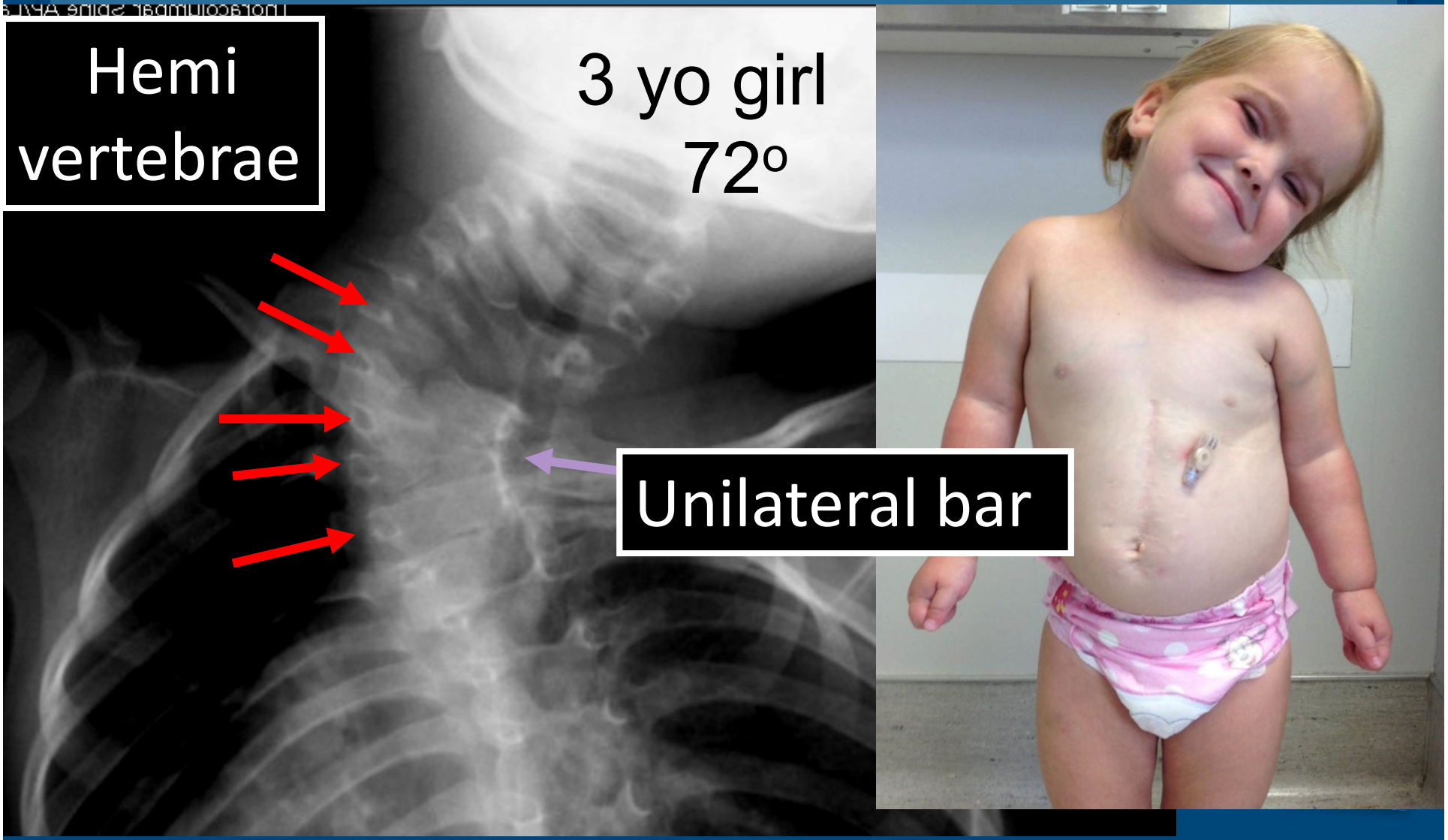
Cervicothoracic Congenital Scoliosis: Treatment of shoulder balance and head tilt

David L. Skaggs, MD, MMM
Professor and Chief of Orthopaedic Surgery
University of Southern California
Children's Hospital Los Angeles
Endowed Chair of Pediatric Spinal Deformity

USC University of Southern California

Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER

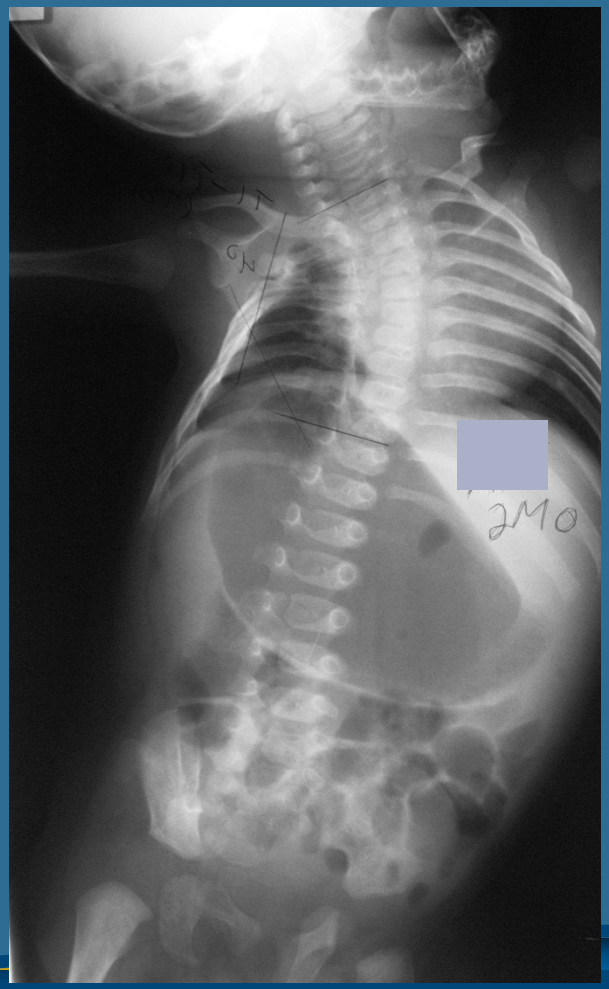
Visible Deformity - Head Tilt



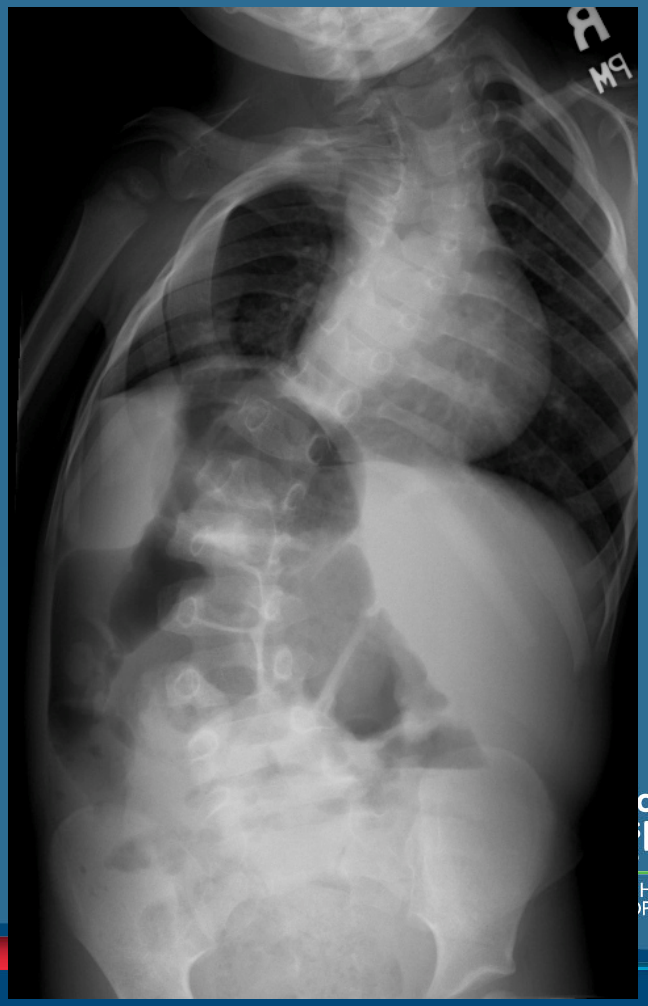
Step 1: Is it progressive???

Ask for CXRs from birth

2 mo



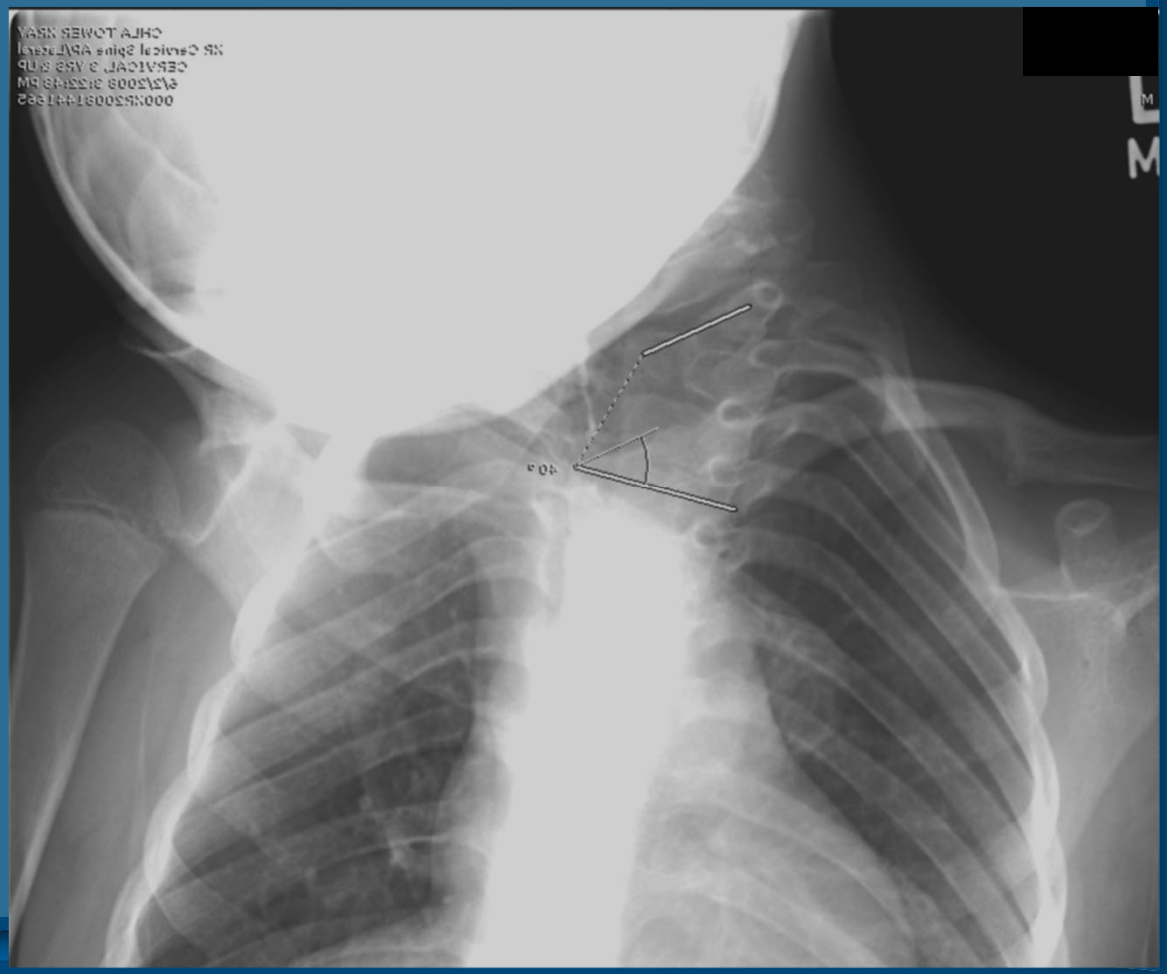
3 yrs



dren's
pital
ANGELES
HILDREN'S
PAEDIC CENTER

Step 2: Set Parental Expectations

- Head Tilt and Shoulder Balance likely to improve, but will never be perfect.



Step 2: Set Parental Expectations

Evaluation of shoulder balance in the normal adolescent population and its correlation with radiological parameters

Ibrahim Akel · Murat Pekmezci · Mutlu Hayran · Yasemin Genc · Ozgur Kocak · Orhan Derman · Ilkay Erdoğan · Muharrem Yazici

Euro Spine J, 2008

- Mean shoulder height difference 8mm ±6mm
- 28% have ≥10mm shoulder height difference (and self report level shoulders)
- T1 tilt poorly correlated with shoulder balance

USC University of Southern California

Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER

Step 3: Surgical Techniques
Congenital Cervicothoracic Scoliosis

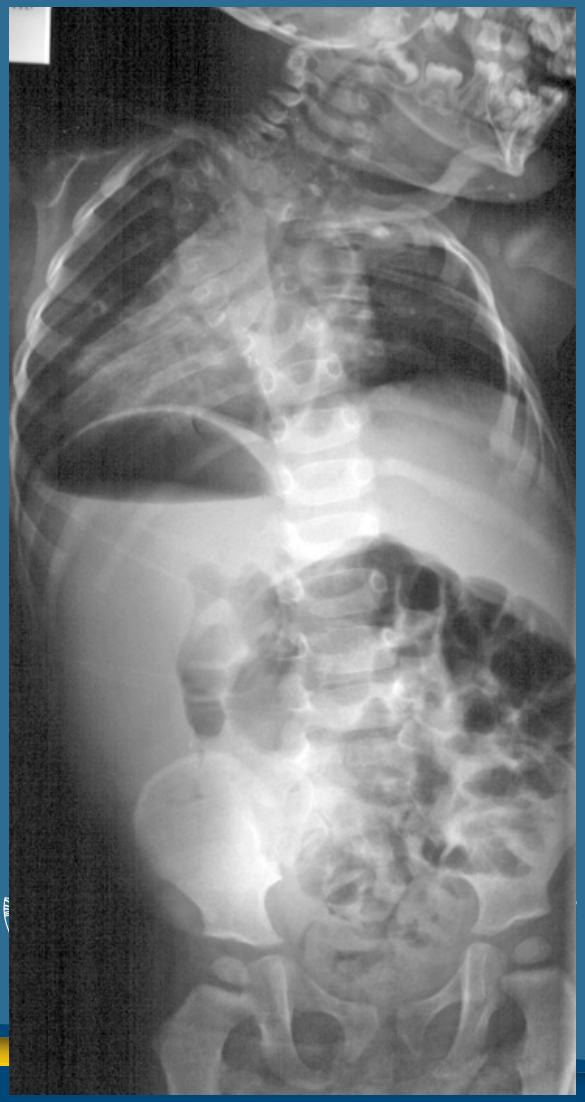
1. Fusion
2. Resection
3. Distraction over time

No role for Bracing

USC University of Southern California | Children's Hospital Los Angeles – Children's Orthopaedic Center

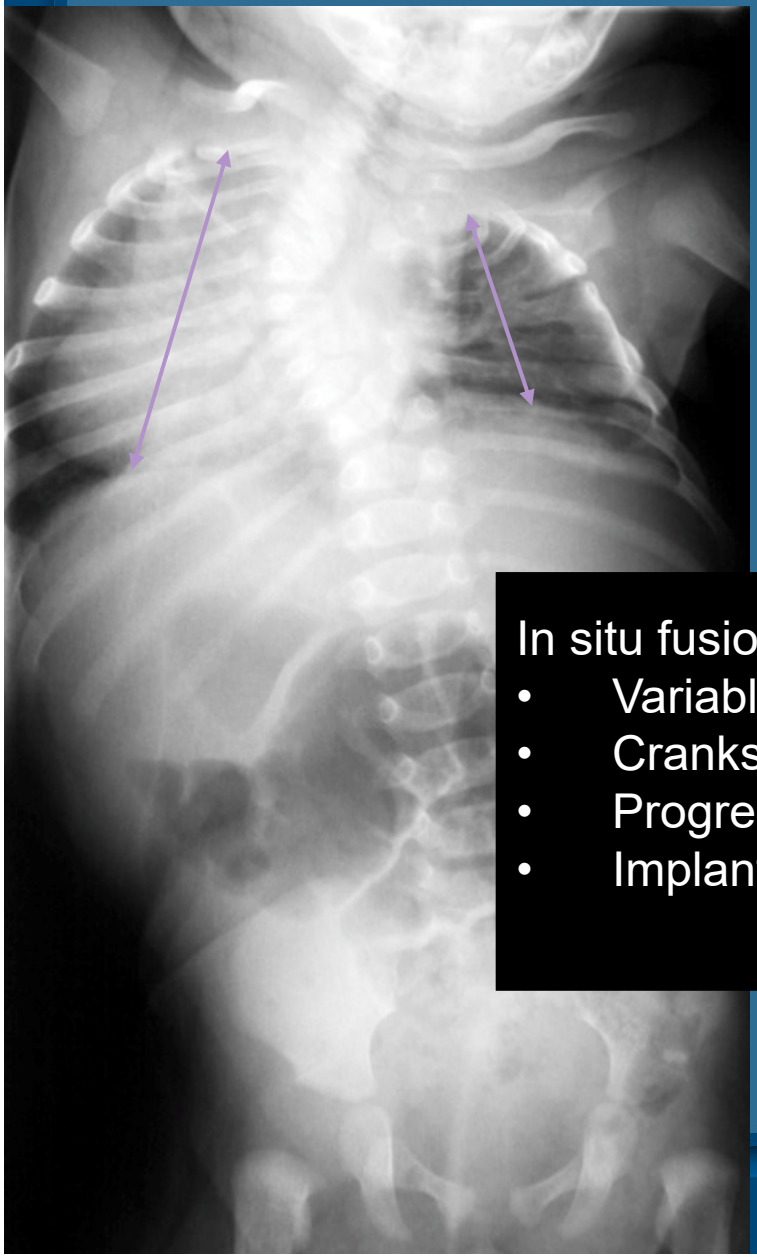
Option #1 Hemi-epiphysiodesis (Fusion)

- <5yrs
- <50 deg curve
- Posterior fusion alone
- Fuse 1/3-1/2 vertebrae
- Cant get correction from cast

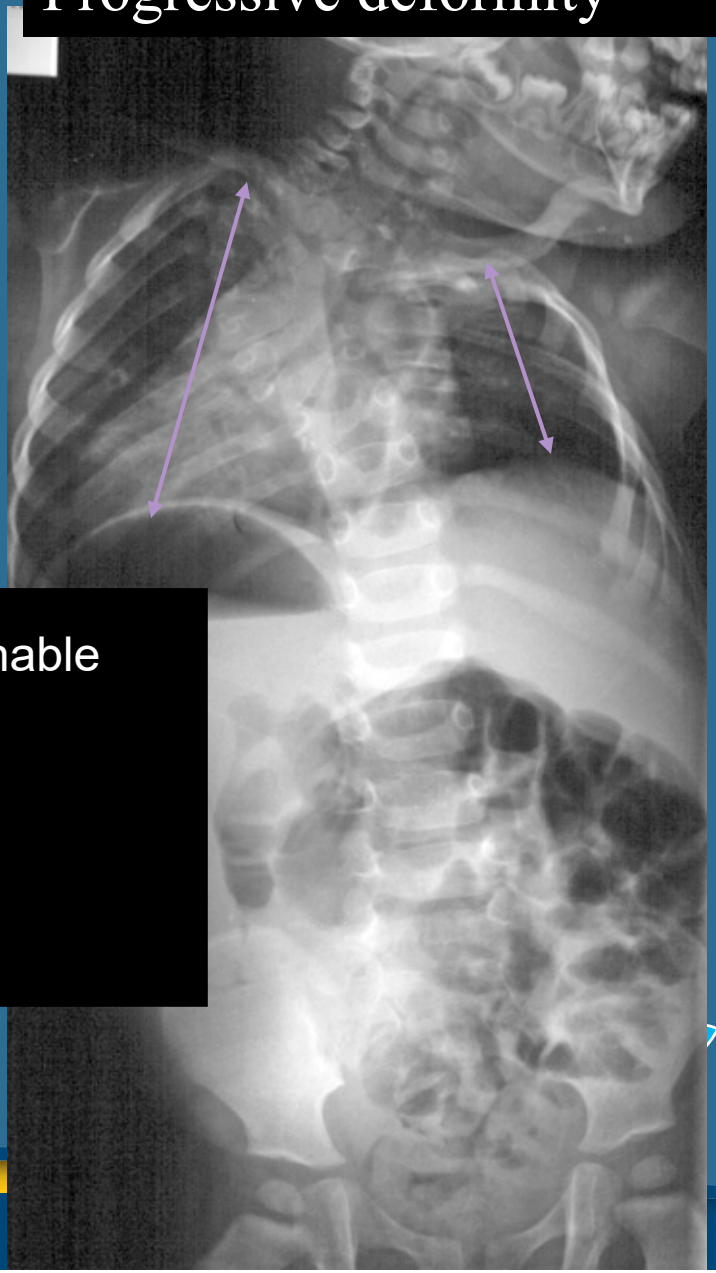


Winter

3 month old
Fused St. Elsewhere



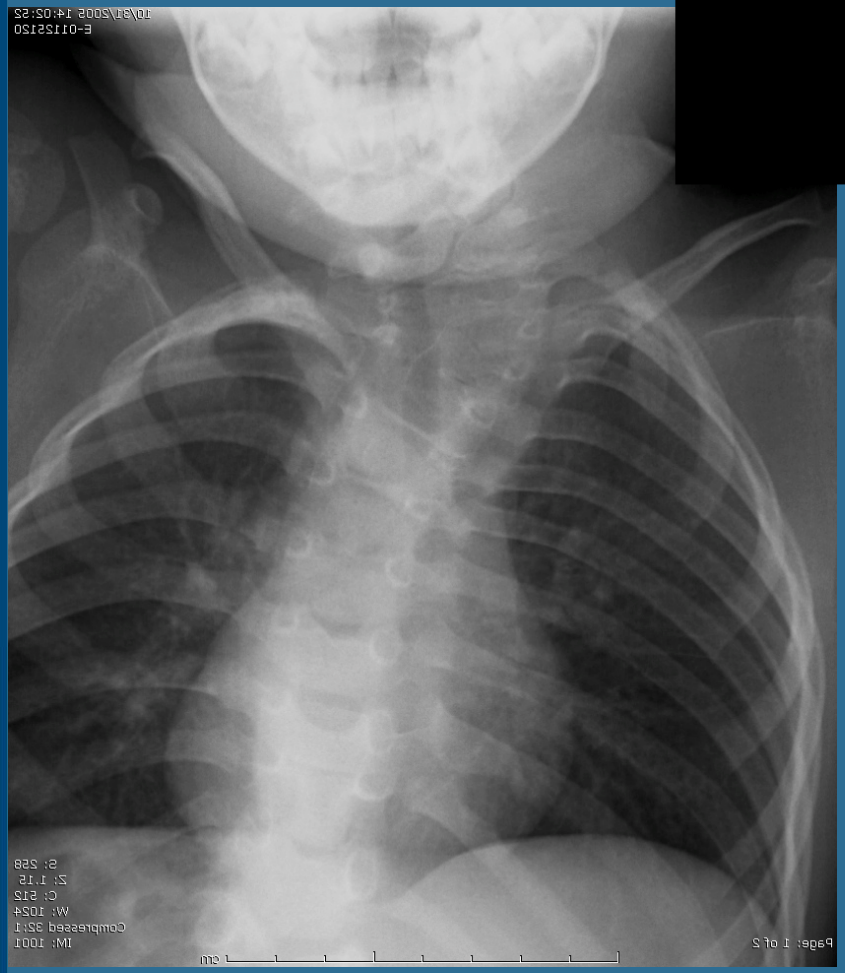
1 year after in-situ fusion
Progressive deformity



In situ fusion alone questionable

- Variable results
- Crankshaft
- Progressive
- Implants help?

