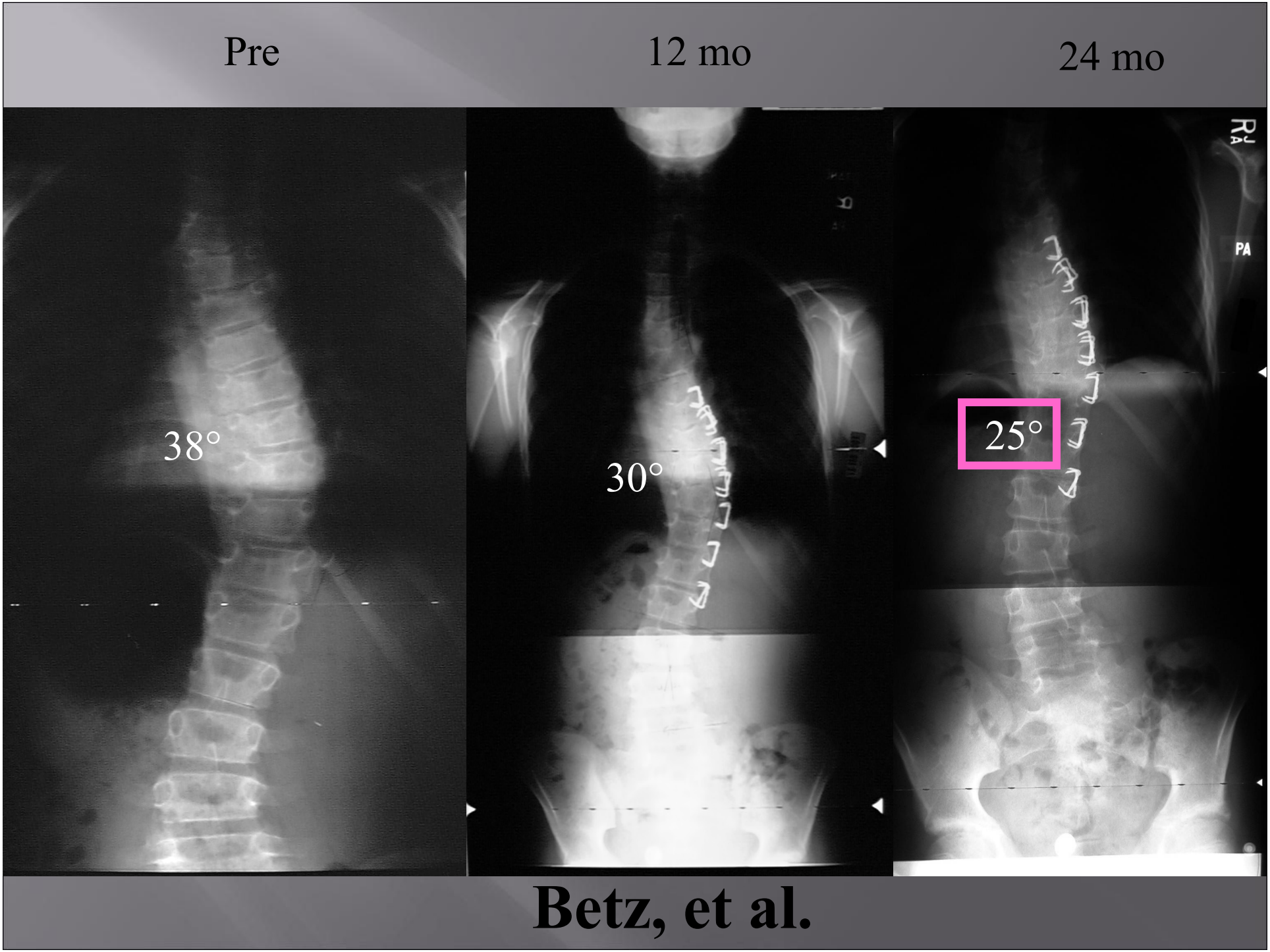
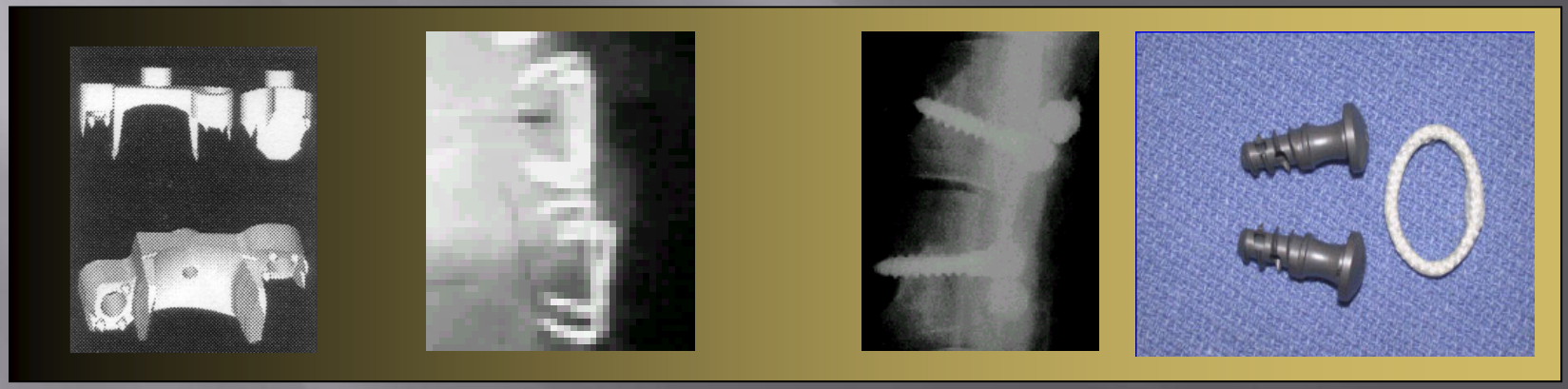


Betz, et al.

Convex Implant Strategies

Wall Betz Newton Braun



RIGID ⟷ FLEXIBLE

Heuter-Volkmann Principle

- **Compression inhibits physeal growth**
- At what curve severity does gravity compress the concave disc beyond its ability to sustain longitudinal growth?

- Empirically, 30°-40° range.

Convex scoliosis tethering

- Guided growth of the immature spine is possible.
- Early identification of appropriate patients.
- Minimally invasive surgery.
- Fusionless correction of deformity.
- Implant innovation.


Thank you

"Reconstructive" orthopaedics

- Reconstruction implies reconstitution or preservation of normal anatomy
- Examples: relocation of DDH, repair of dislocating shoulder, ACL repair

"Salvage" orthopaedics

- Salvage implies creating an abnormal condition which is better than the previous pathology.
- Examples: amputation, fusion, prosthetic joints

Long term effects of spinal fusion

- 15 year old female
- Uninstrumented scoliosis fusion 1947
- Third patient to wear new Milwaukee brace post-surgery

Long term effects of spinal fusion

- 70 year old female
- Scoliosis fusion 54 years previously
- Some pain in lumbar spine
- 2001: L-5, S-1 decompression for stenosis