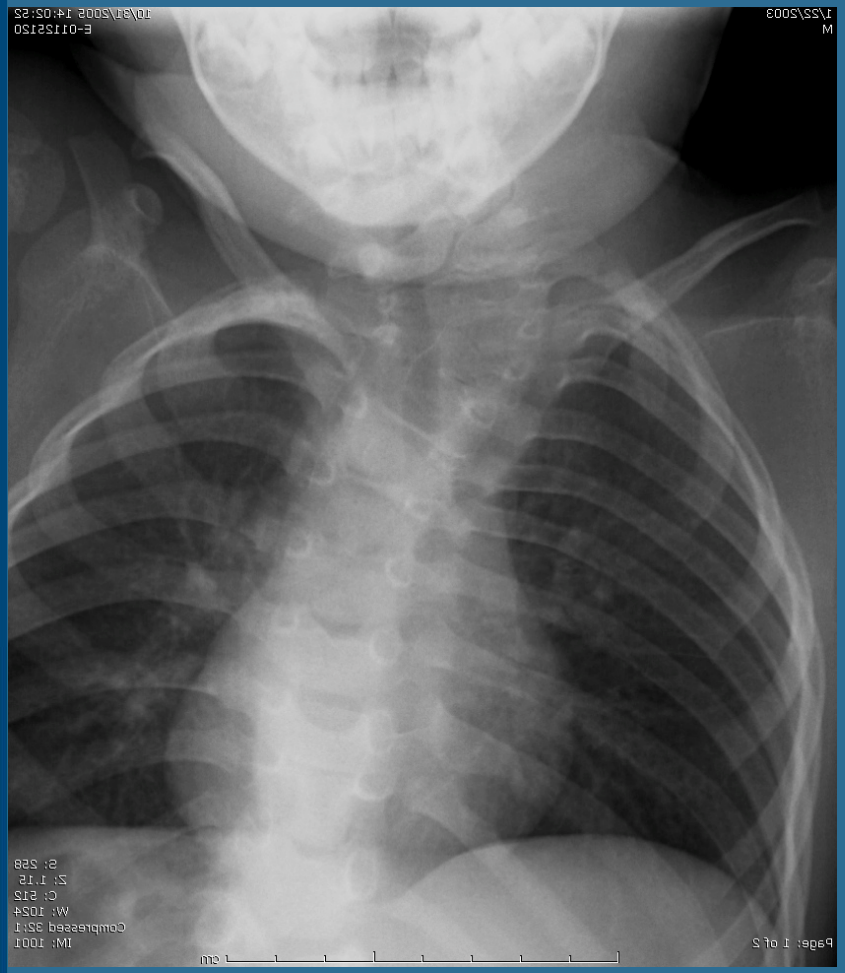
2 yo congenital scoliosis
Hemi Vertebrae Opposite Bar

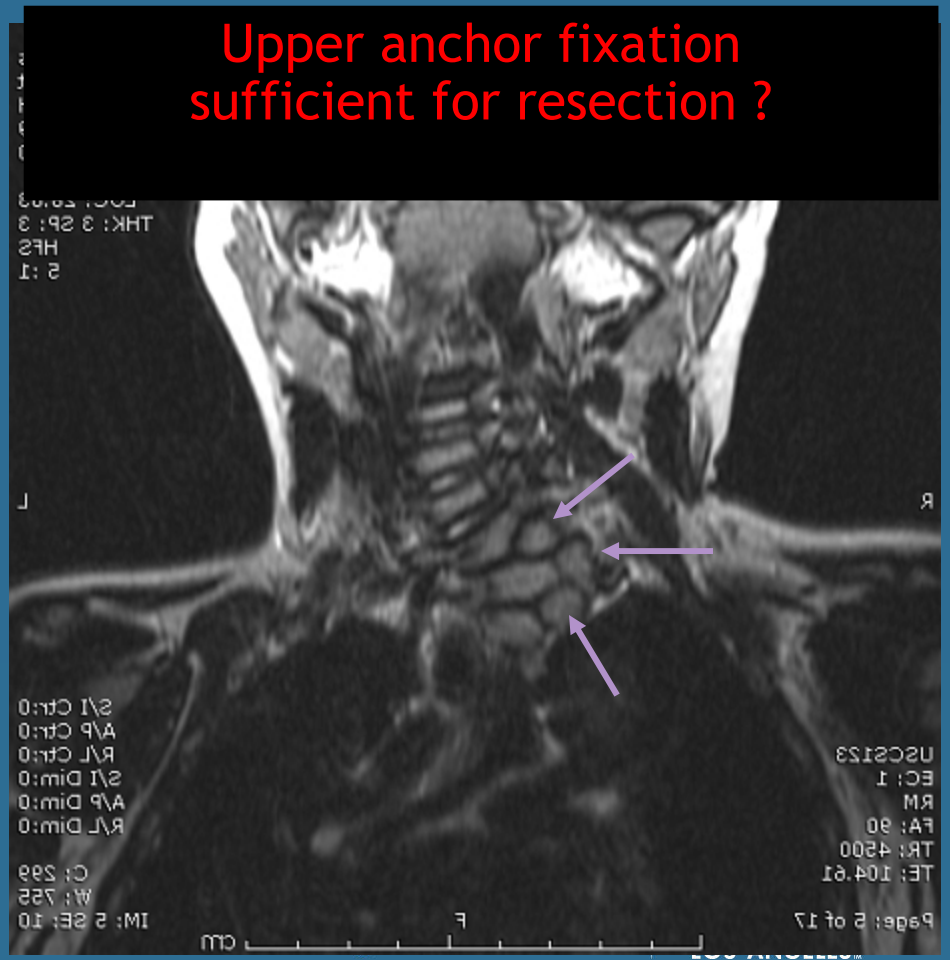


Progression likely
Multiple growthplates convexity

CHILDREN'S
ORTHOPAEDIC CENTER

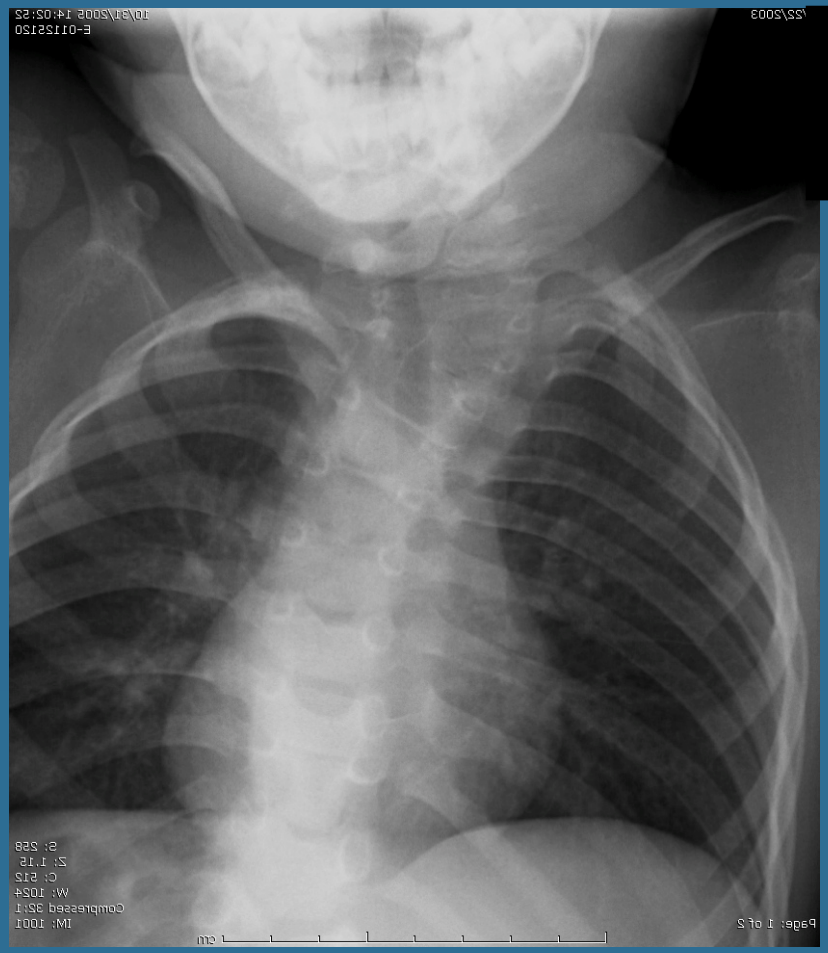
2 yo congenital scoliosis
Hemi Vertebrae Opposite Bar

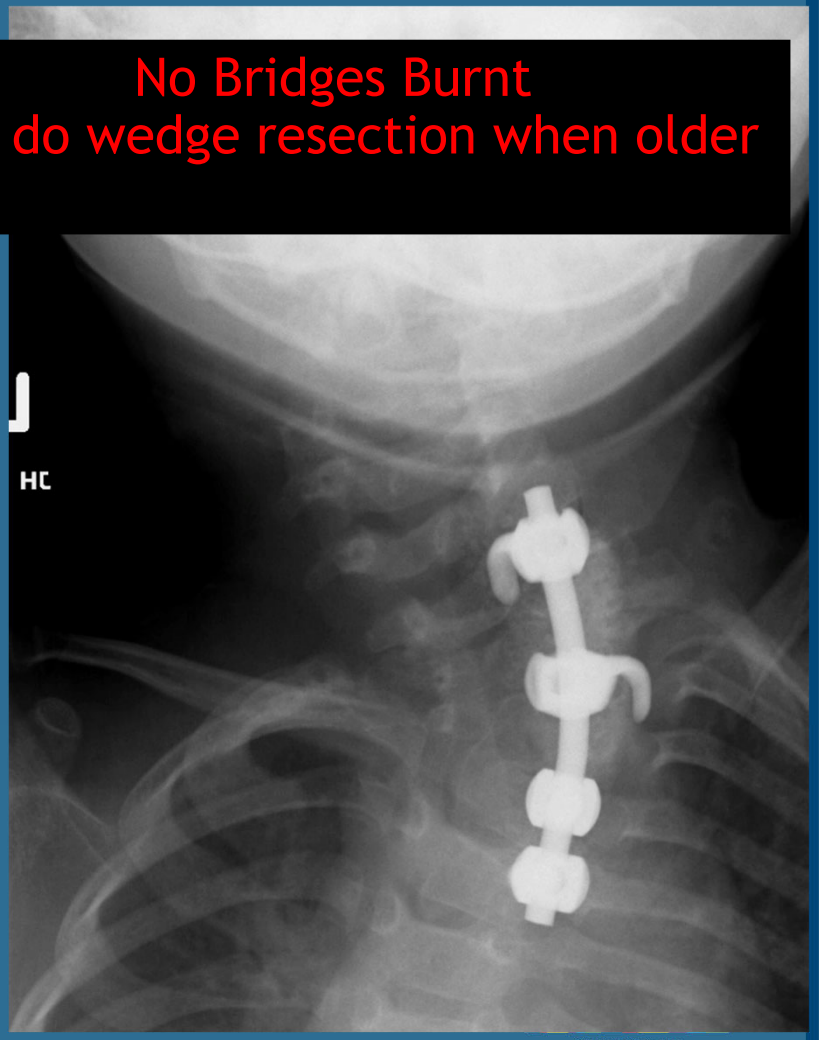




CHILDREN'S
ORTHOPAEDIC CENTER

Implants allow Some compression (correction)
Pedicle screws *may* help control anterior

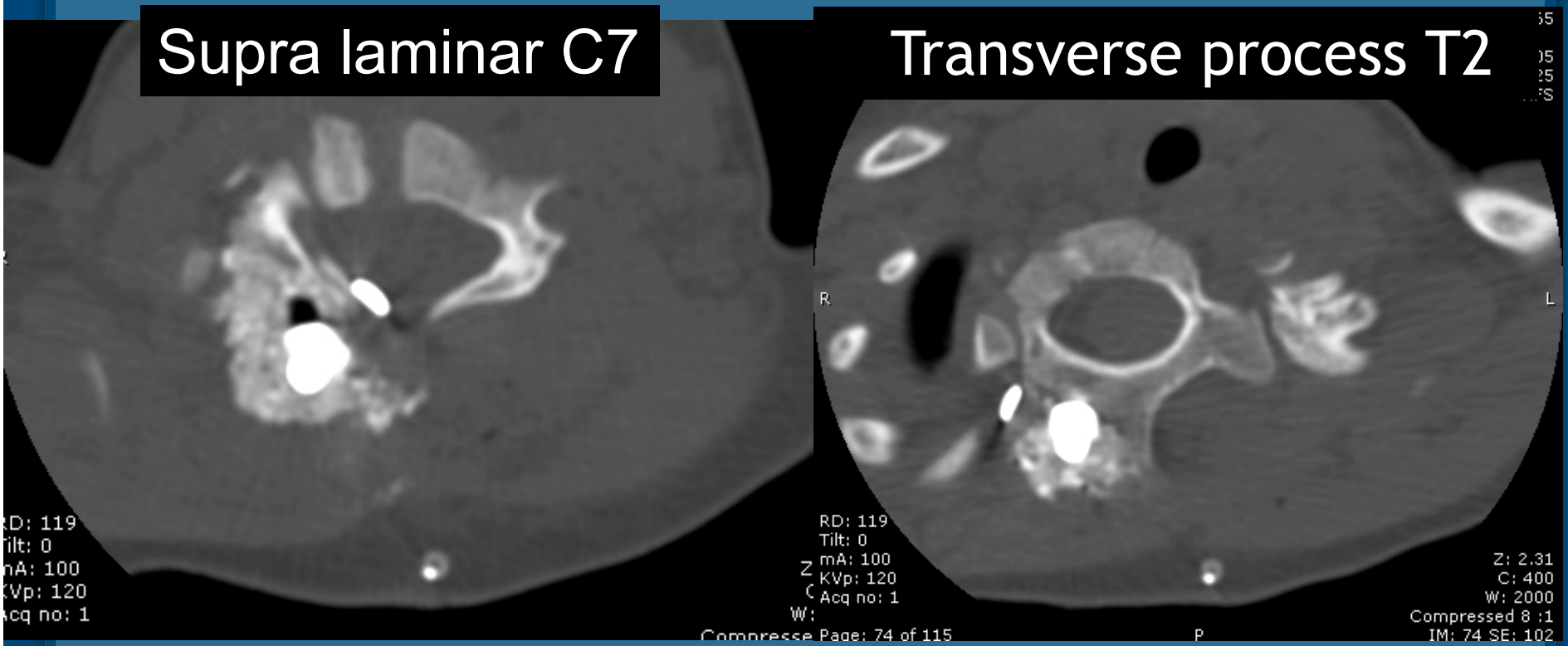




CHILDREN'S
ORTHOPAEDIC CENTER

Adult sized implants may be too big

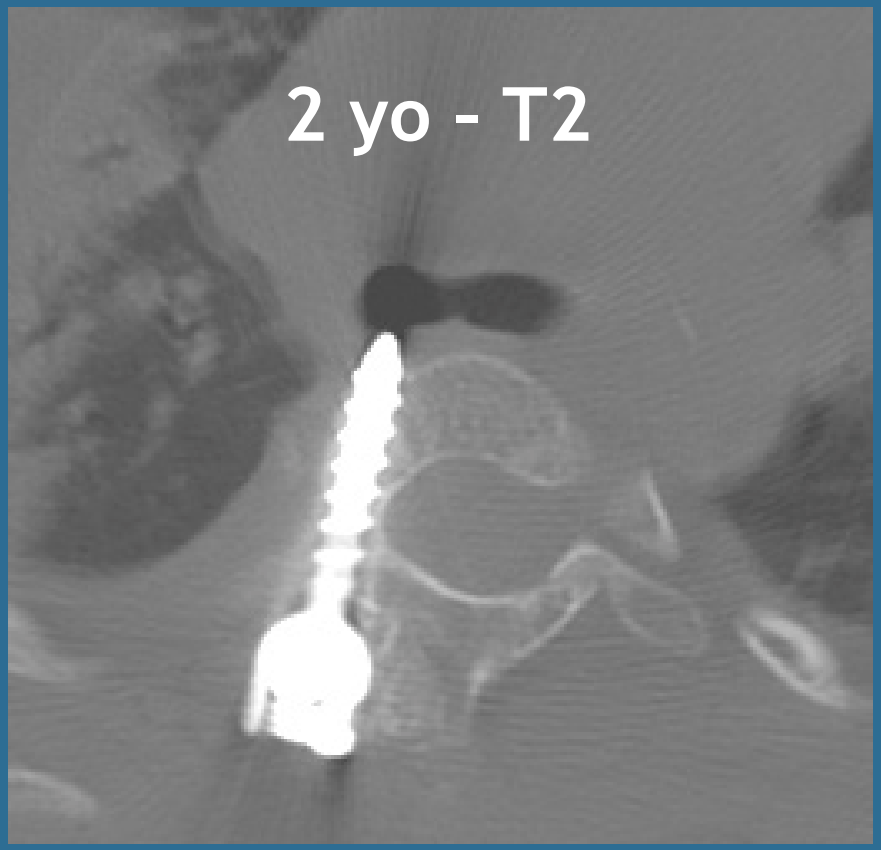
Use Downsized Implants
2 year old - 4.5 mm system

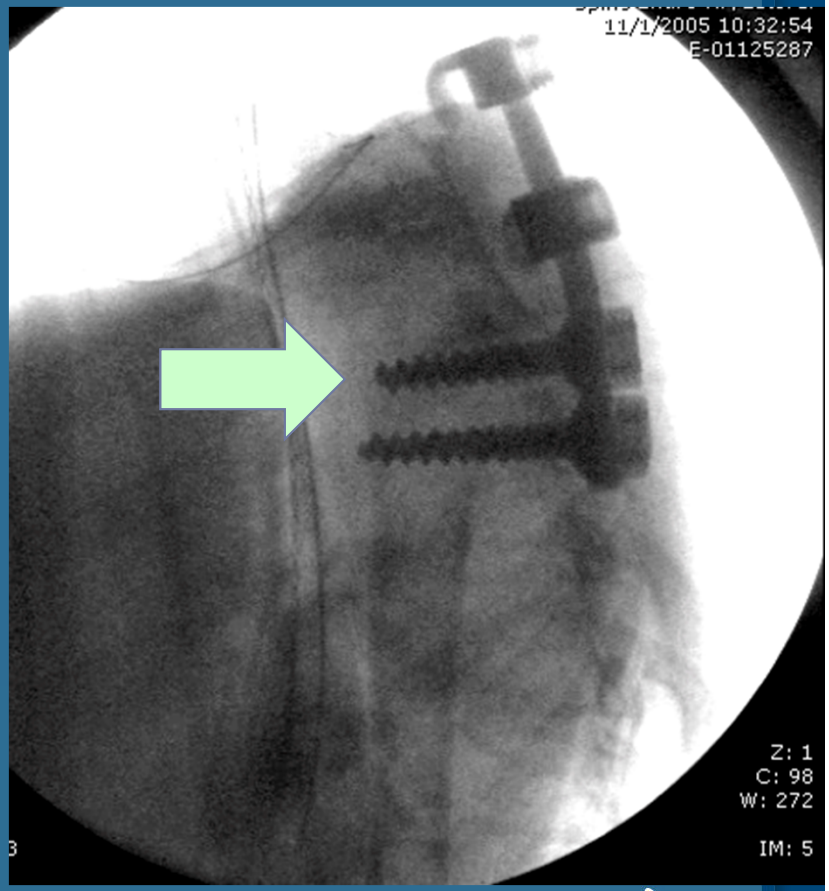


USC University of Southern California

Children's Hospital Los Angeles
CHILDREN'S ORTHOPAEDIC CENTER

If Pedicle Screws to Long Cut them Shorter



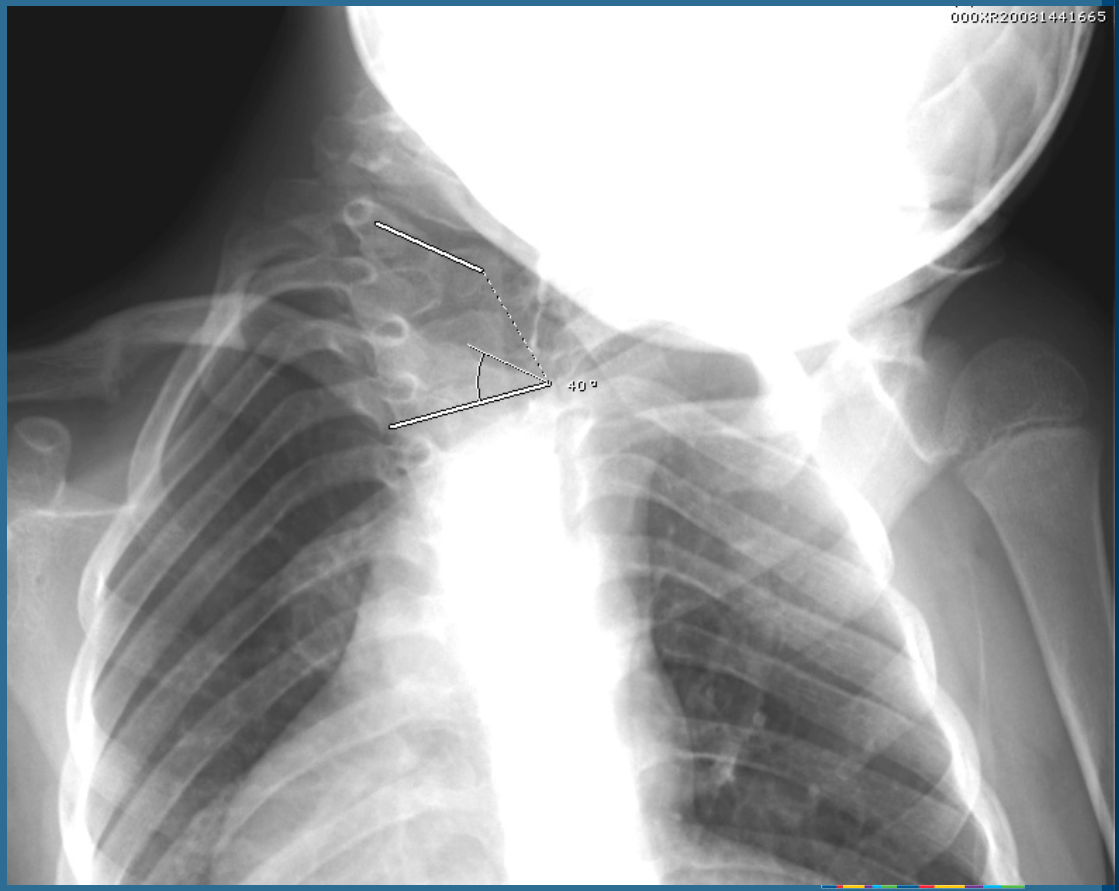


USC University of Southern California

Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER

Option #2 Resection and Fusion

7yo 40°



CHILDREN'S
ORTHOPAEDIC CENTER

Anterior Exposure of the Cervicothoracic Spine using a Combined Cervical and Thoracic Approach

BY LYLE J. MICHELI, M.D.*, AND ROGER W. HOOD, M.D.*, BOSTON, MASSACHUSETTS

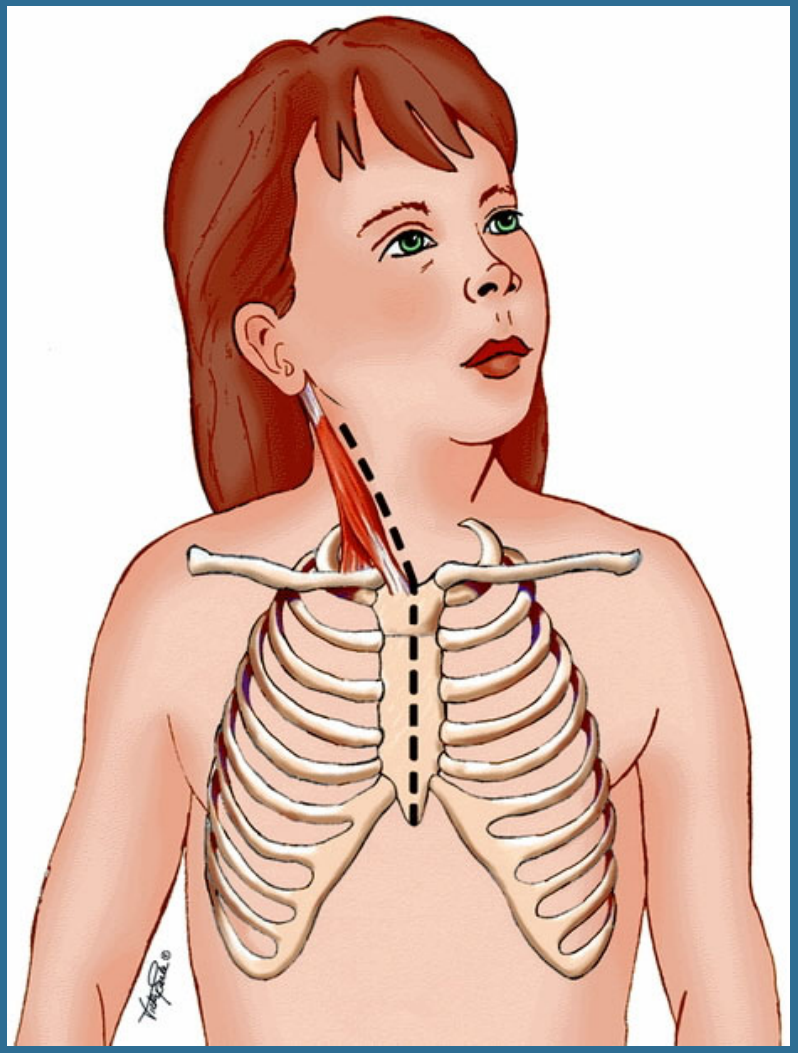
From the Department of Orthopaedic Surgery, Children's Hospital Medical Center, Boston

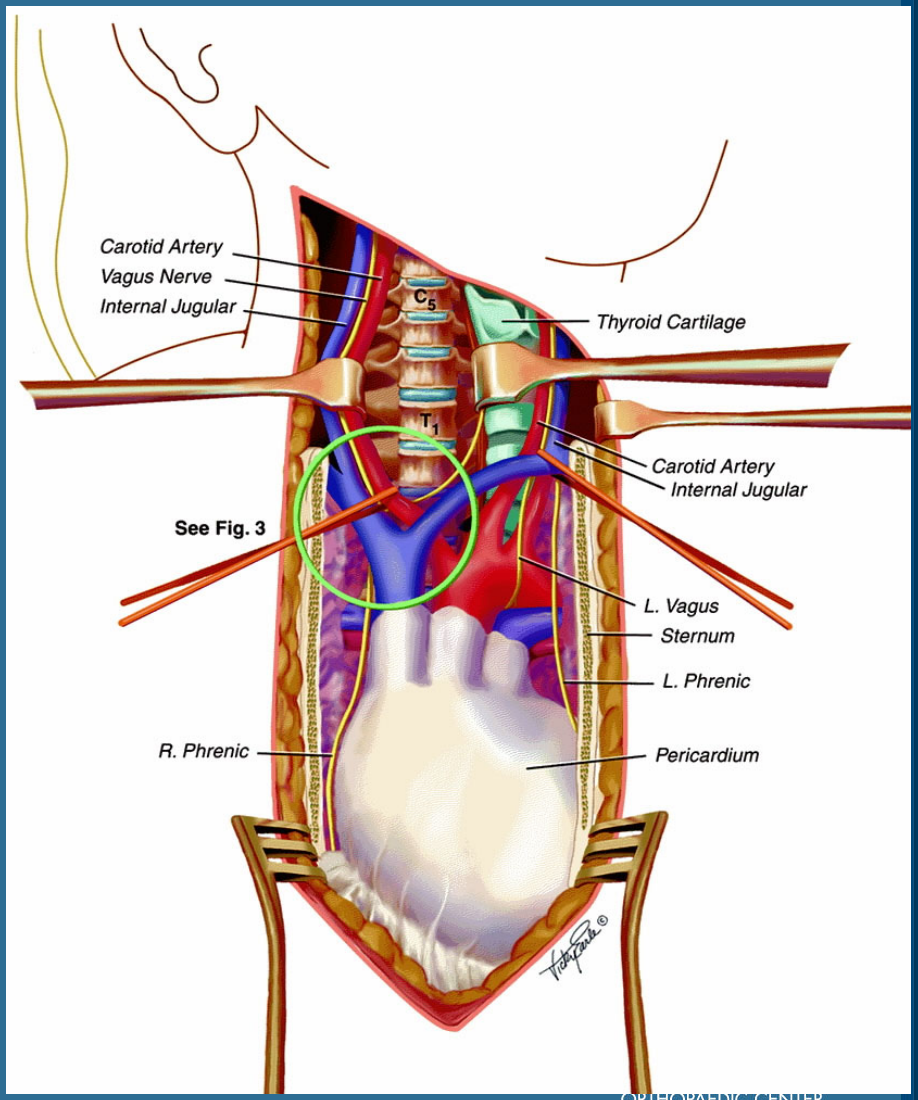
FIG. 2

sity of
alifornia

Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER

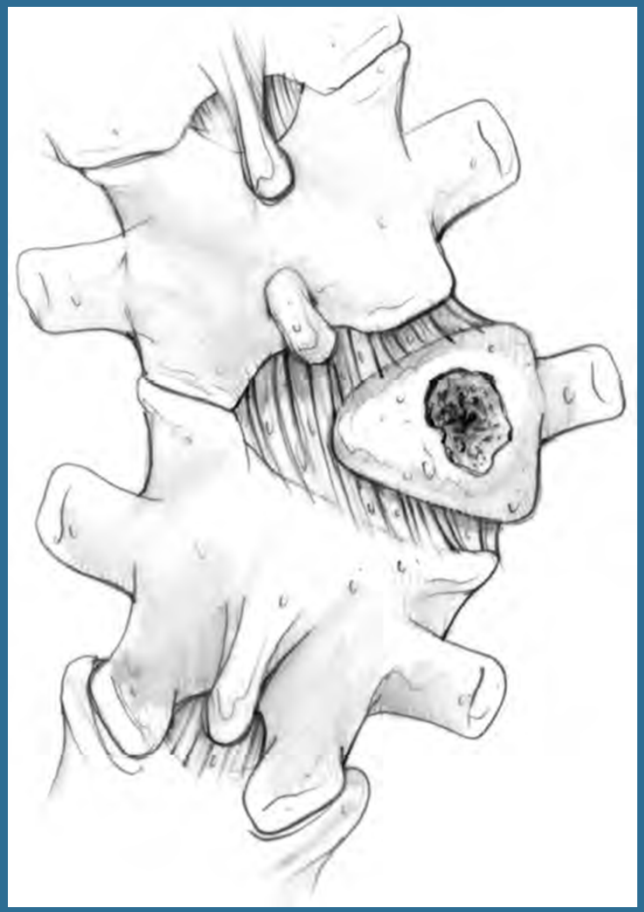
Sternal Split

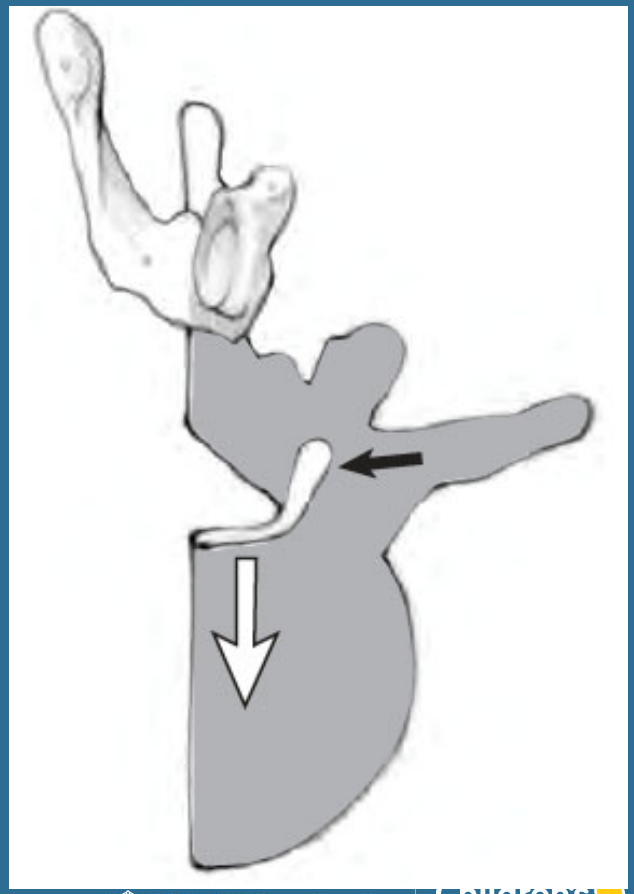




[redacted]

I Prefer All Posterior Resection



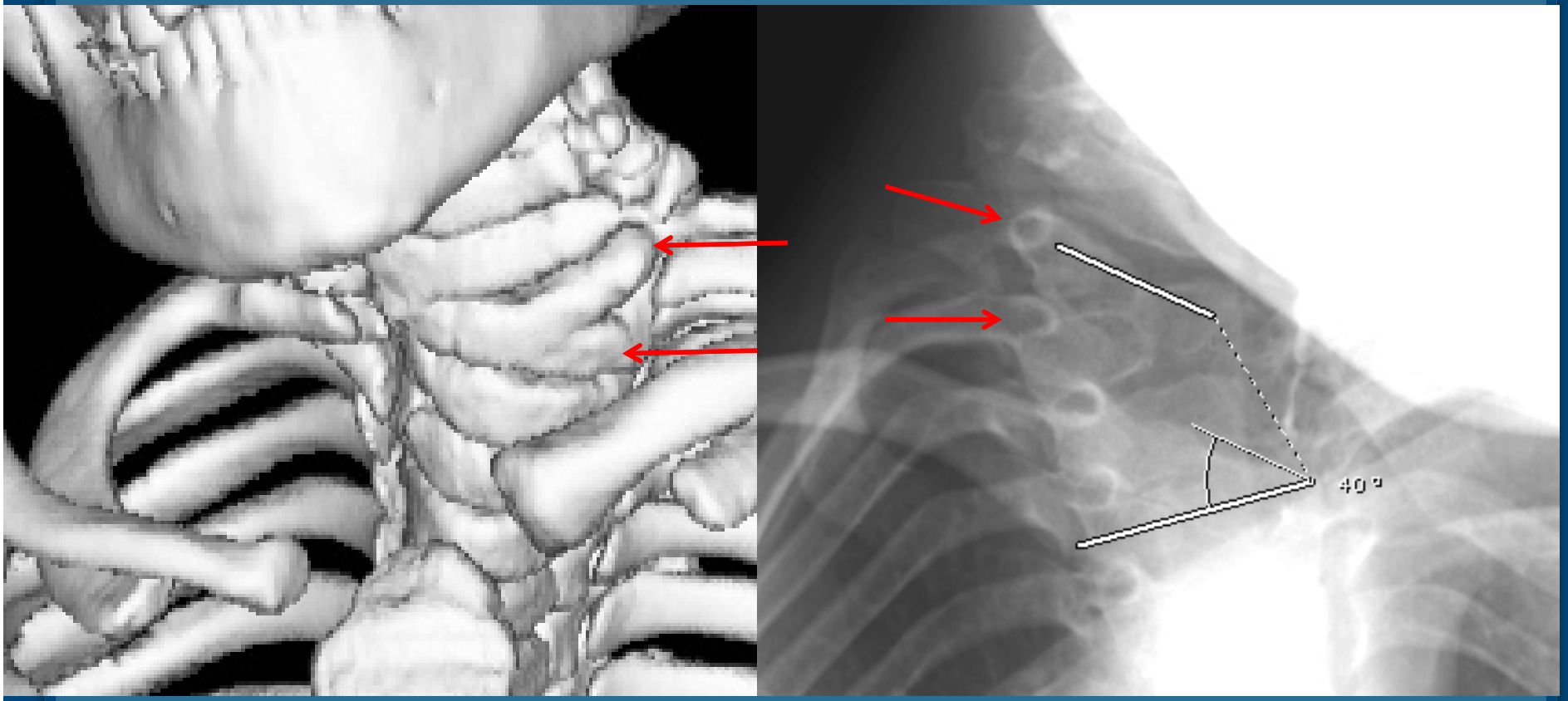


USC University of Southern California

Children's Hospital Los Angeles

CHILDREN'S ORTHOPAEDIC CENTER

Pre-Op Hemivertebrae 40º

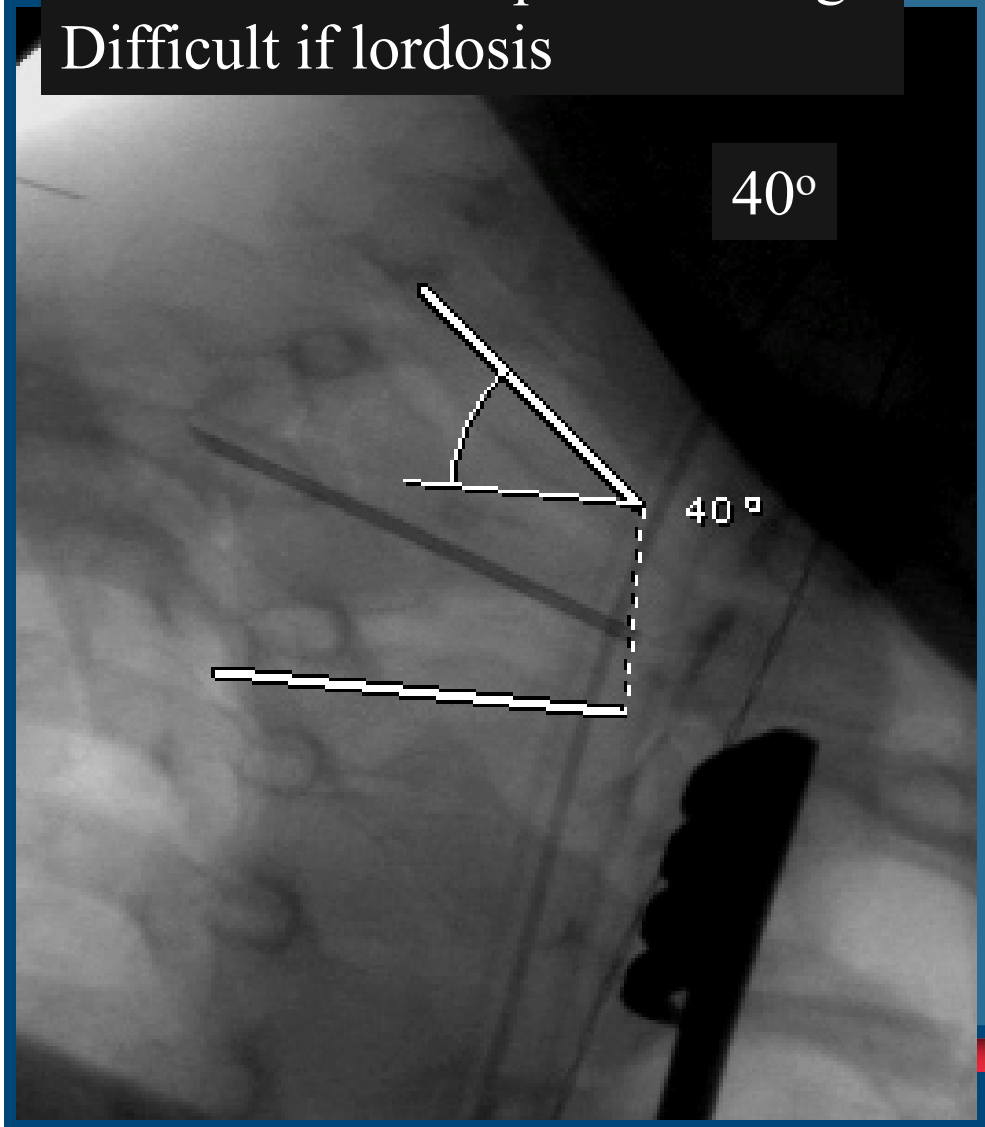


USC University of Southern California

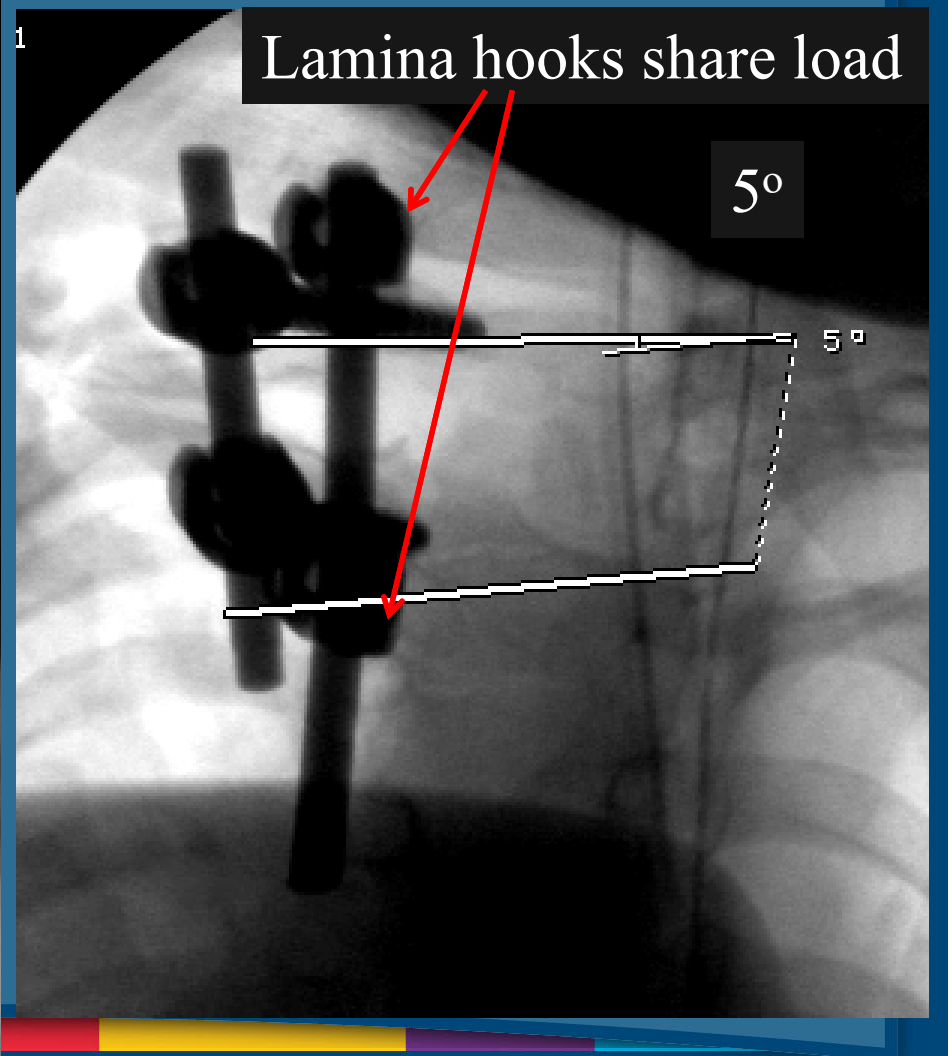
Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER

1.75 unilateral vertebral resection

Hooks on ribs help close wedge
Difficult if lordosis

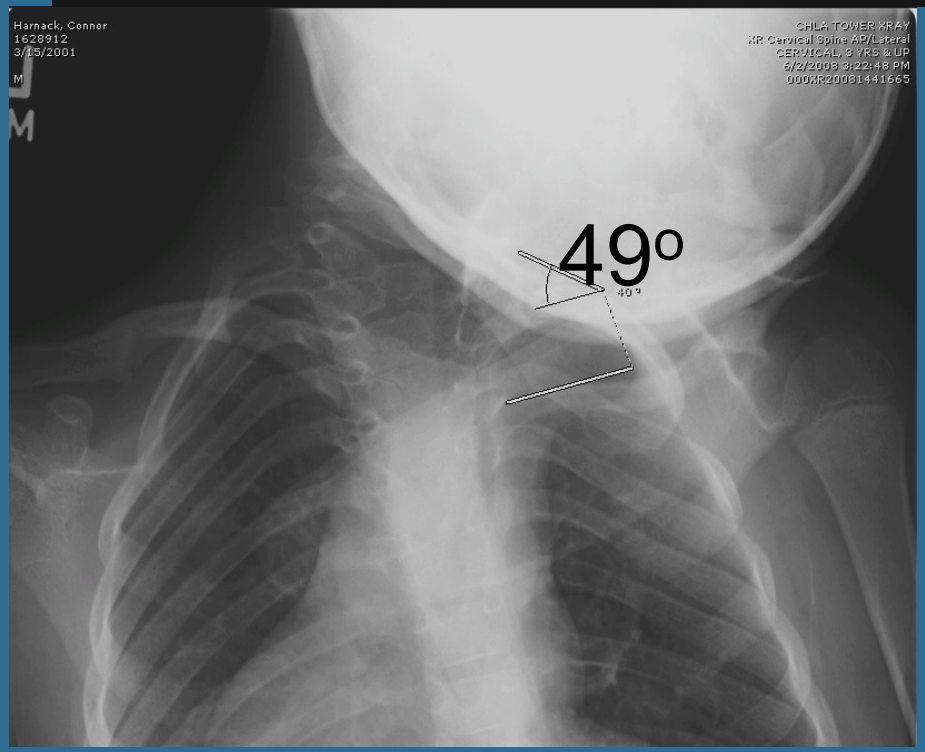


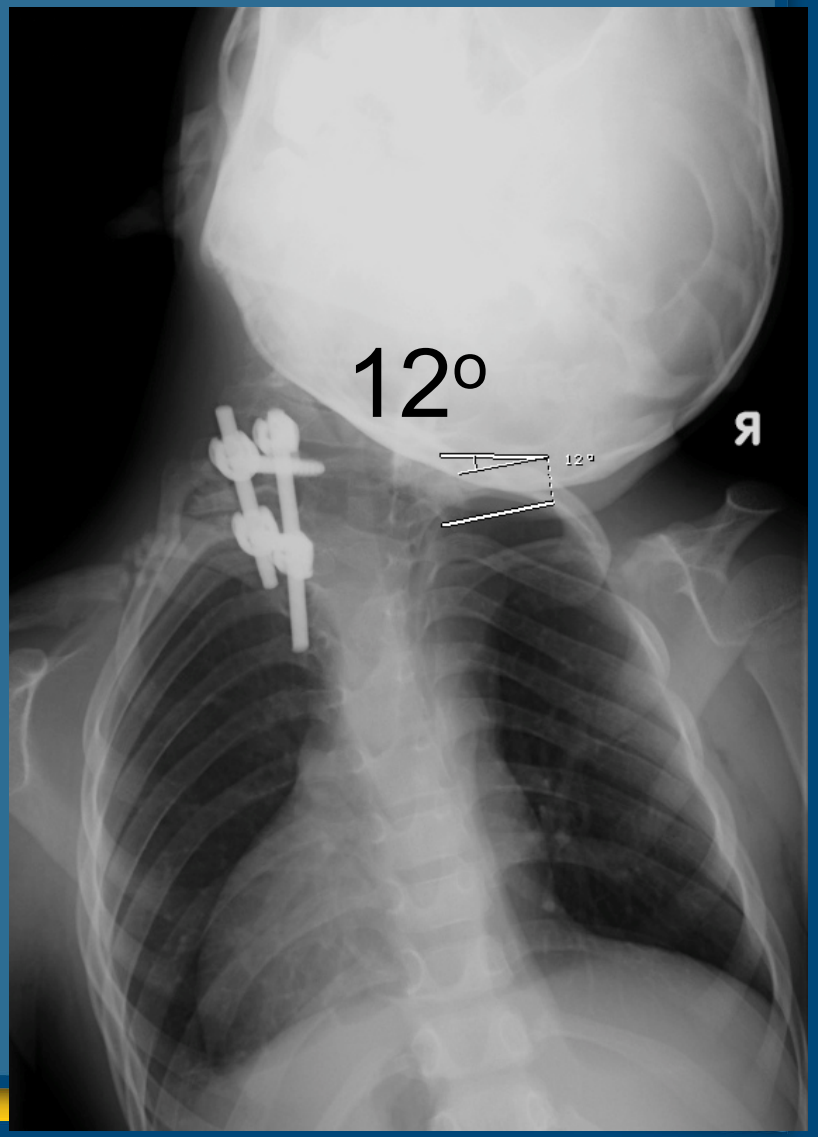
Lamina hooks share load



If can fix in one surgery safely - first choice

Challenges:
Strong Enough Bone for Anchors
Protect with Halo

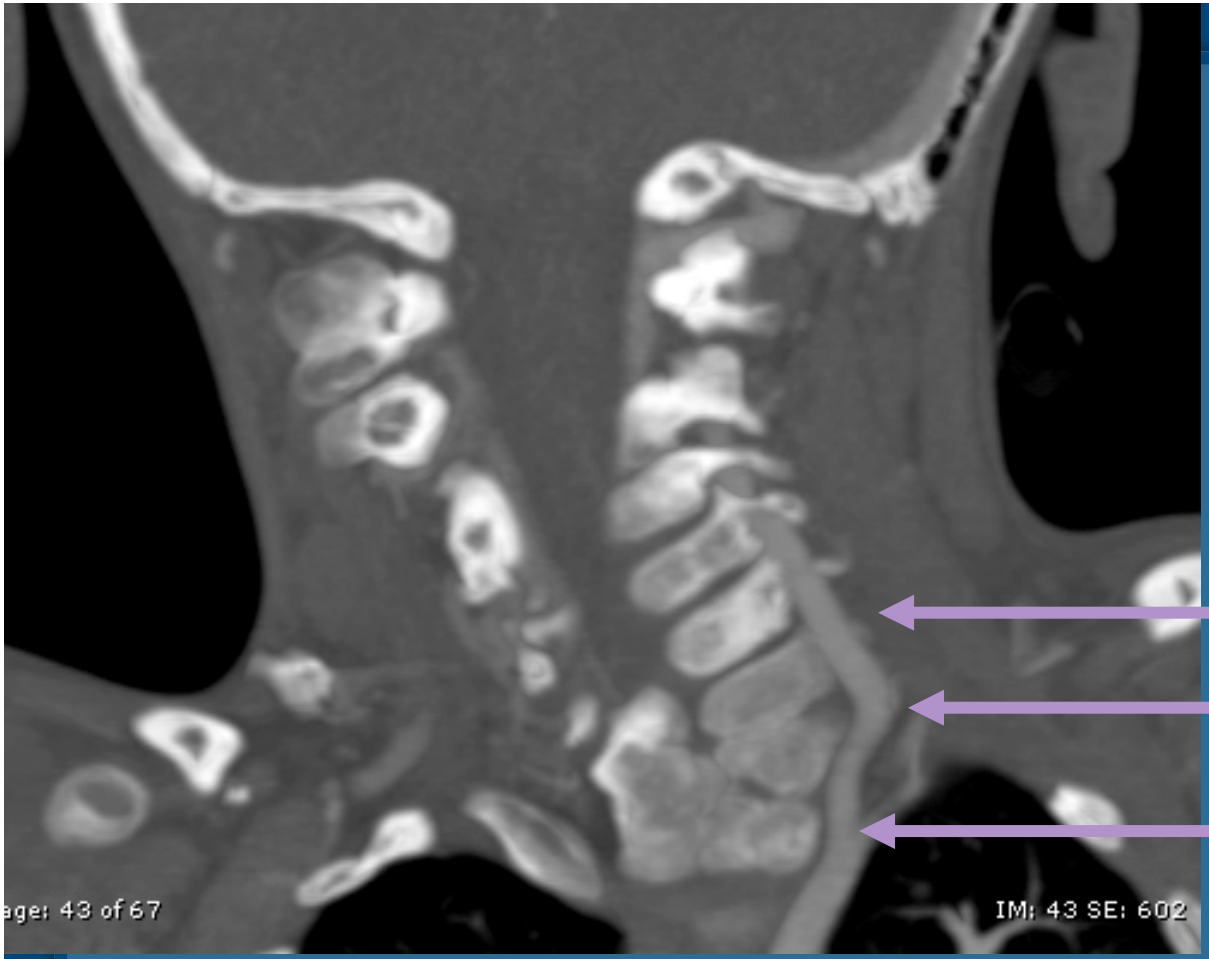




Halo Vest Useful

University of Southern California

Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER



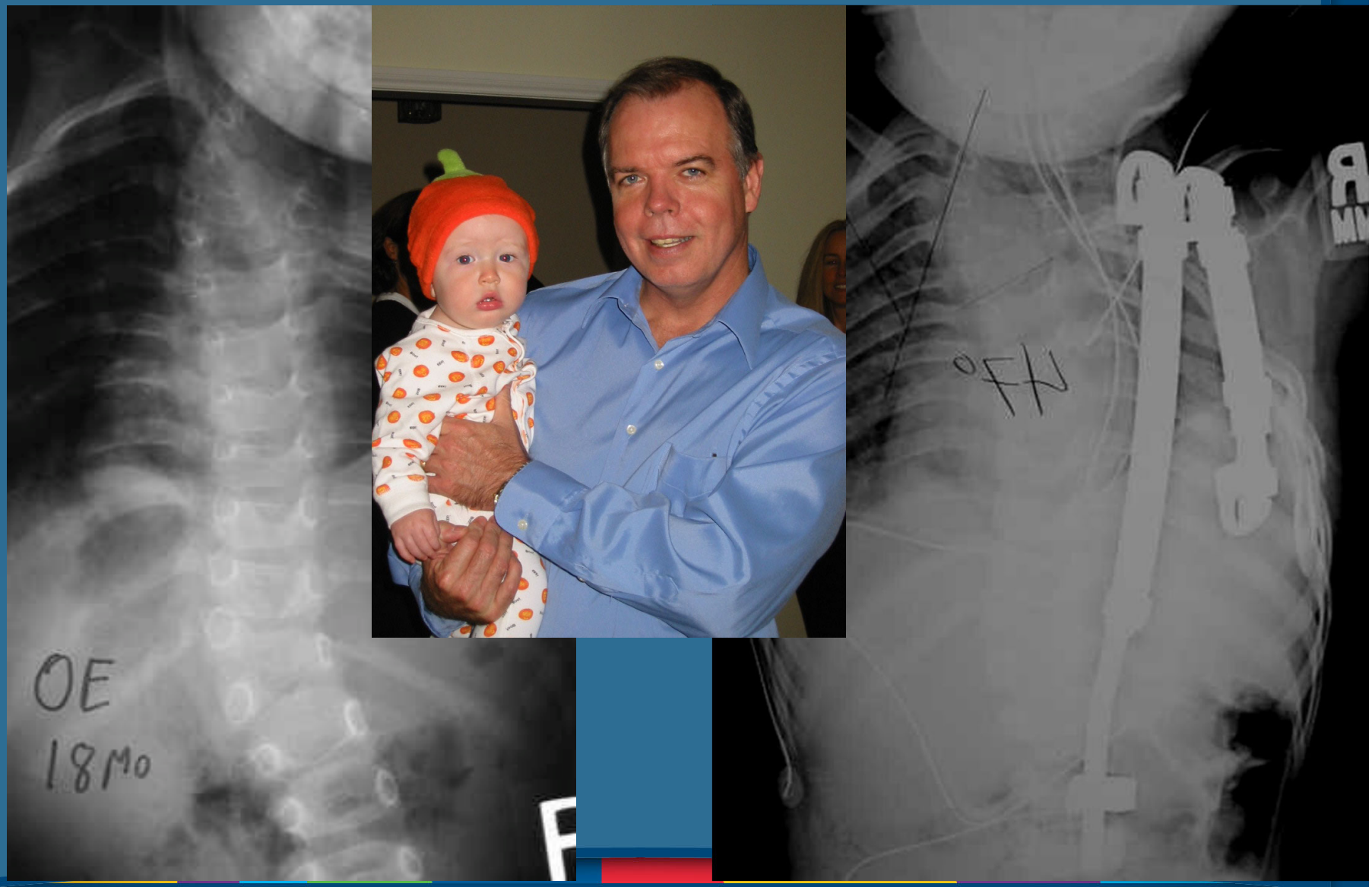
Pre-OP
CT Angio

? Single
Vertebral Artery

USC University of Southern California

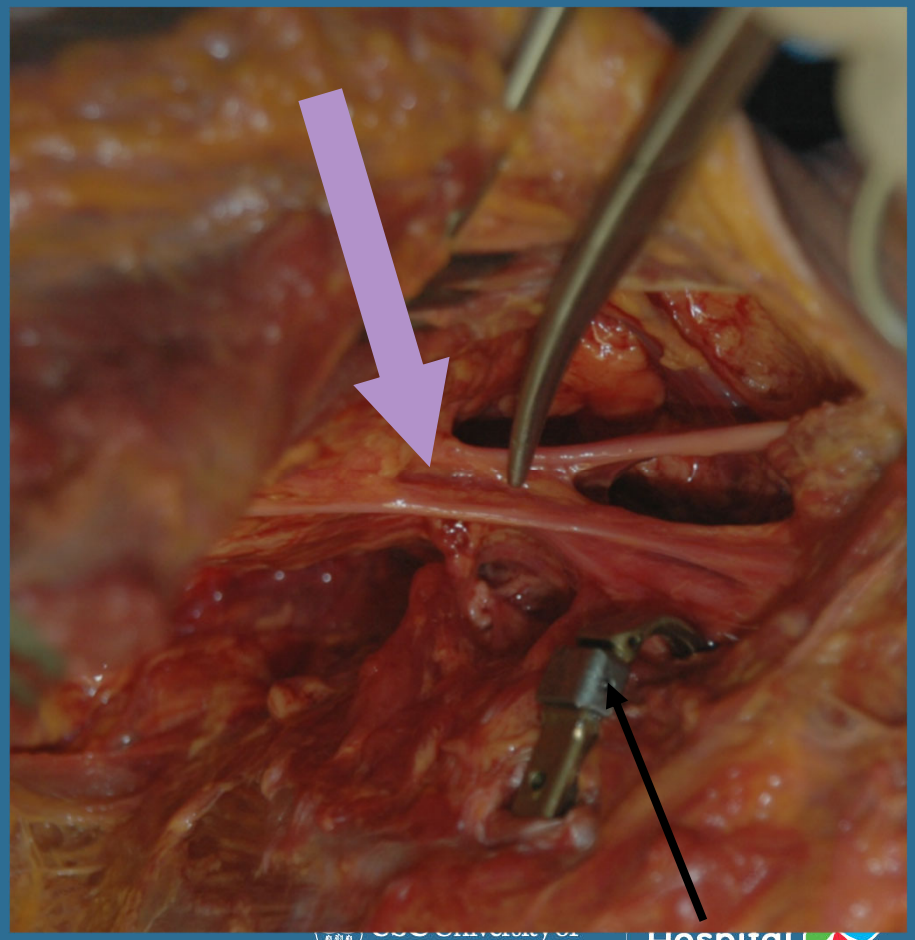
Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER

Option #3 Distraction Over Time
"Last" option

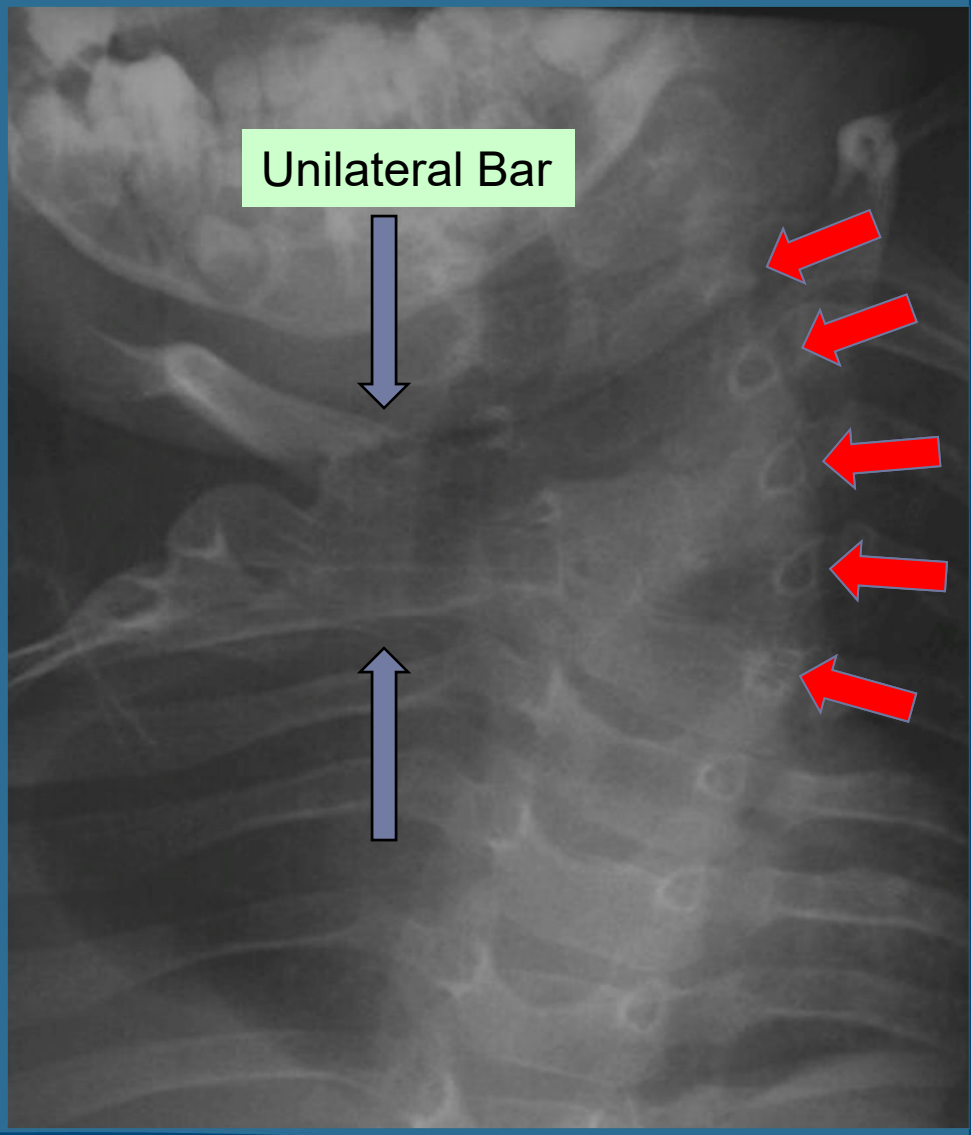


Brachial Plexus Palsy Injuries

- First rib adjacent to brachial plexus
- Avoid Solitary First Rib
- Monitor:
  - Pulse
  - SSEP, MEP



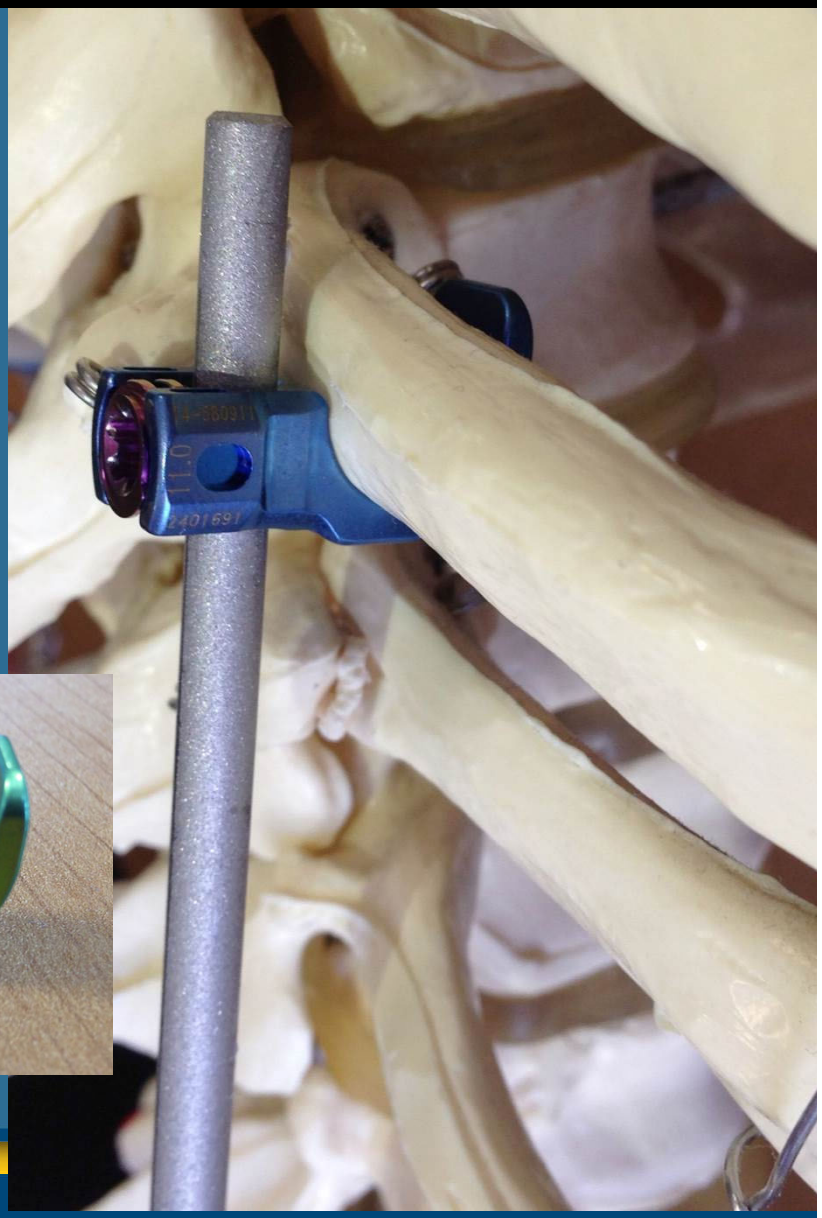
First Rib Stout – OK to distract against



Midline Incision - Plan for final fusion

- No Dissection of Proximal Spine
- Split muscles just lateral to TP

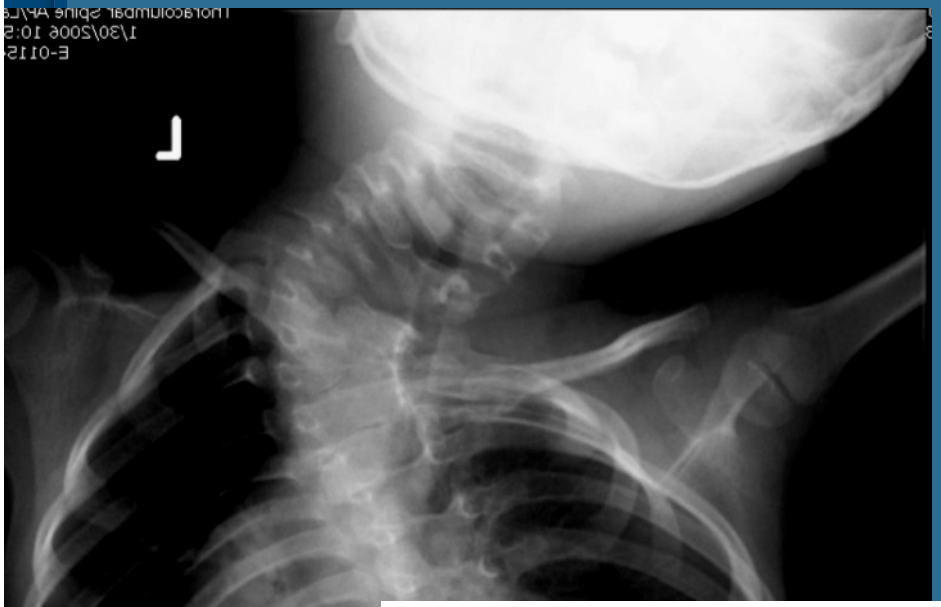
Adjacent to TP

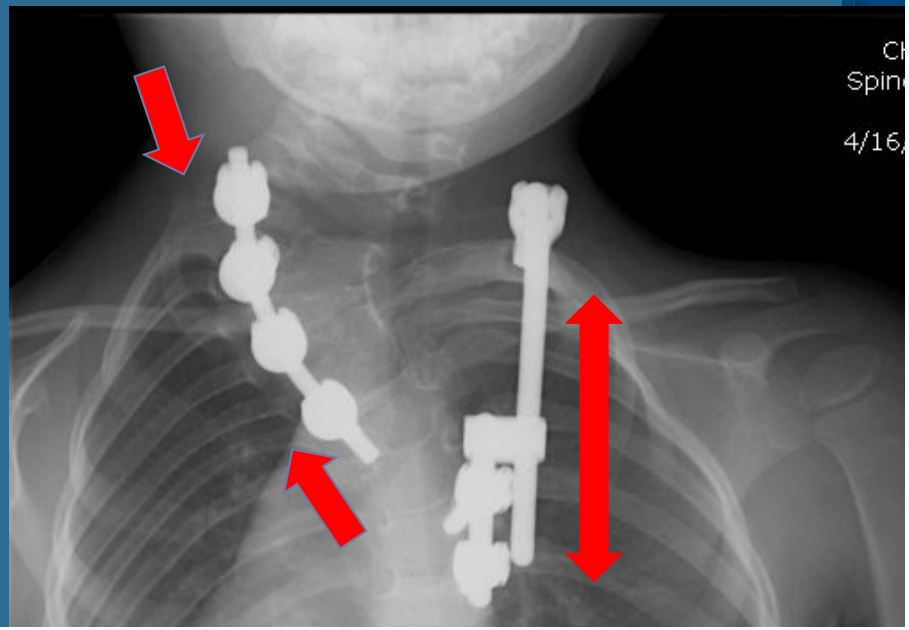


Current Preference:
Hemiepiphsiodesis + Distraction over time

Stop Bad Growth

Encourage Good Growth





Congenital Cervicothoracic Scoliosis Treated wit Hemiepiphysiodesis and Placement of Distraction-Based Instrumentation

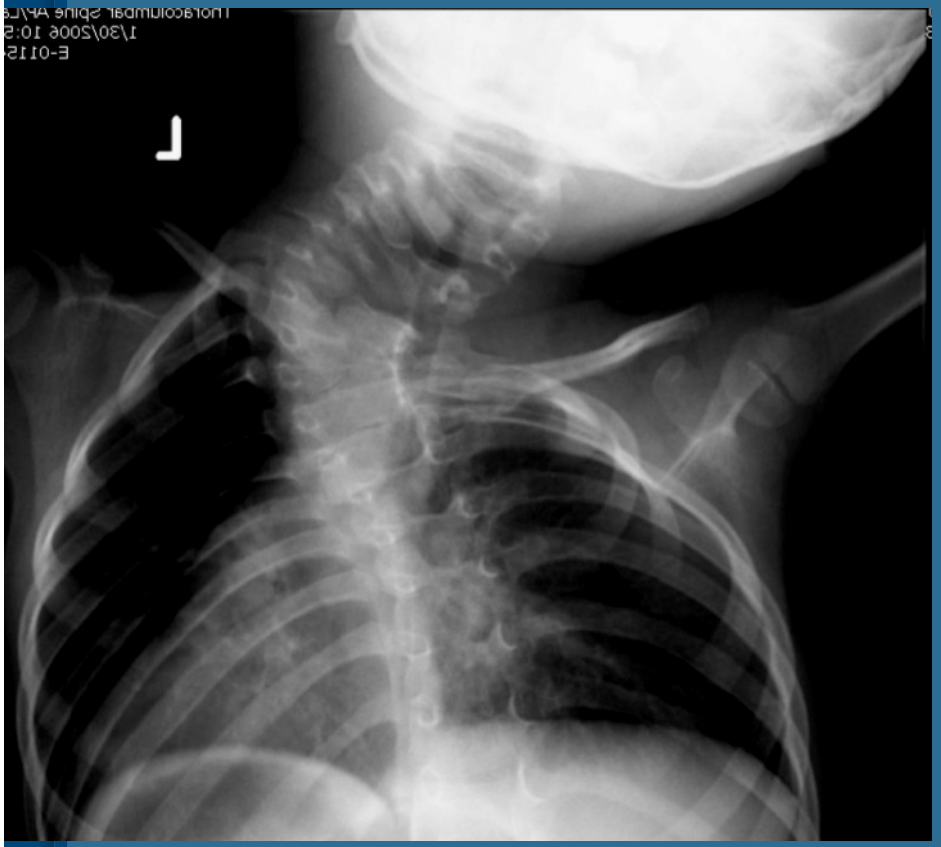
JBJS, 2013

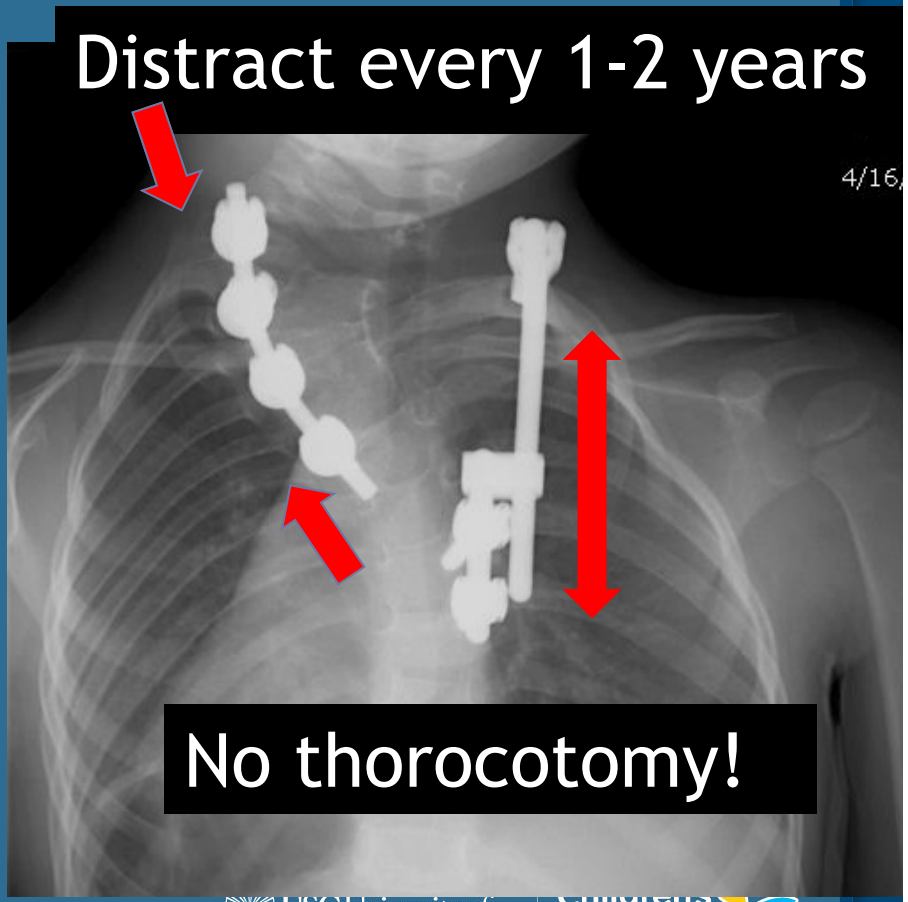
A Case Report

Lindsay Andras, MD, Rachel Tobin, and David L. Skaggs, MD

Investigation performed at Children's Orthopaedic Center, Children's Hospital Los Angeles, Los Angeles, California

Hemiepiphsiodesis + Distraction over time





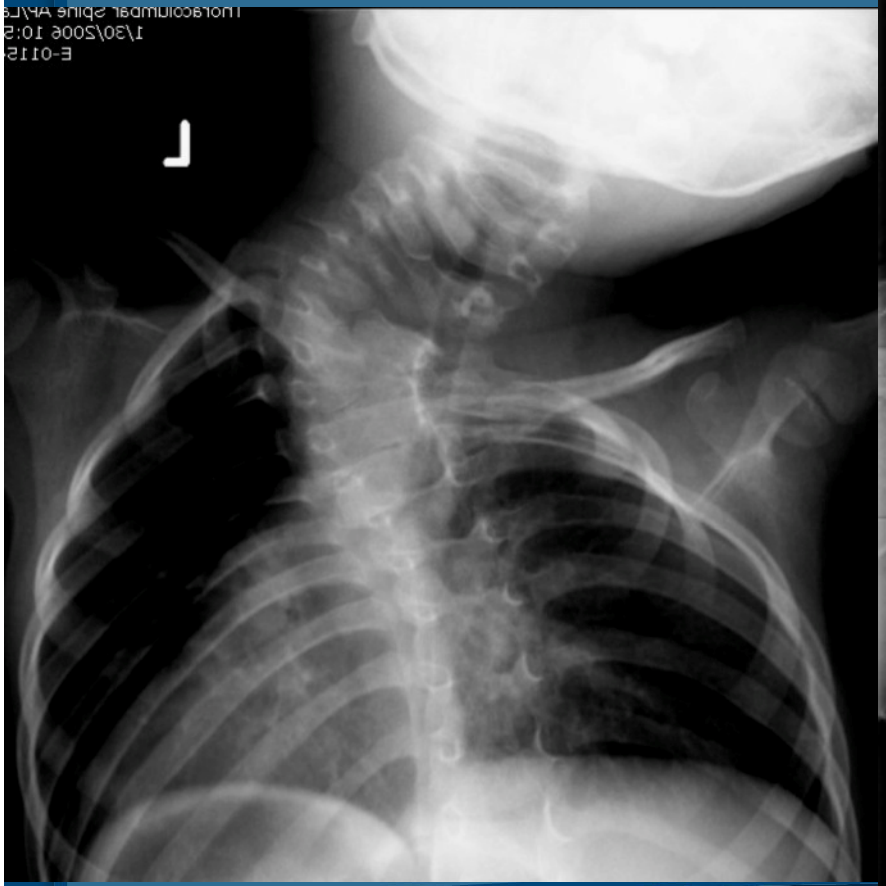
USC University of Southern California

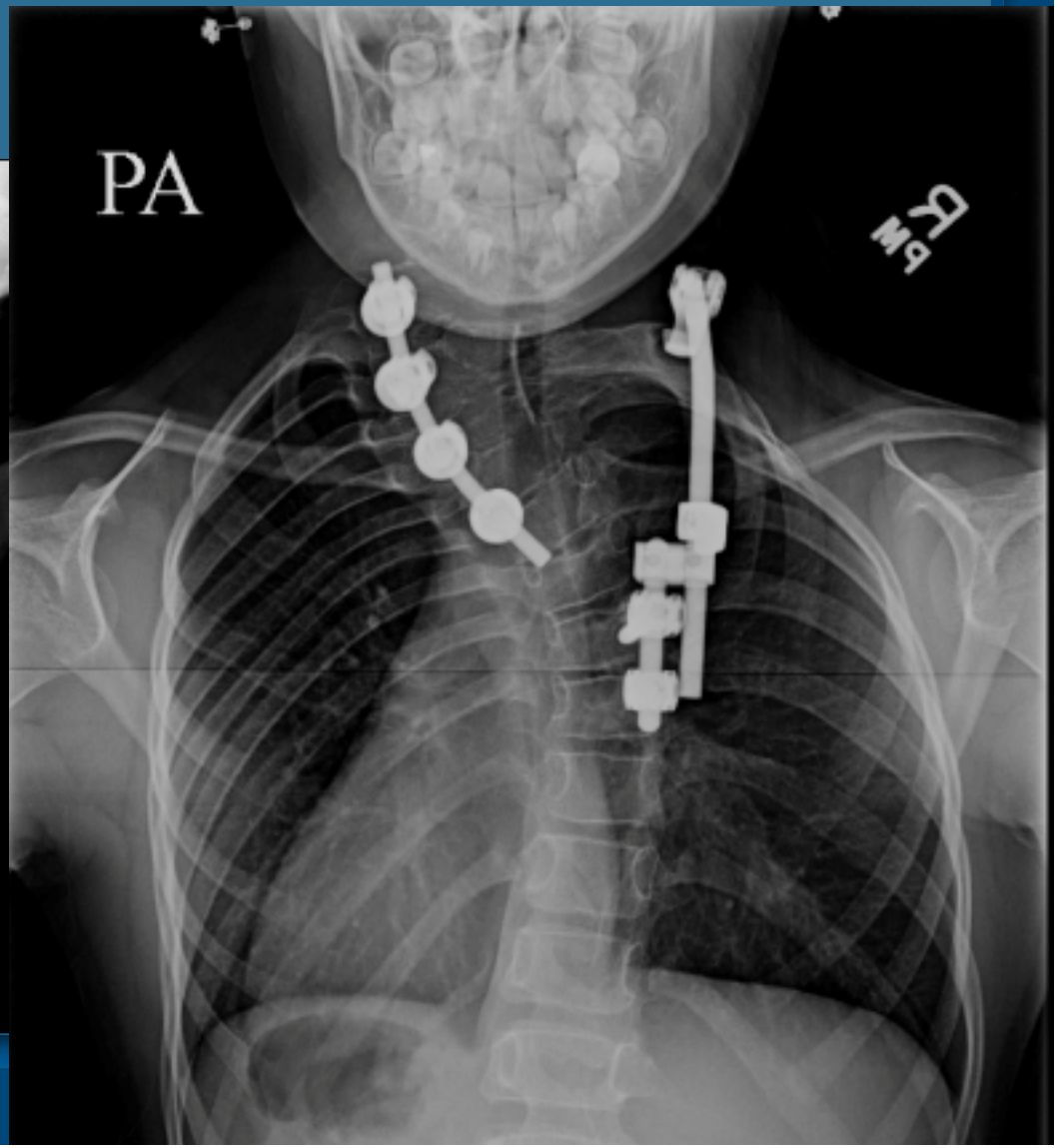
Children's Hospital Los Angeles

CHILDREN'S ORTHOPAEDIC CENTER

Pre-op

7 years post-op





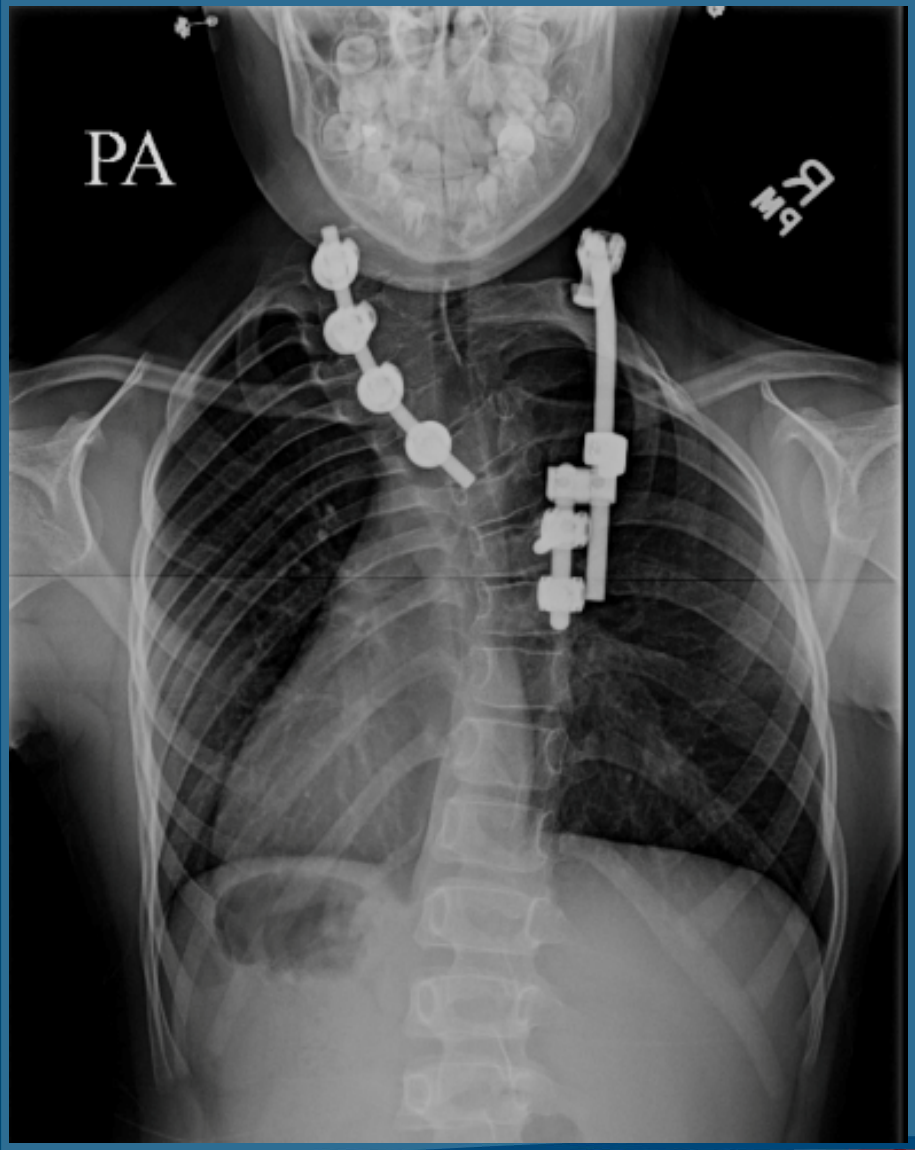
3yo
Pre-op

5 yo

9 yo

ORTHOPAEDIC CENTER

9 yo



Complications of Distracting on Ribs

USC University of Southern California

Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER

Lengthening complication

- Monitoring normal intra-op

USC University of Southern California

Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER

Arm pain post op when arm at side

- Monitoring normal intra-op

USC University of Southern California

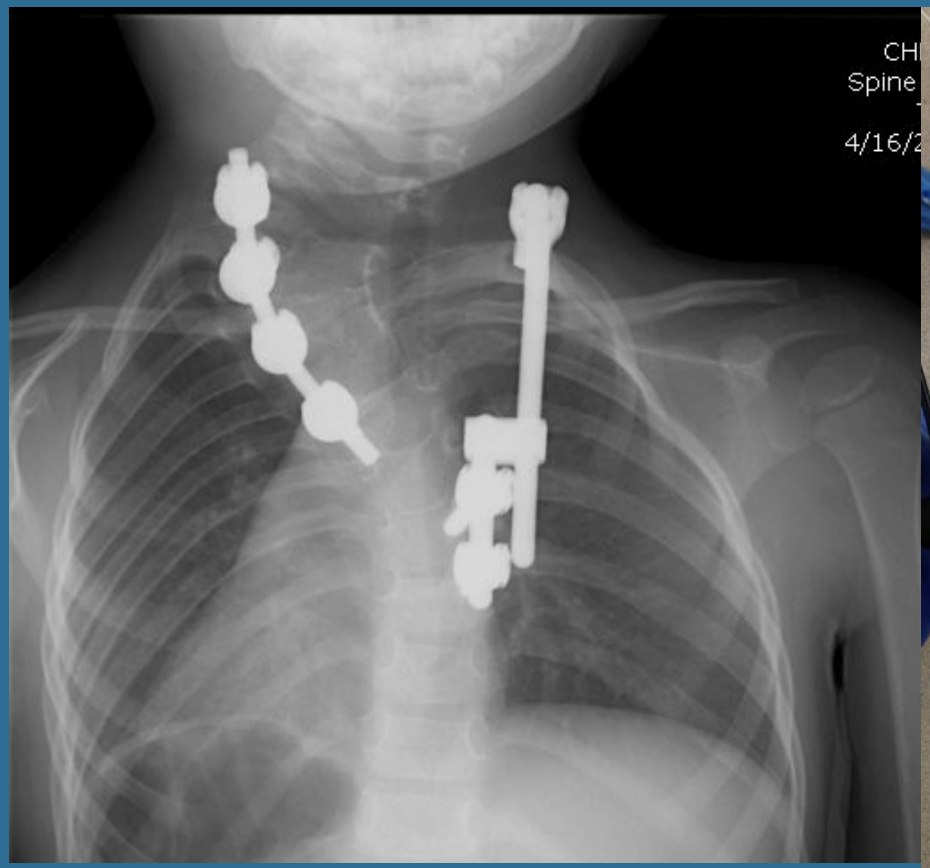
Children's Hospital Los Angeles
CHILDREN'S ORTHOPAEDIC CENTER

Return to OR in Few Days

MEPs
Normal

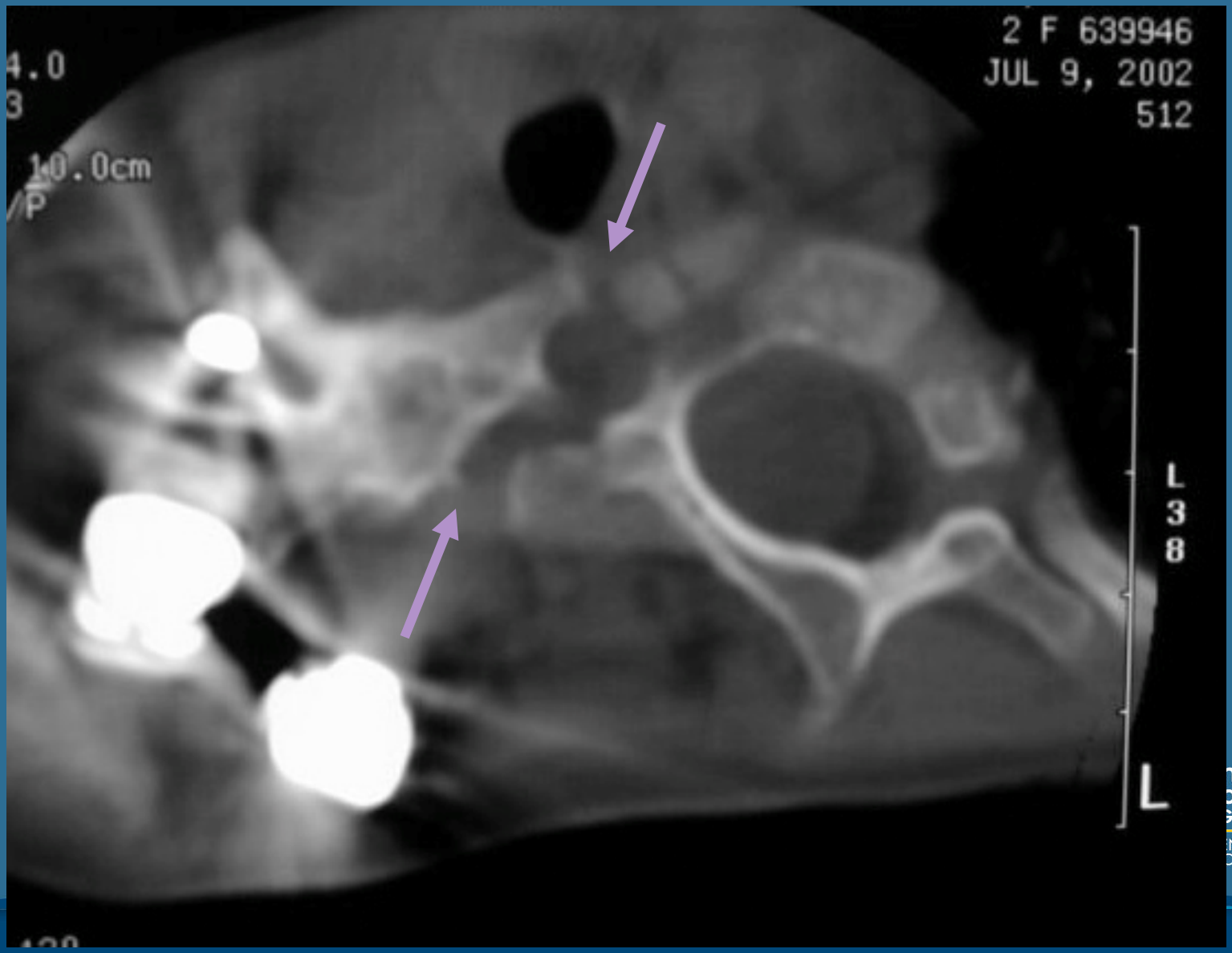
MEPs
50% Diminished

Lesson:
Position arms at side when distracting on top rib



ORTHOPAEDIC CENTER

Complication: Rib Mass Avulsion



Rib Avulsion: Treatment

- Step 1
  - Remove Devices
  - Fuse Avulsed ribs to spine

Rib Avulsion: Treatment

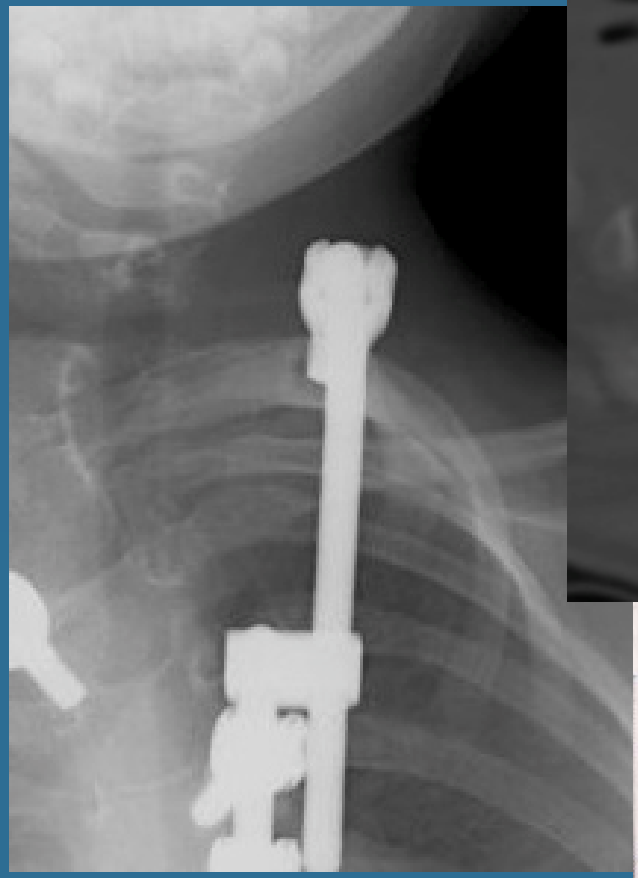
- Step 1
  - Remove Devices
  - Fuse Avulsed ribs to spine
- Step 2 (4-6 months)
  - Replace Device
  - Modest Distraction

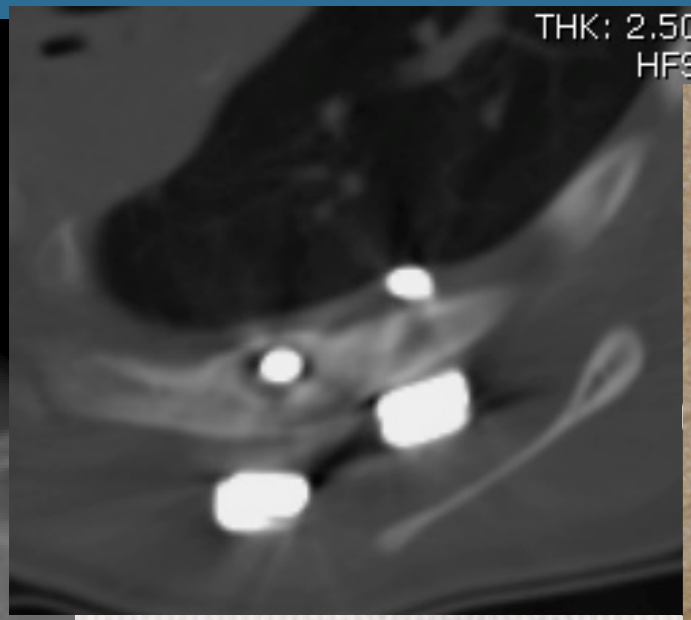
Pre-OP

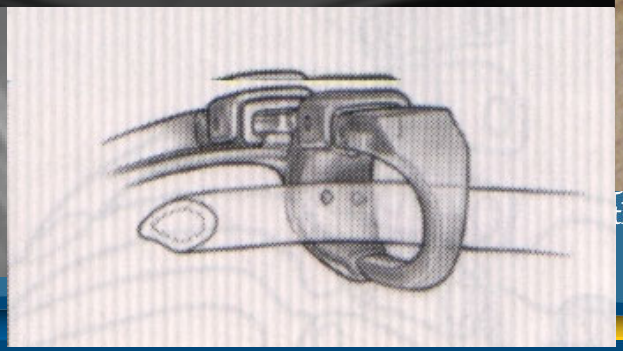
Post-op

Complications: Implants Migrate Through Ribs
Treatment: Put them back!

Migrations inherent in non-constrained, growing systems

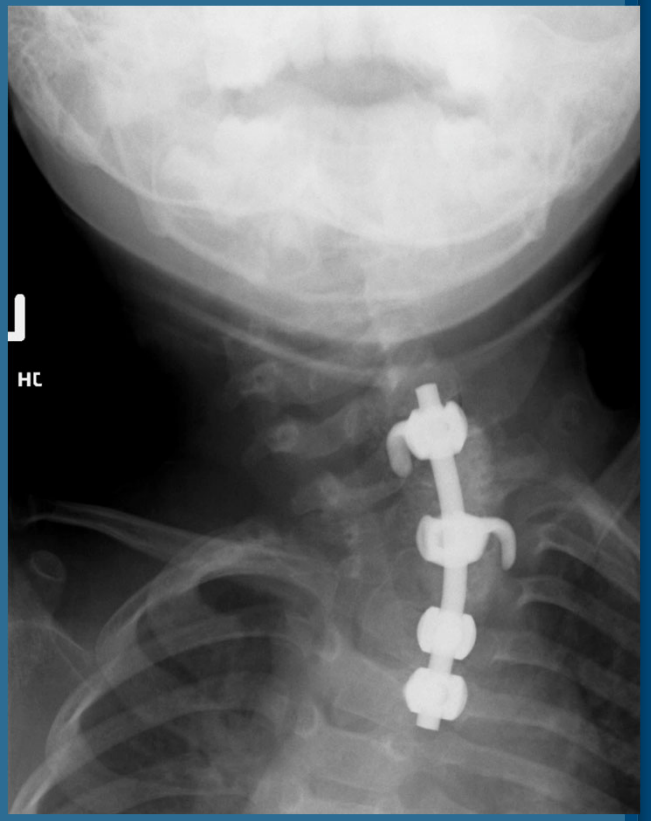






Conclusions

- Simple fusion
  - Deformity acceptable
  - ≤ 4? vertebrae – with implants
  - Risk averse
- Excision
  - Deformity concerning
  - Well defined hemi-vertebrae
  - ≤ 2? vertebrae
- Fusion + Distraction
  - Muliple levels involved
  - Risk of Thoracic Insufficiency Syndrome
  - Multiple operations acceptable
  - Solid upper anchors

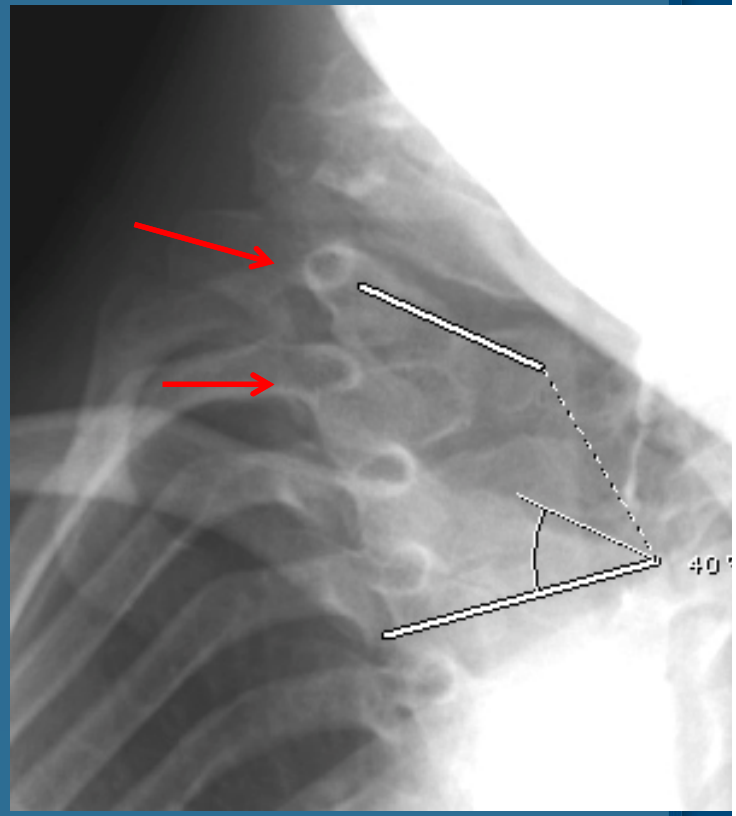


USC University of Southern California

Children's Hospital Los Angeles
CHILDREN'S ORTHOPAEDIC CENTER

Conclusions

- Simple fusion
  - Deformity acceptable
  - ≤ 4? vertebrae – with implants
  - Risk averse
- Excision
  - Deformity concerning
  - Well defined hemi-vertebrae
  - ≤ 2? vertebrae
- Fusion + distraction
  - Muliple levels involved
  - Risk of Thoracic Insufficiency Syndrome
  - Multiple operations acceptable
  - Solid upper anchors

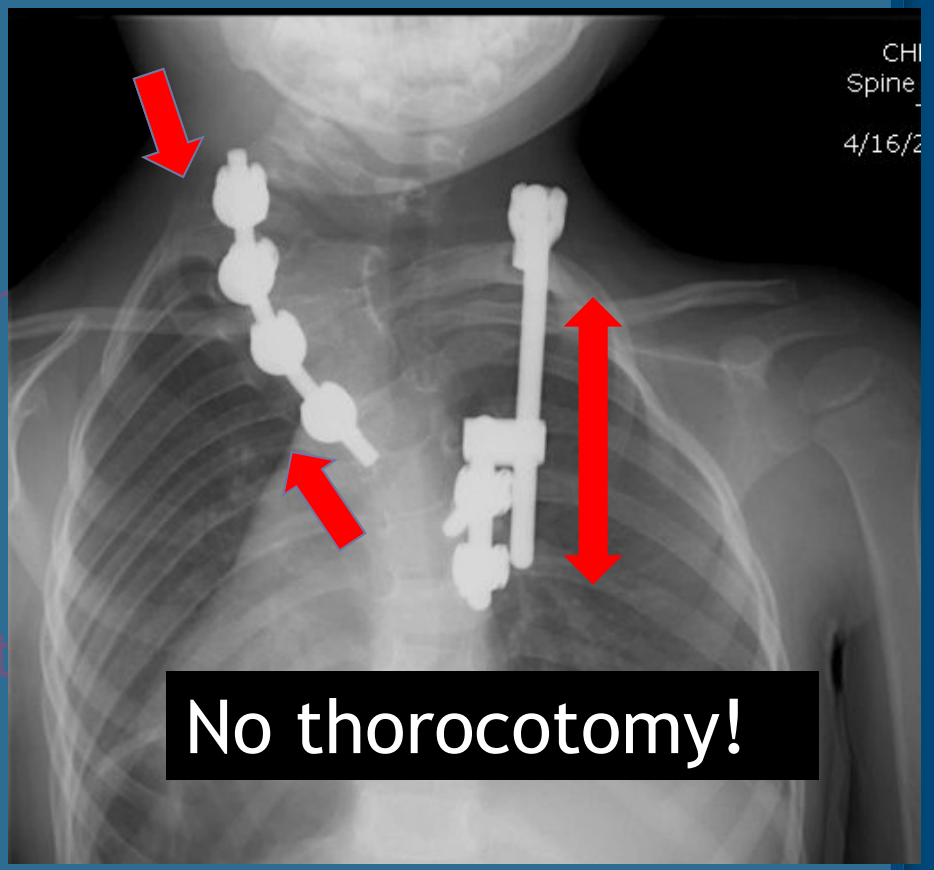


USC University of Southern California

Children's Hospital Los Angeles
CHILDREN'S ORTHOPAEDIC CENTER

Conclusions

- Simple fusion
  - Deformity acceptable
  - ≤ 4? vertebrae – with in
  - Risk averse
- Excision
  - Deformity concerning
  - Well defined hemi-vert
  - ≤ 2? vertebrae
- Fusion + Distraction
  - Deformity Not Acceptable
  - Muliple levels involved
  - Multiple operations acceptable
  - Solid upper anchors



USC University of Southern California

Children's Hospital Los Angeles
CHILDREN'S ORTHOPAEDIC CENTER


Thank
You

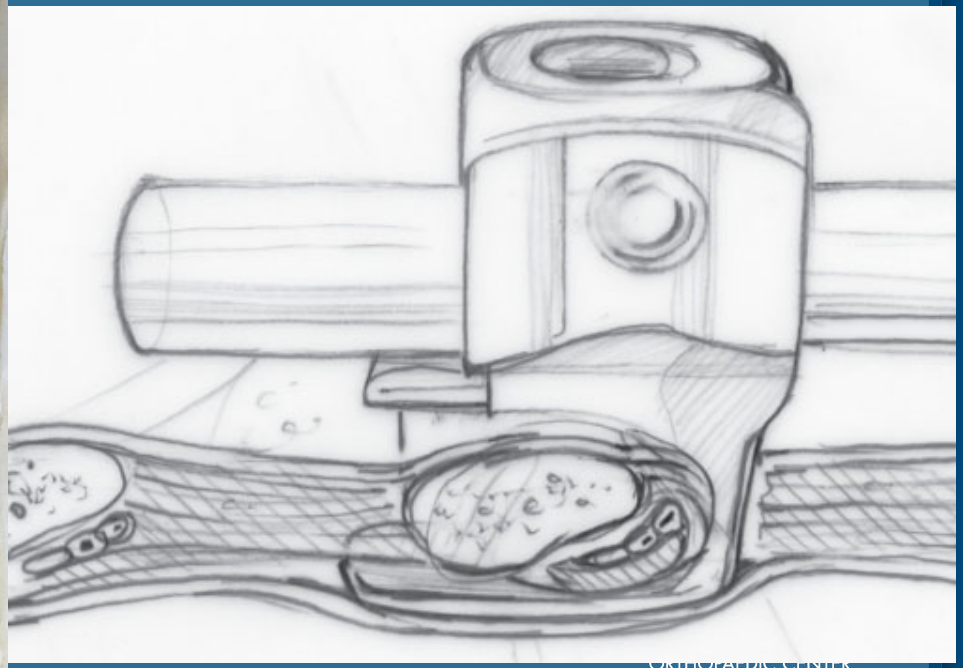
Adjacent to TP

Extra-Periosteal

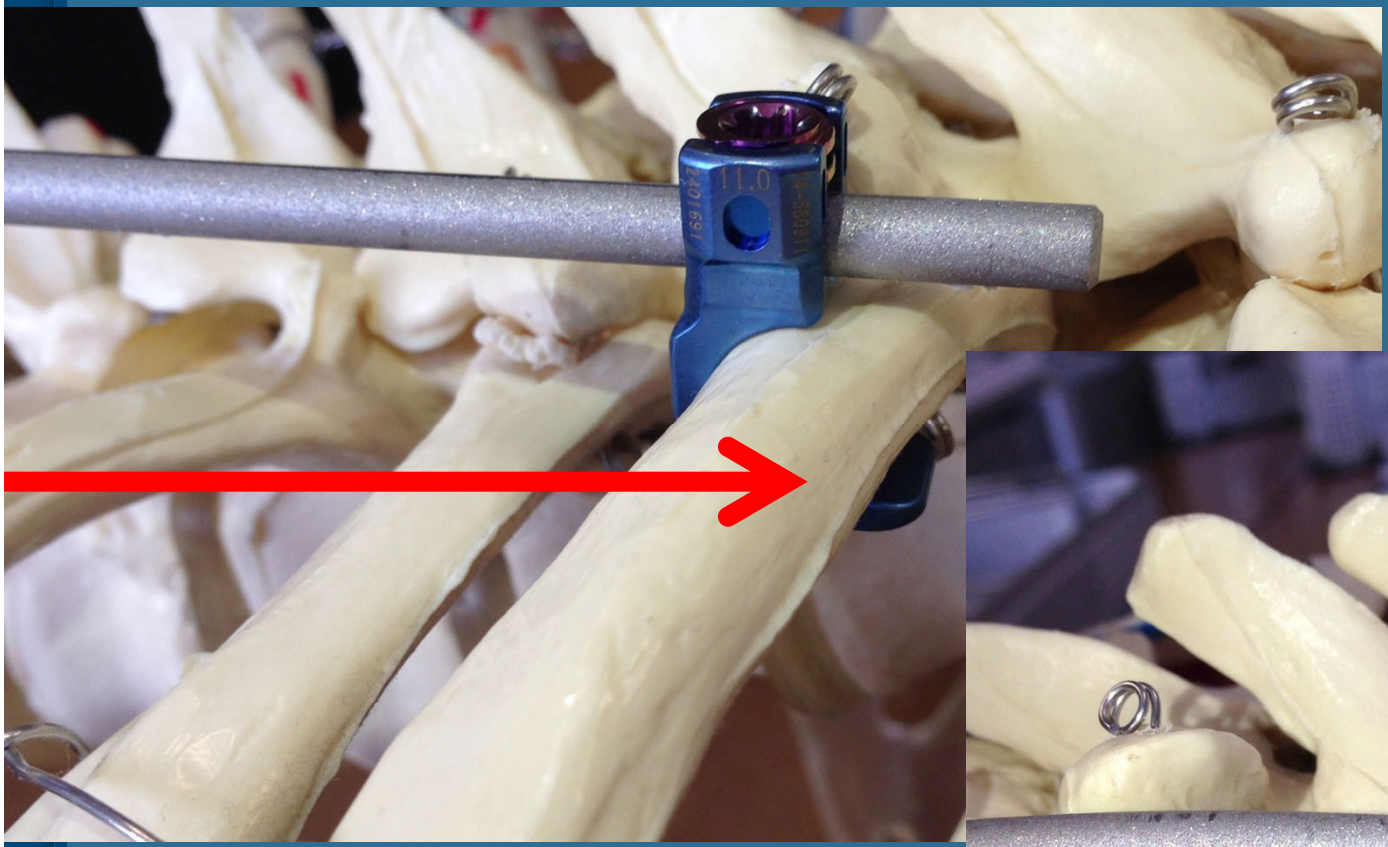
Want ribs to hypertrophy

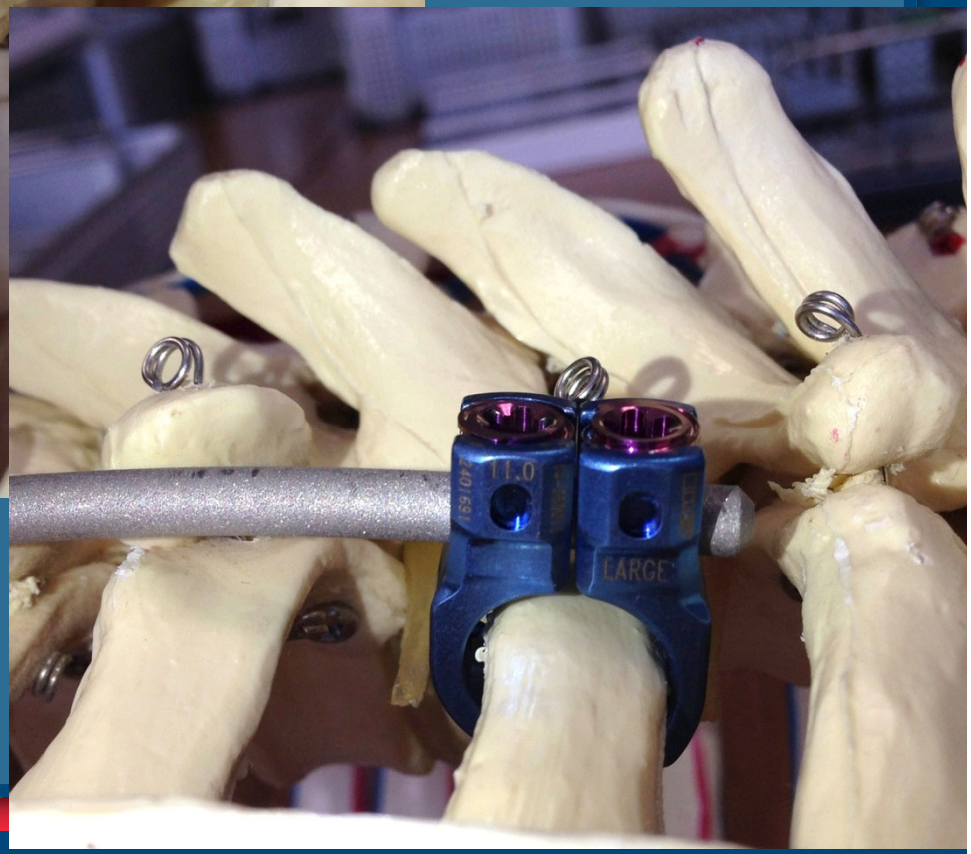
NOT in chest

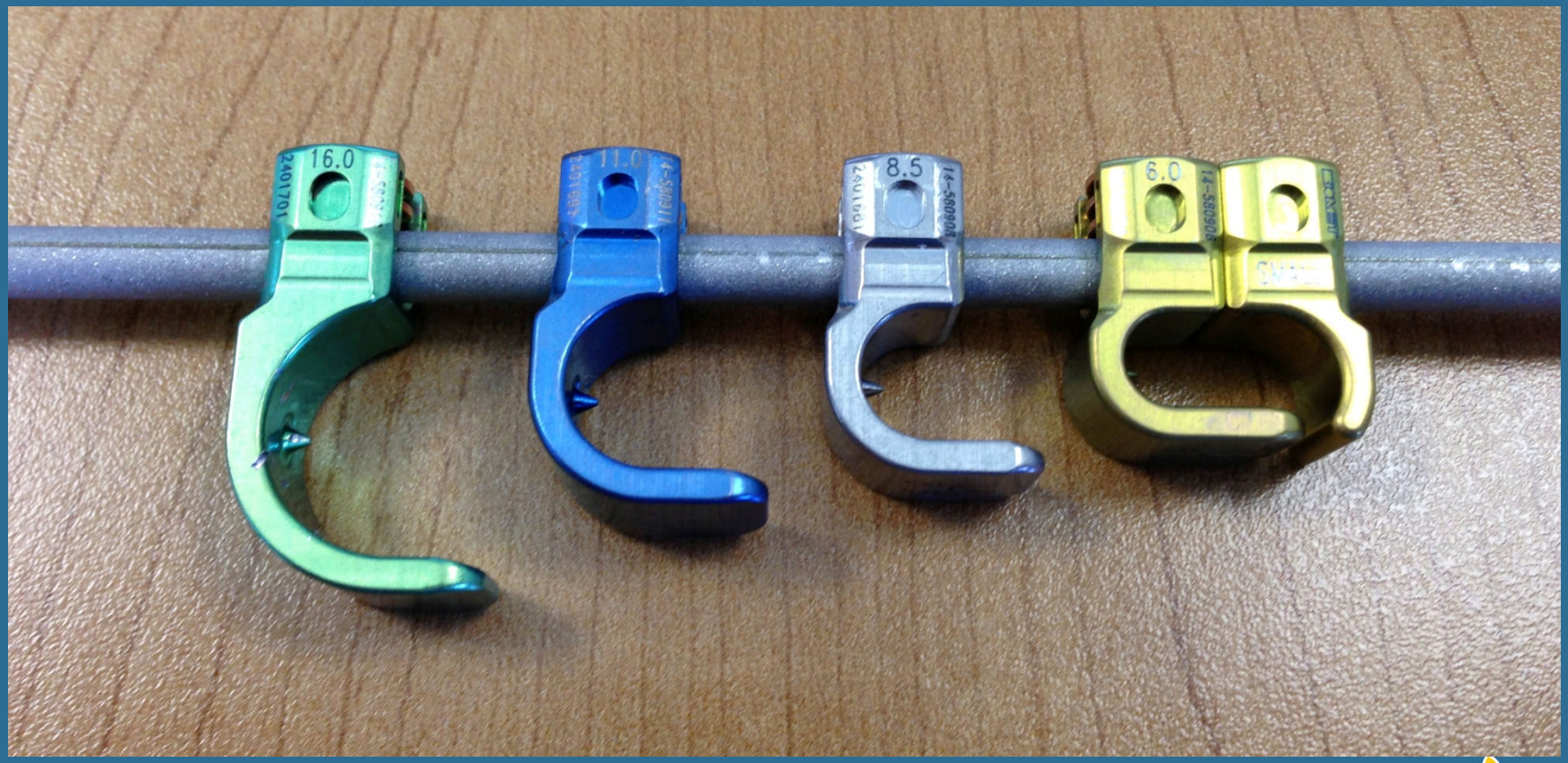
No chest tube



No Advantage to “Claw” (my opinion)







USC University of Southern California

Children's Hospital LOS ANGELES

CHILDREN'S ORTHOPAEDIC CENTER


USC University of
Southern California


Children's
Hospital
LOS ANGELES
CHILDREN'S
ORTHOPAEDIC CENTER


USC University of
Southern California


Children's
Hospital
LOS ANGELES
CHILDREN'S
ORTHOPAEDIC CENTER

Pre-op

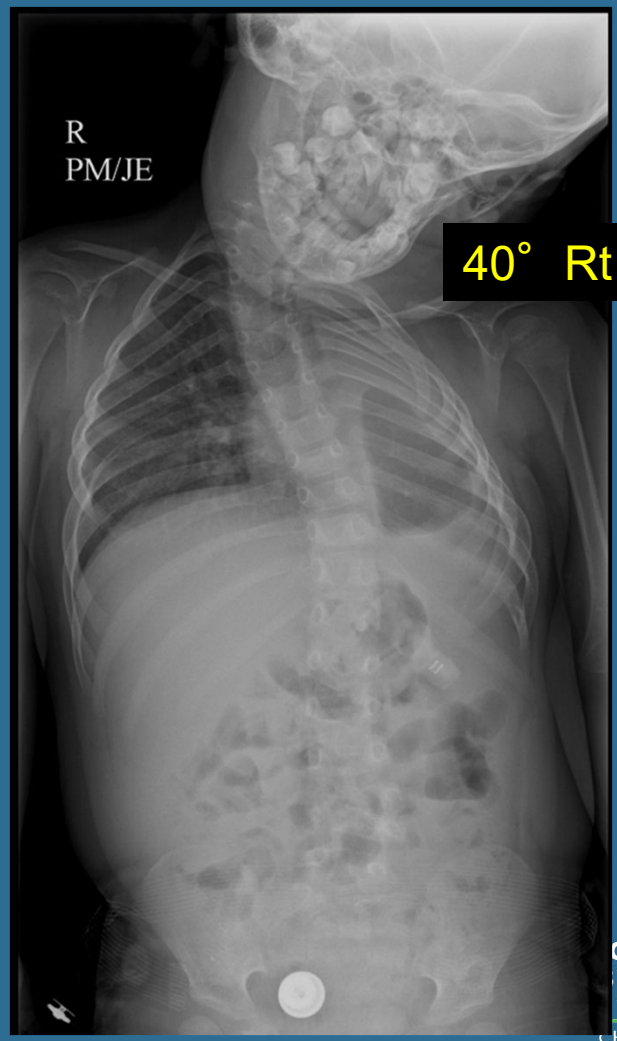
2 yrs post

USC University of Southern California

Children's Hospital LOS ANGELES

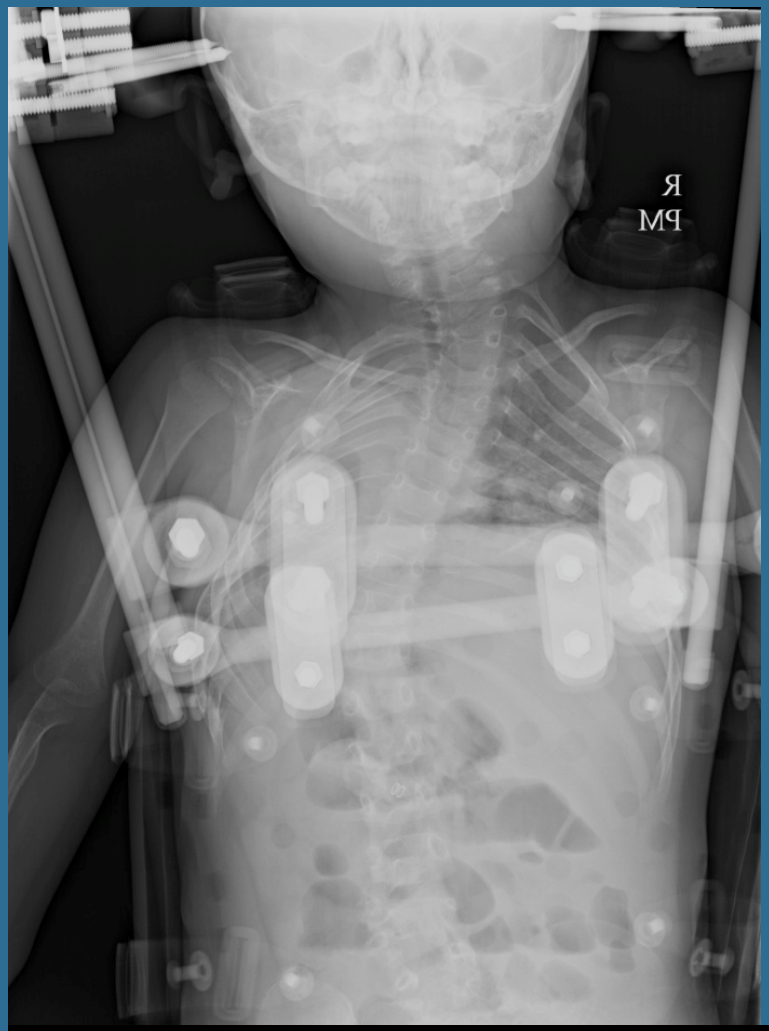
CHILDREN'S ORTHOPAEDIC CENTER

Congenital Scoliosis with Right Side T2 Hemivertebrae



CHILDREN'S ORTHOPAEDIC CENTER

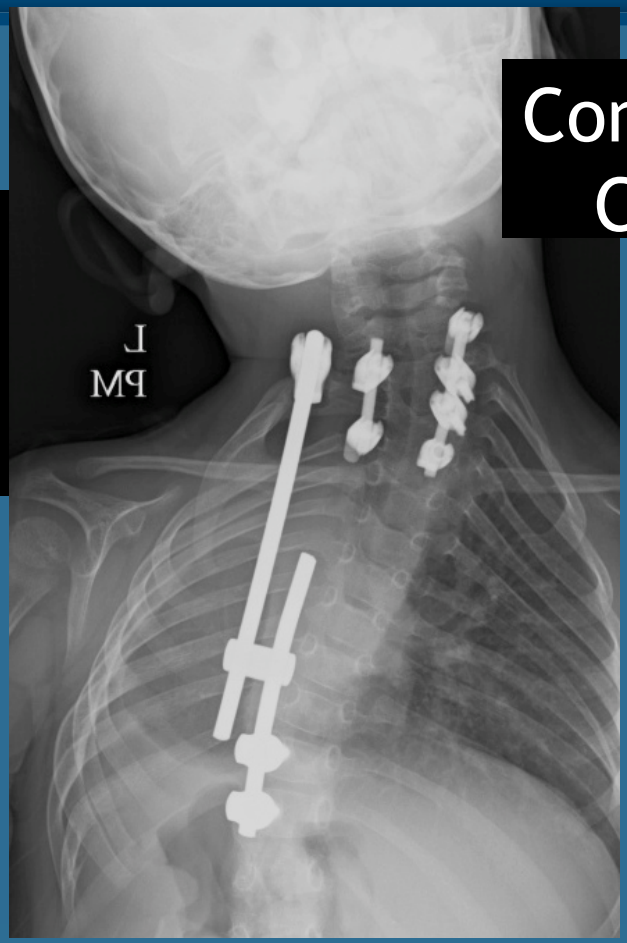
By age 4
the Cervical curve
progressed to 45°

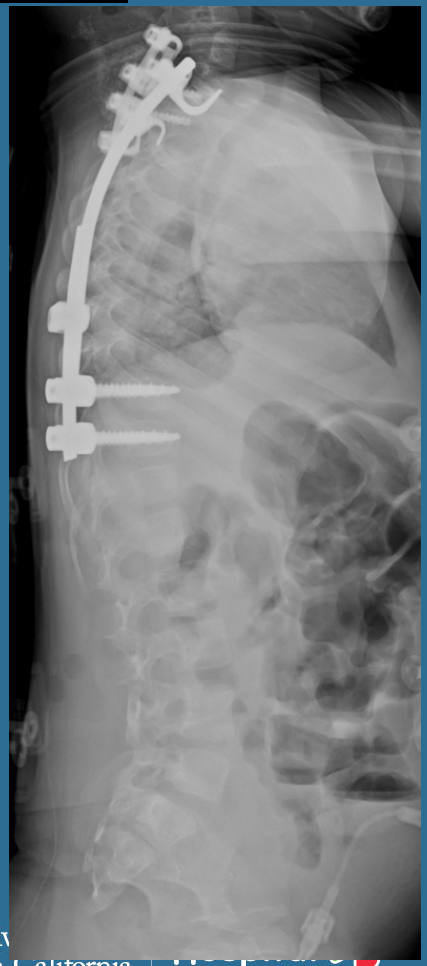


Intra op Halo was placed
to slowly bring her head tilt to neutral
2 weeks prior to instrumentation
and fusion

Convex Fusion C7-T4

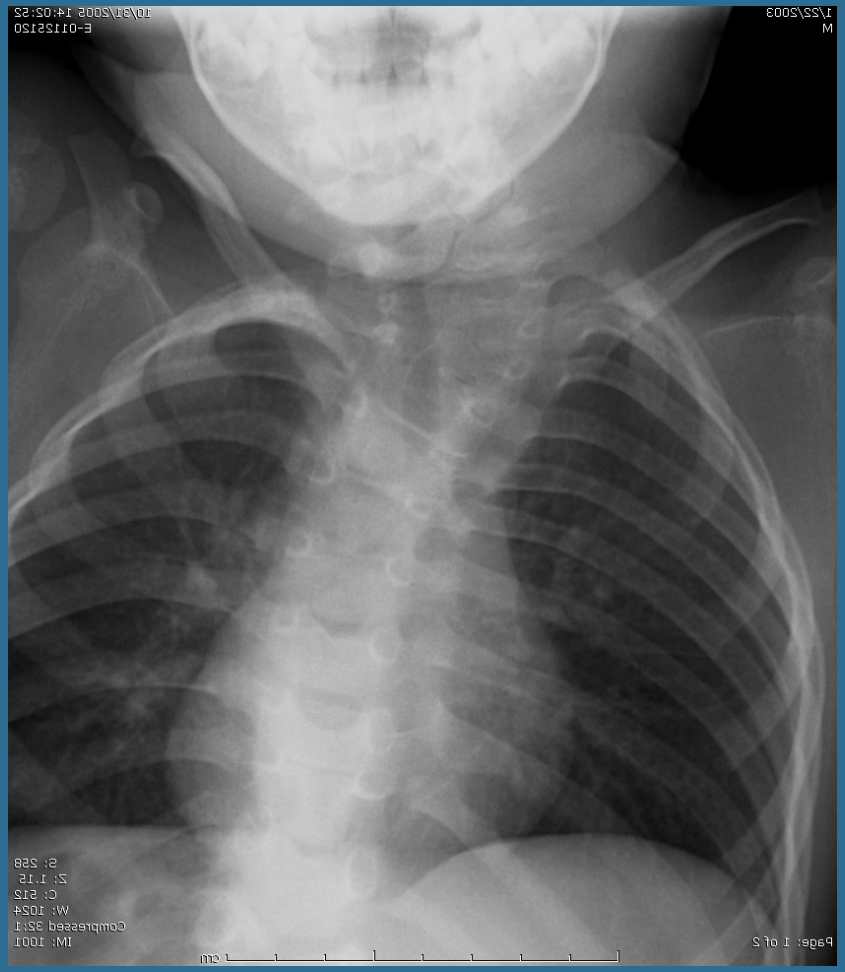
- Concave
- Distraction over time

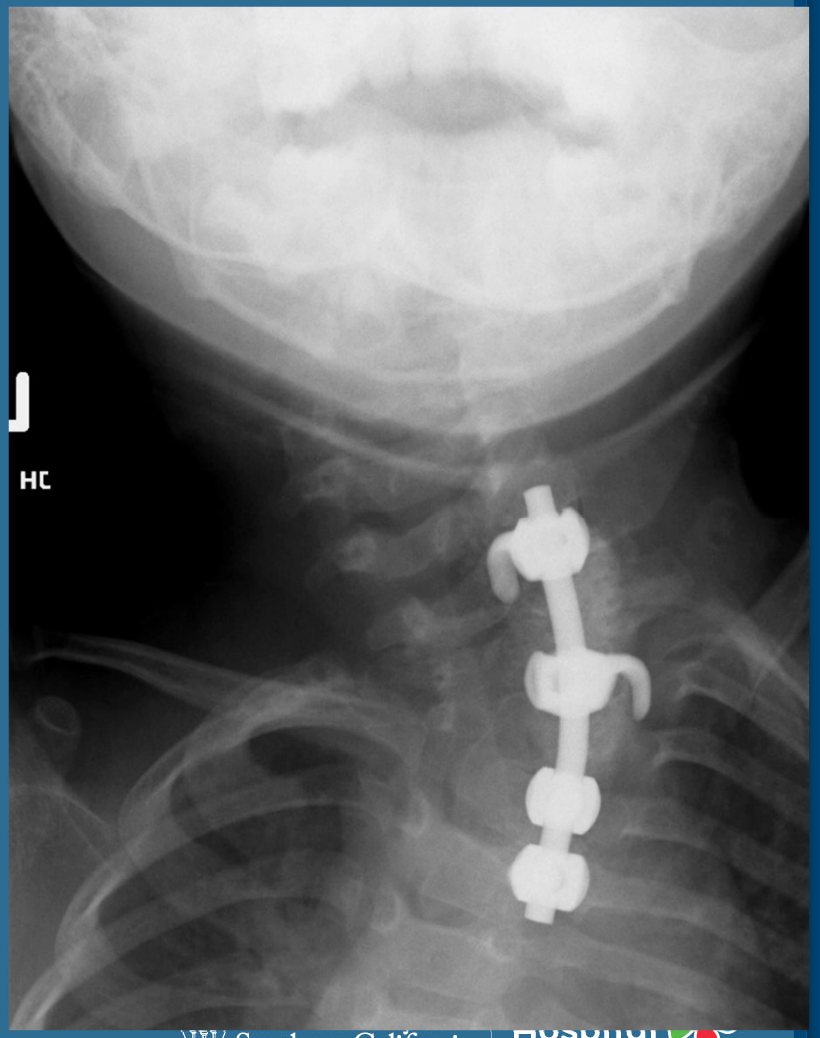




CHILDREN'S
ORTHOPAEDIC CENTER

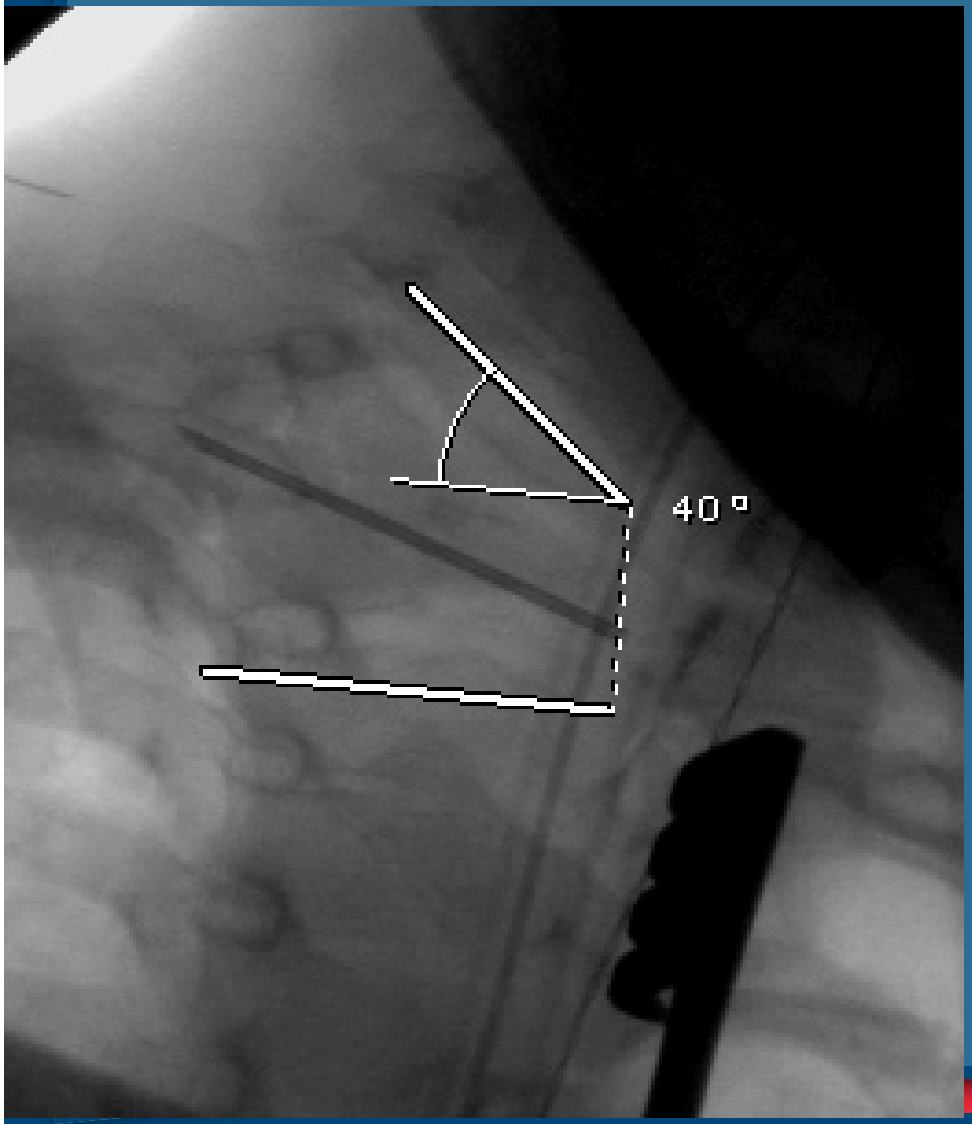
Option #1 Hemiepiphysiodesis (Fusion in situ)

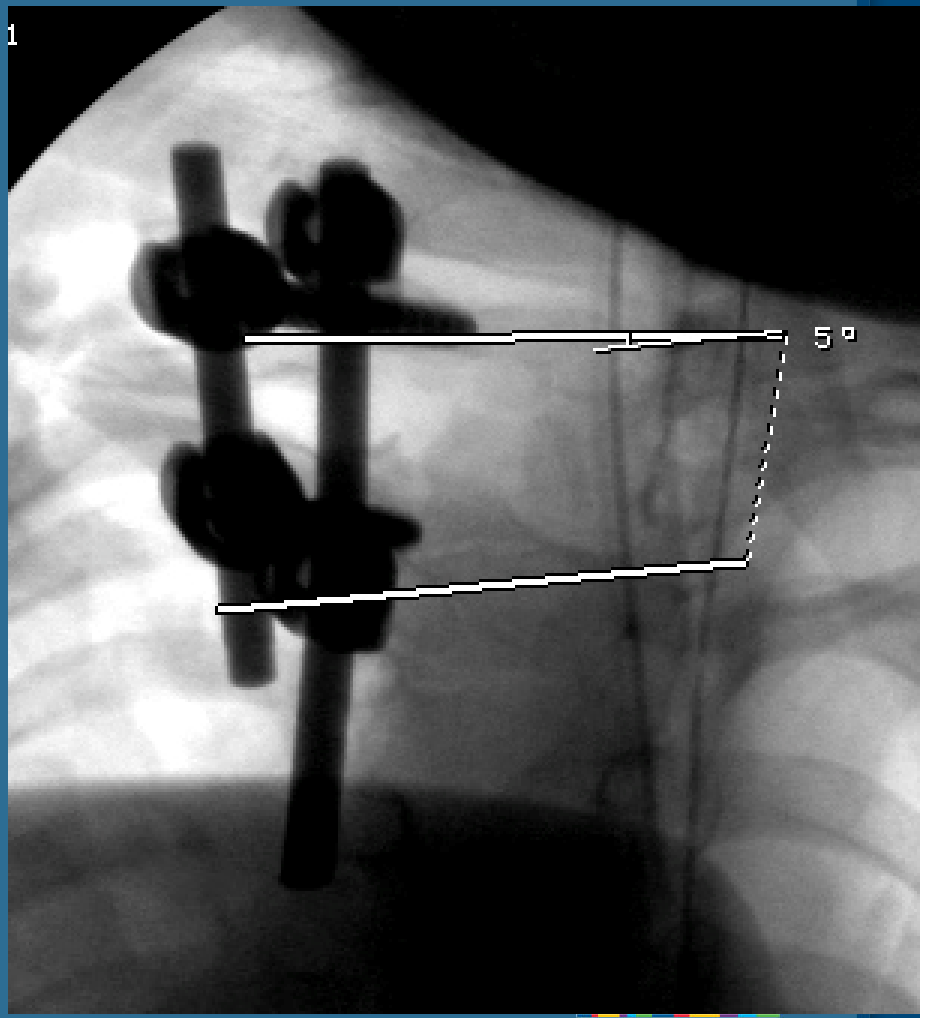




Southern California | Hospital for Special Surgery LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER

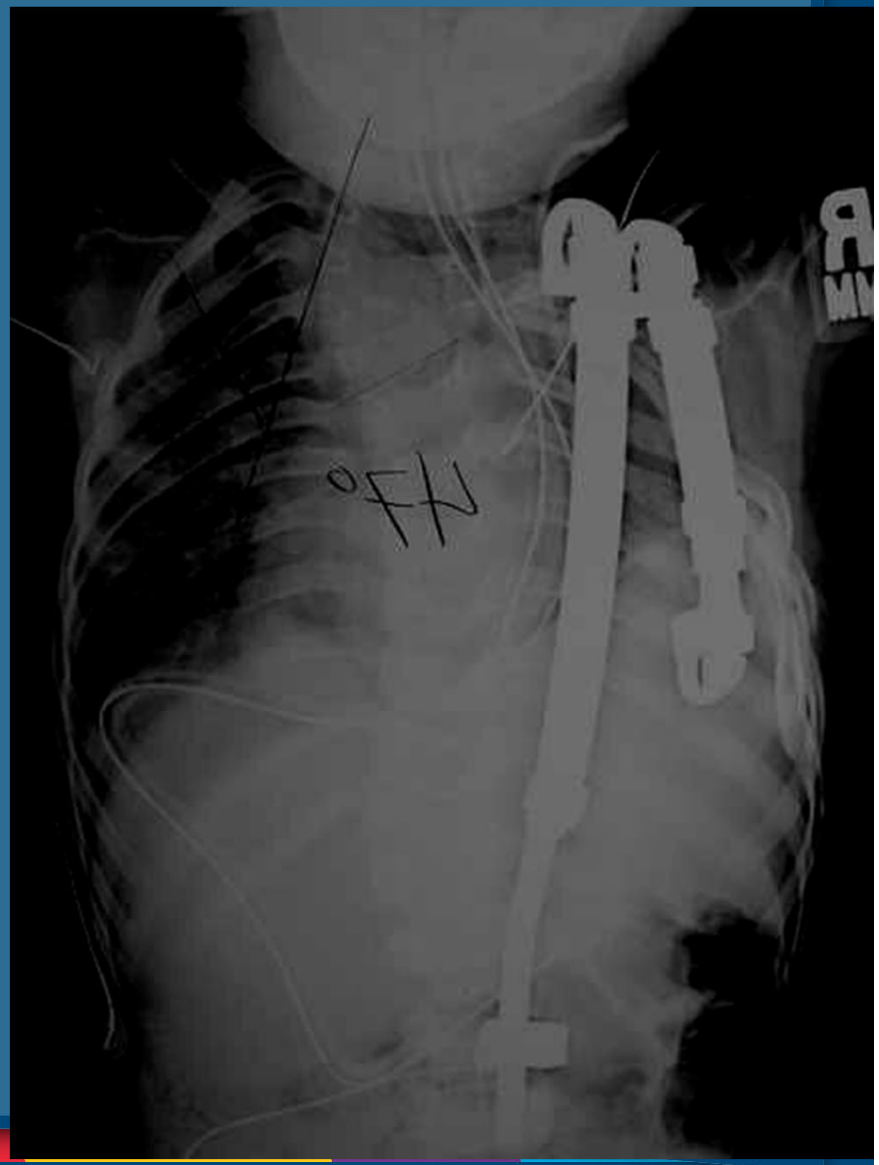
Option #2 Resection and Fusion



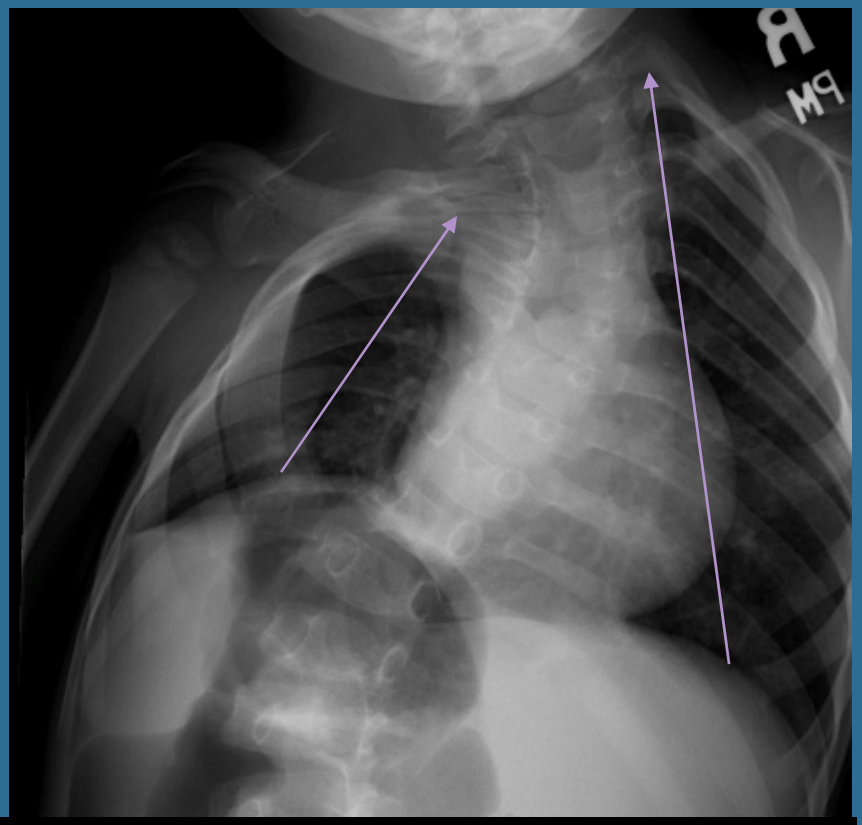


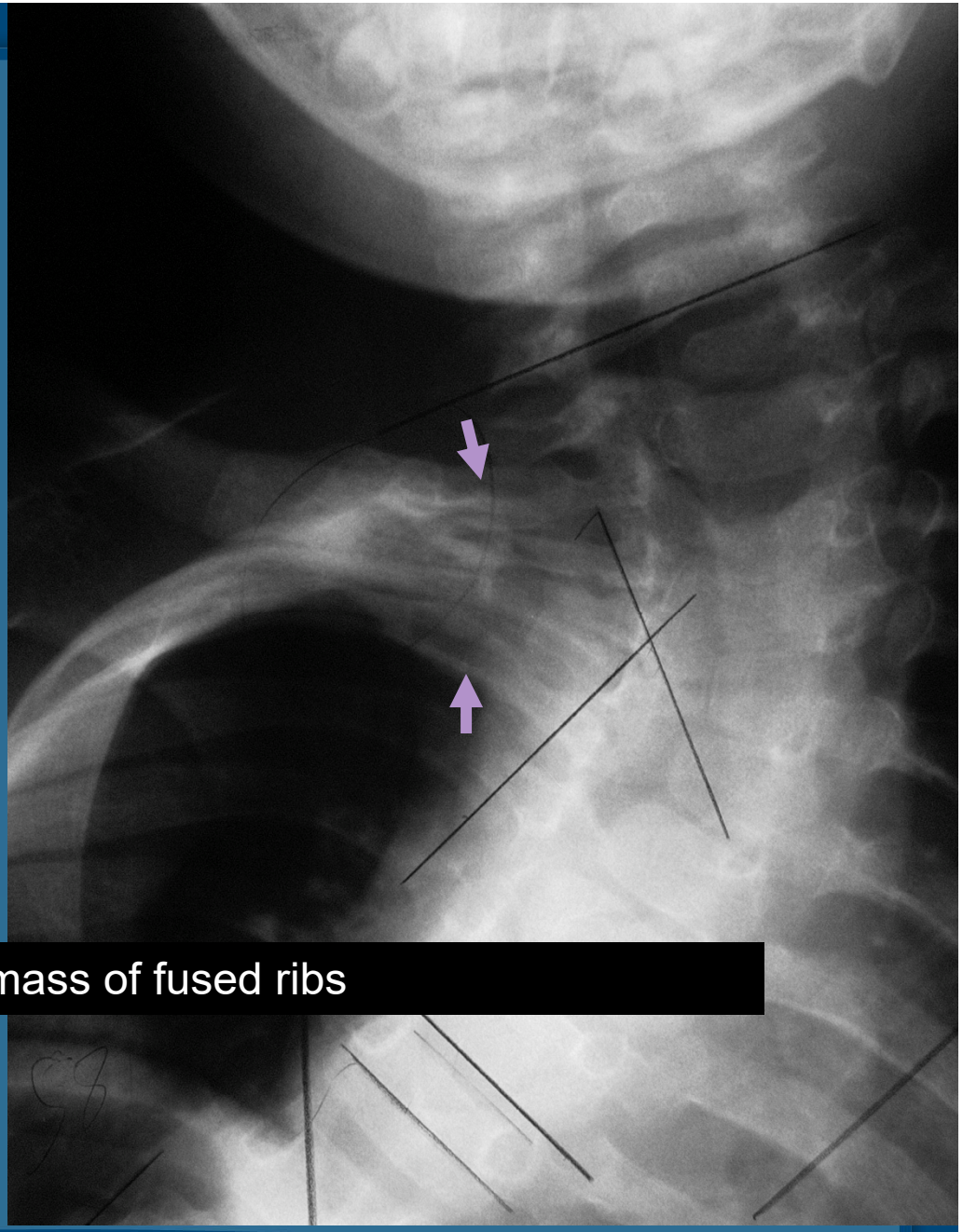
18 mo after in-situ fusion

Option #3 Distraction Over Time



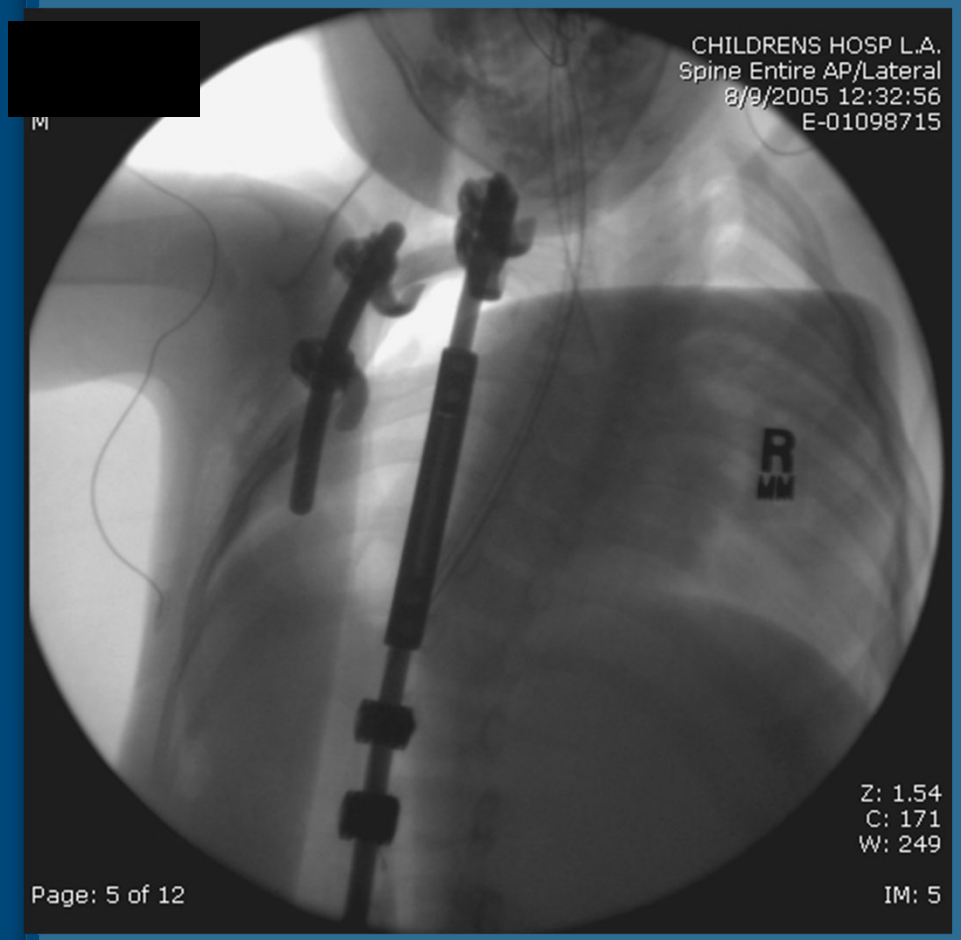
3 yo – progressive deformity





OK to us mass of fused ribs

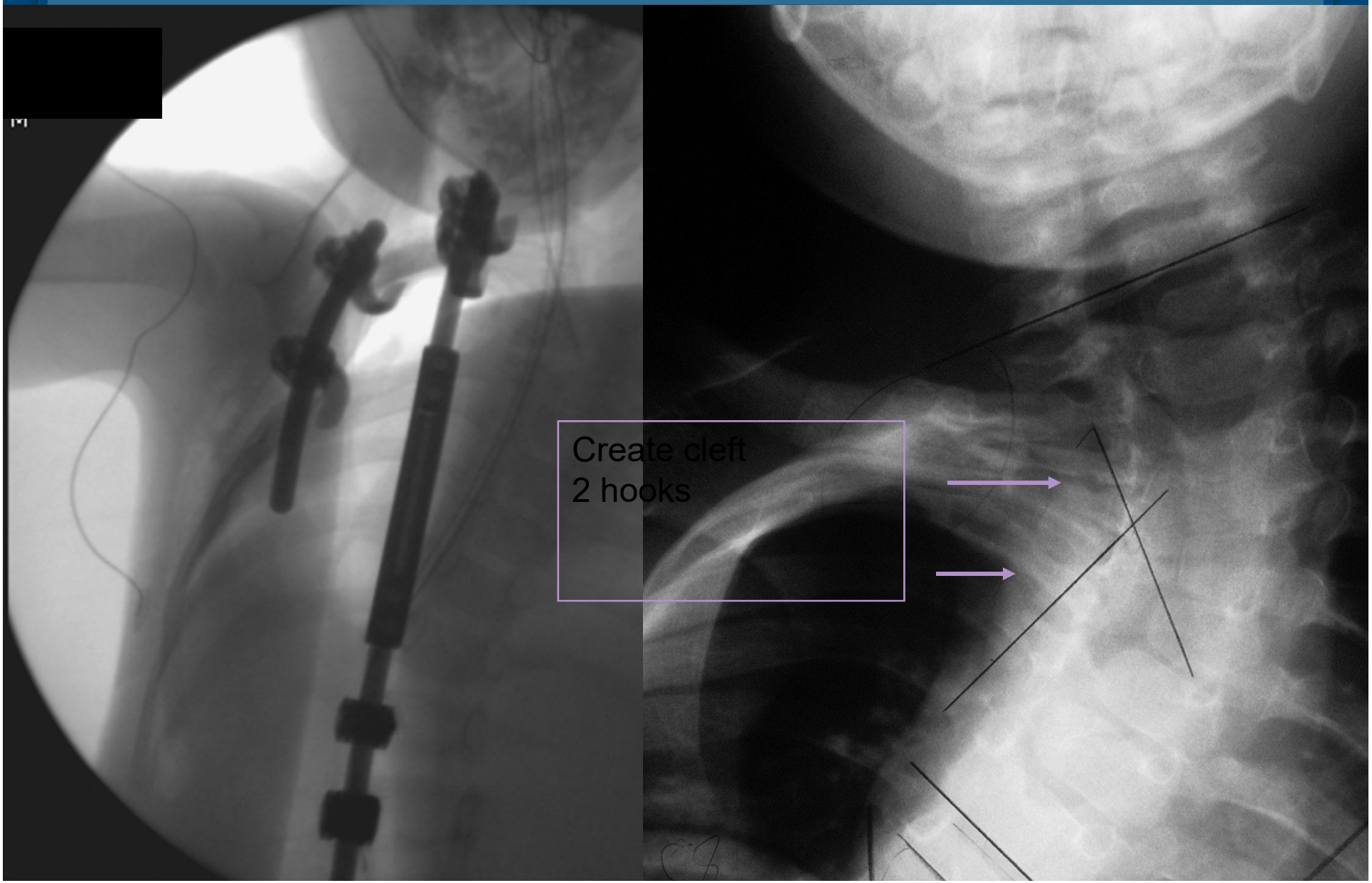
Step 1 - concave distraction



USC University of Southern California

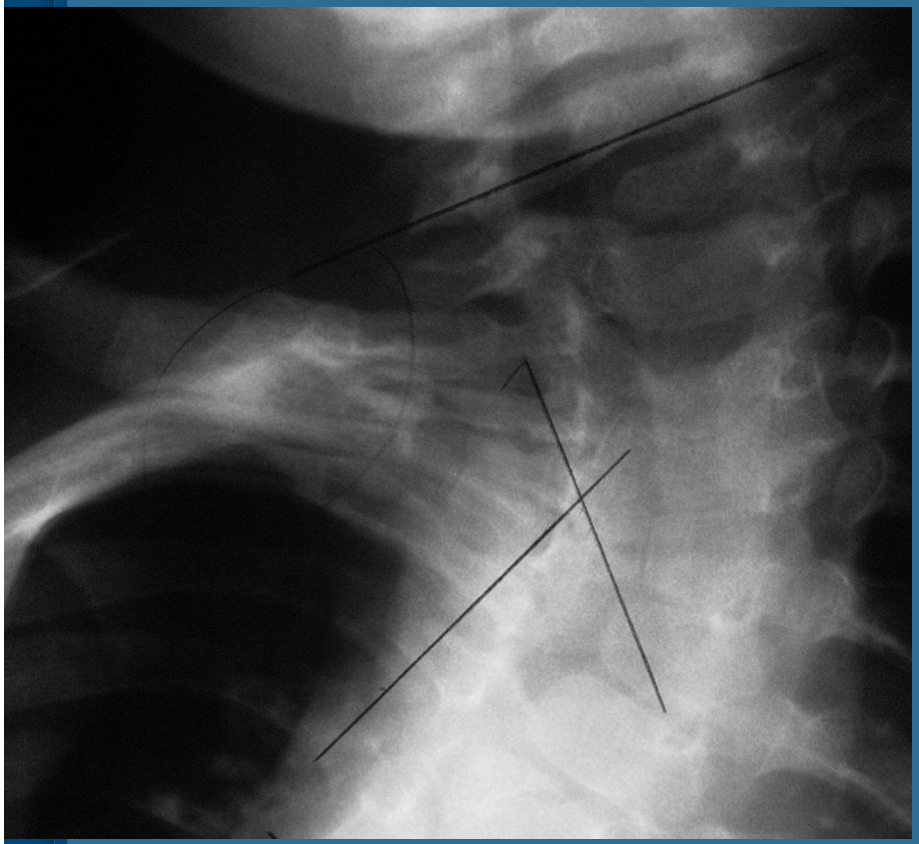
Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER

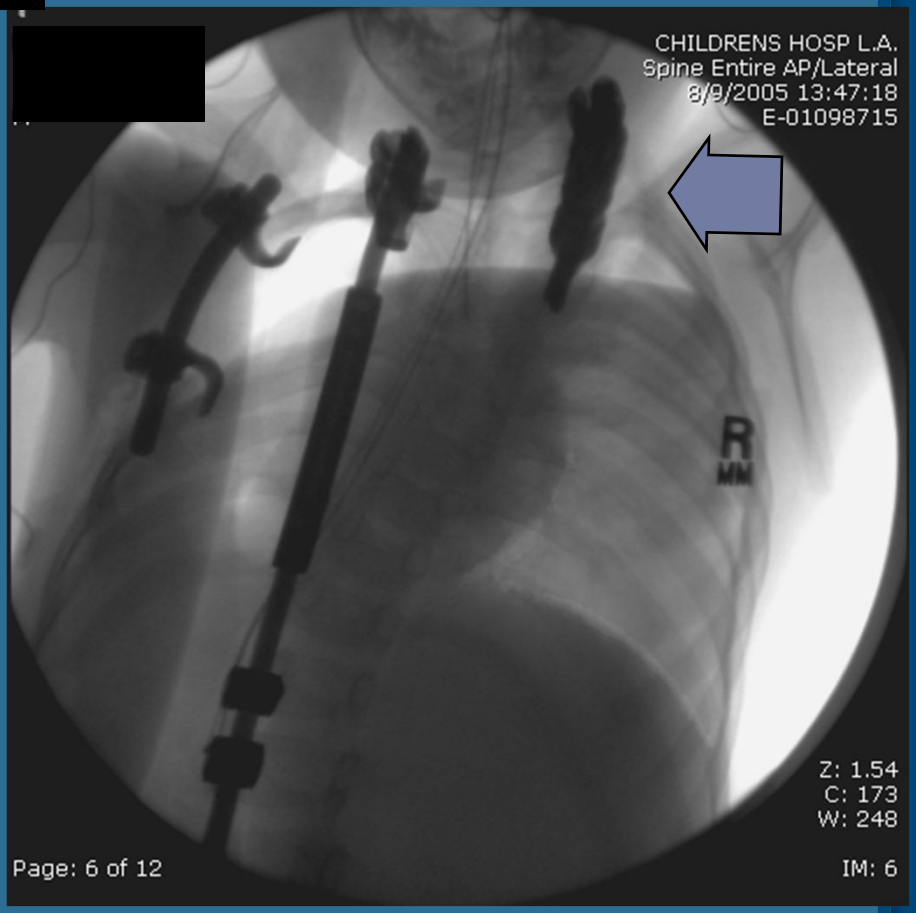
Step 1 - concave distraction



Step 2 - convex hemi-epiphysiodesis

[redacted]

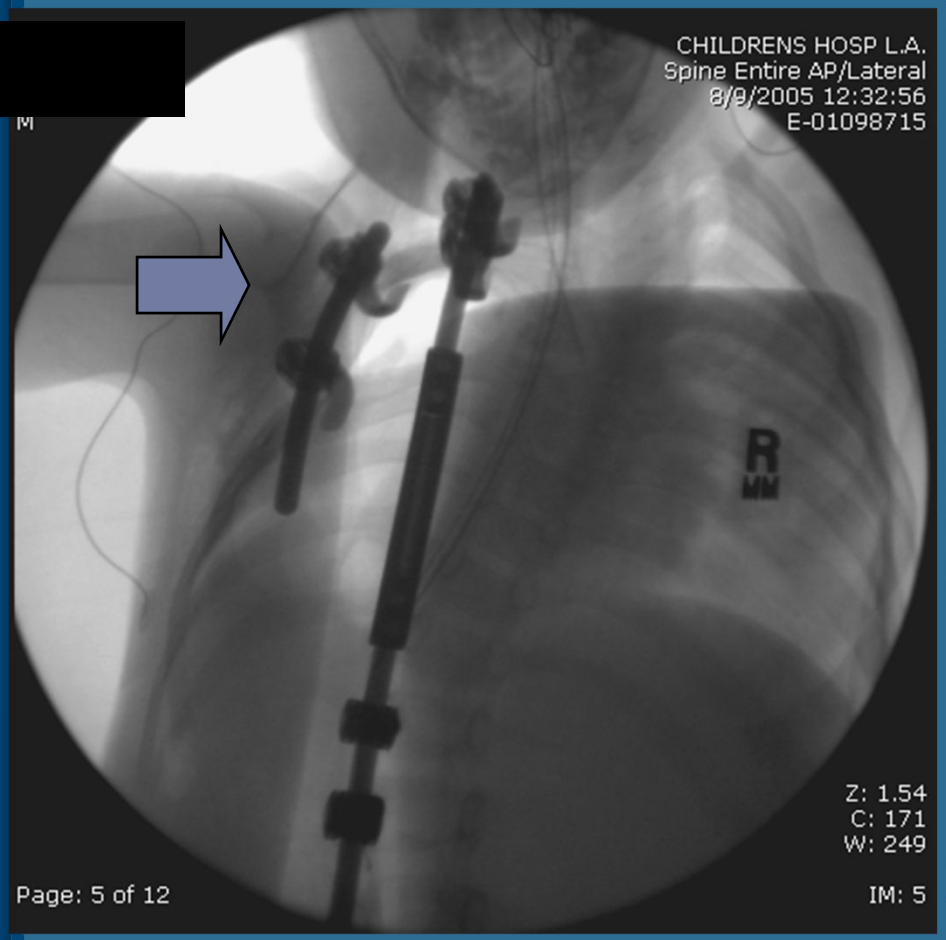


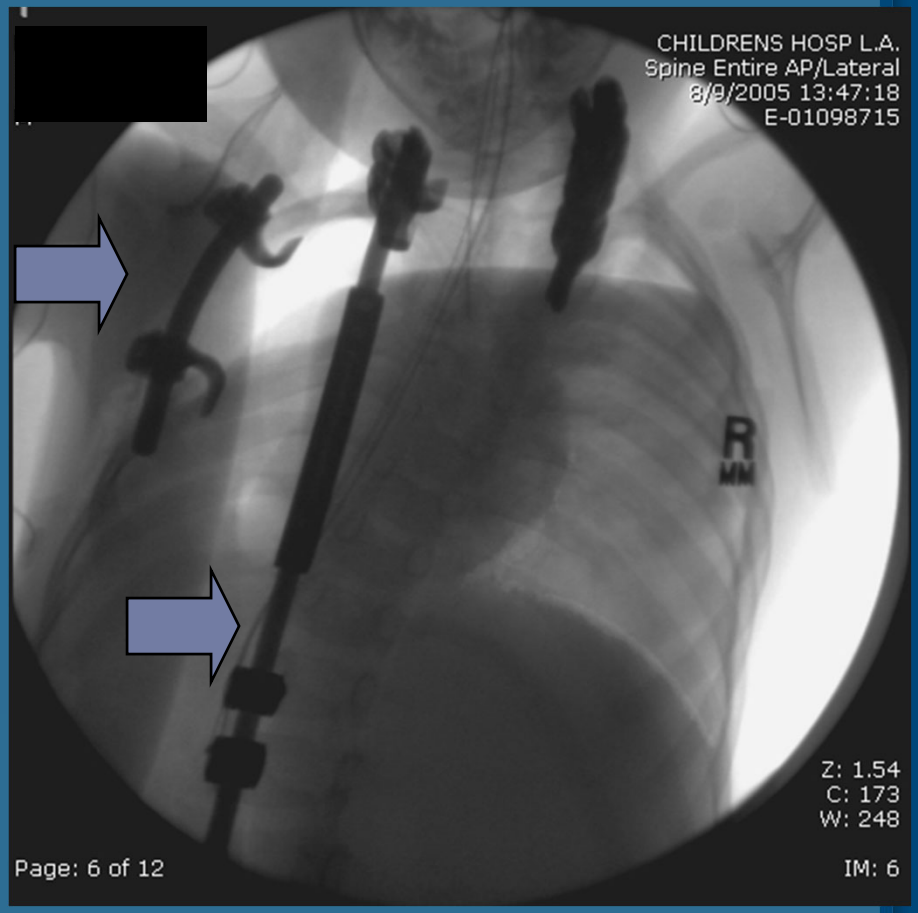


USC University of Southern California

Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER

Step 3- Intra-operative Distraction Over Time

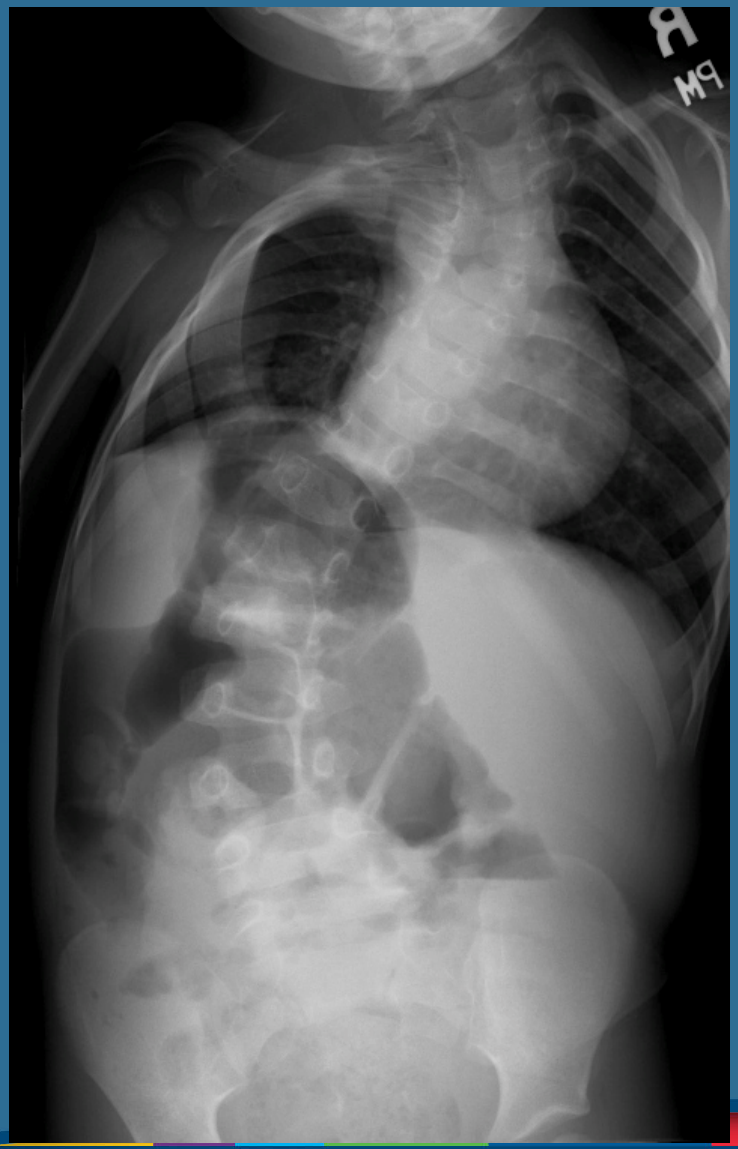


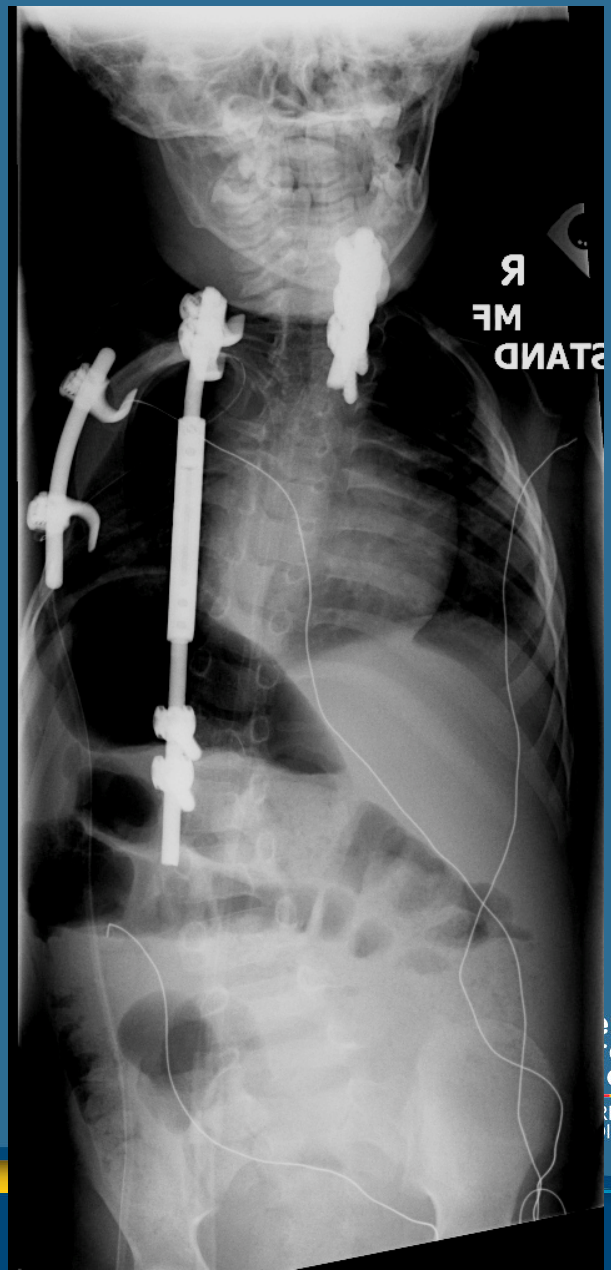


USC University of Southern California

Children's Hospital Los Angeles
CHILDREN'S ORTHOPAEDIC CENTER

Midline Incision – no thorocotomy





The Effect of Early Thoracic Fusion on Pulmonary Function

Lori Karol, M.D., Charles Johnston, M.D.,
Kiril Mladenov, M.D., Peter Schochet, M.D.,
and Patricia Walters, RRT-NPS.
Texas Scottish Rite Hospital for Children
Dallas Texas

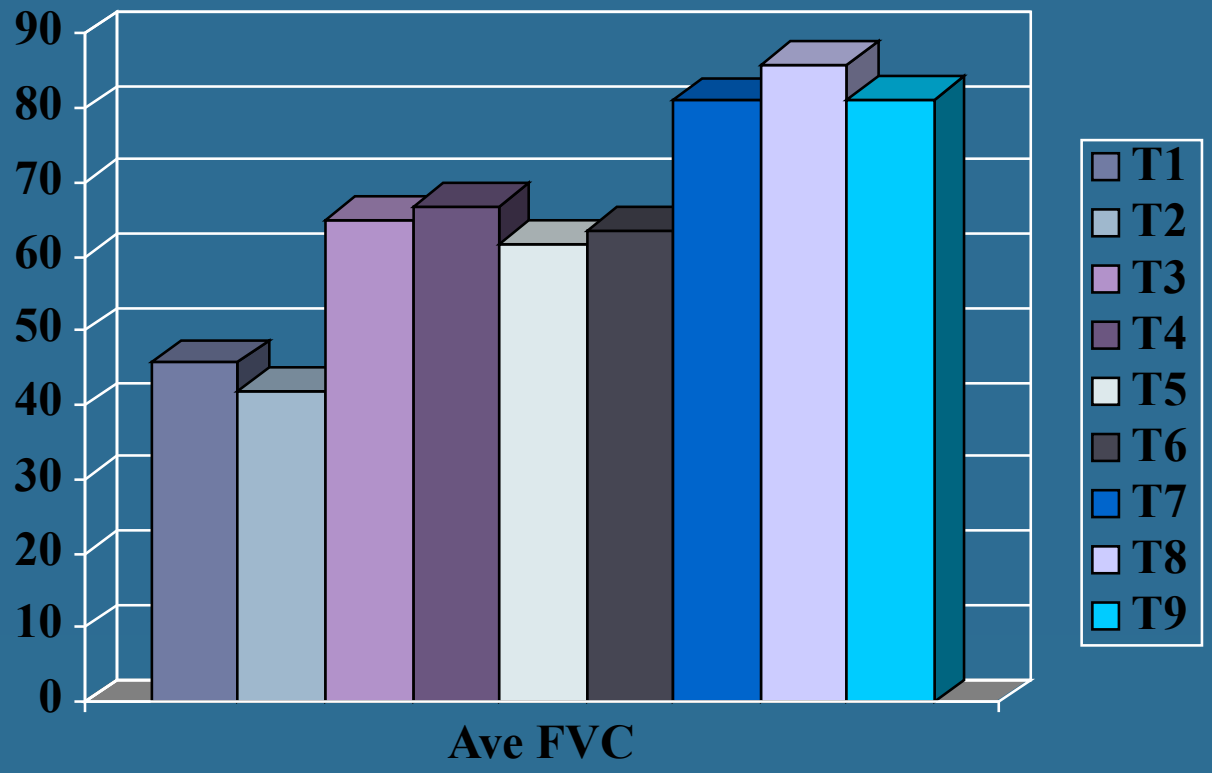
RESULTS

- 28 patients spinal fusions
- Age at surgery = 3 yrs (4 mos – 8 yrs)
- Ave f/u 11 years (6 – 20 yrs)
- 27/28 had anterior surgery

USC University of Southern California

Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER

FVC VS. PROXIMAL LEVEL OF FUSION



USC University of Southern California

Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER

Cephlad Extent of Fusion More Important than # segments Fused

- FVC < 50%
  - 67% (8/12) top of fusion T1 or T2
  - 25% (4/16) top of fusion T3-T9
  - P=0.0004

USC University of Southern California

Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER

Dimeglio - Rabbit Model

- Posteior spine fusion in rabbits
- T1-T6 fusion decreases thoracic volume > T7-T12 fusion

- hypothesis
  - T1-T6 ribs articulate with the sternum
  - T7-T12 ribs do not

Current Technique:

Congenital Cervicothoracic Scoliosis Treated with Hemiepiphysiodesis and Placement of Distraction-Based Instrumentation

A Case Report

Lindsay Andras, MD, Rachel Tobin, and David L. Skaggs, MD

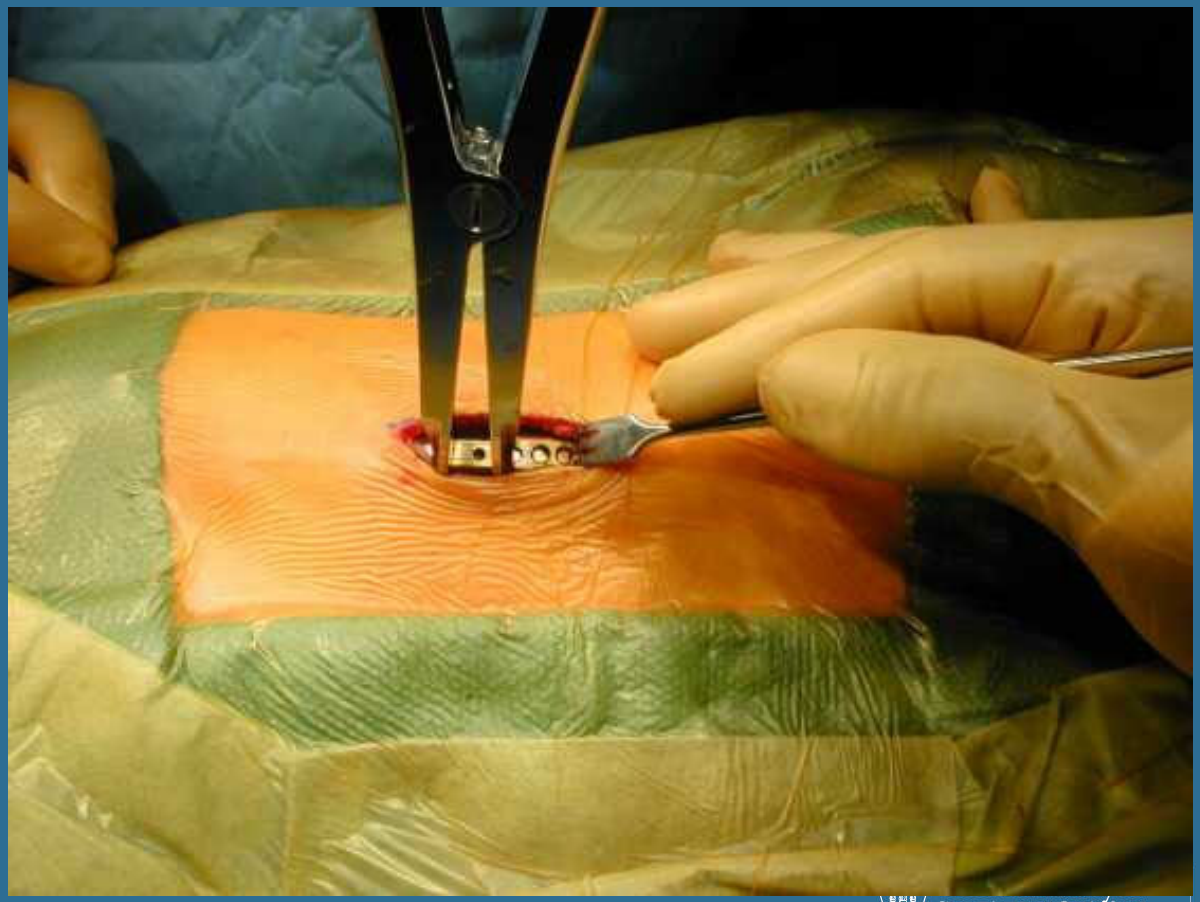
Investigation performed at Children's Orthopaedic Center, Children's Hospital Los Angeles, Los Angeles, California

JBJS, 2013

USC University of Southern California

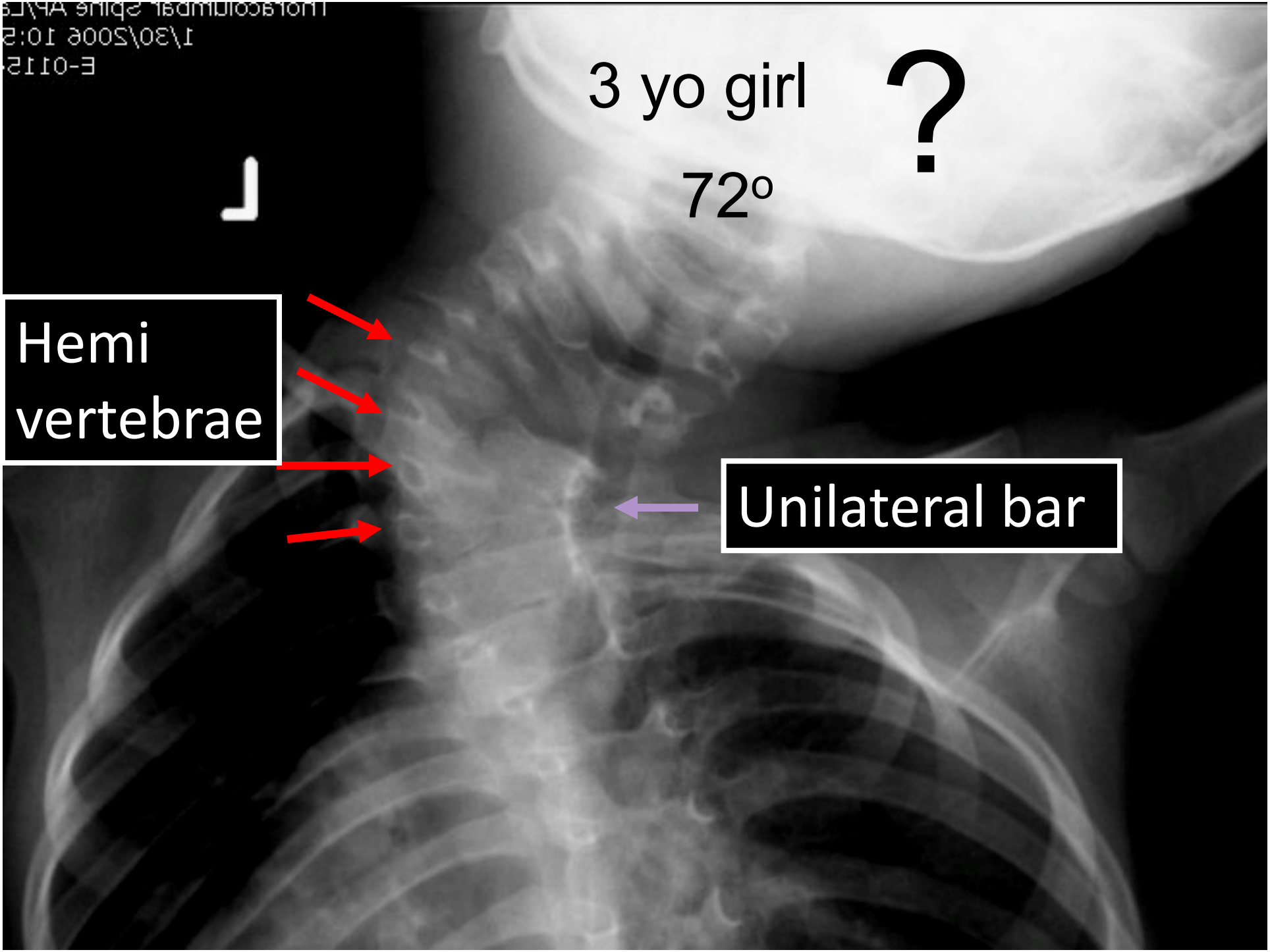
Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER

Lengthenings opportunity for complications MCGRs may change complication rate



Southern California

Children's Hospital LOS ANGELES
CHILDREN'S ORTHOPAEDIC CENTER


3 yo girl
?
72º
Hemi vertebrae
Unilateral bar