Management of Specific Genetic Disorders and Syndromes in the Growing Child

Paul D. Sponseller MD

Johns Hopkins University

Outline

- Diagnoses
- Principles
- Techniques
- Examples

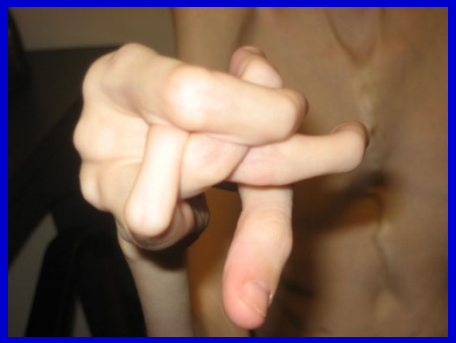
Does Etiology Matter?

Akbarnia et al 2010

- Syndromic spines ~ 25% of EOS population
  - GSSG
- Complications/pt and infections < EOIS
- Balance deteriorated more over time
  - Compared to other diagnoses
- Big difference: Associated issues

Common Early-Onset Scoliosis Syndromes for Spine Surgeons

- Marfan
- Rett syndrome
- Skeletal dysplasias
- NF1
- New ones weekly / never-ending!!
- Systematic Approach needed
  - Common themes



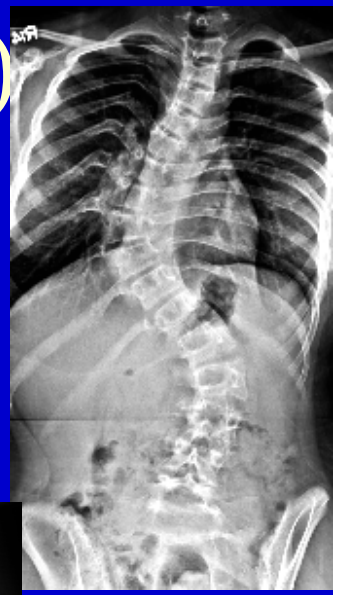
Common Theme

- Diagnosis leads to potential issues
- Significant differences in course of each

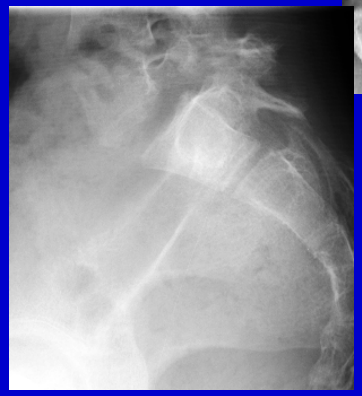
Resources for Syndromes

- Online Mendelian Inheritance in Man (OMIM)
  - Available through NLM/Pub Med
  - Allows search by findings
- National Organization for Rare Disorders (NORD) (http://www.rarediseases.org/)
  - Includes summaries of rare disorders
- Medical Geneticist
  - Some become “primary care” for syndromes

Common Themes: Examine Entire Spine (C,T,L)



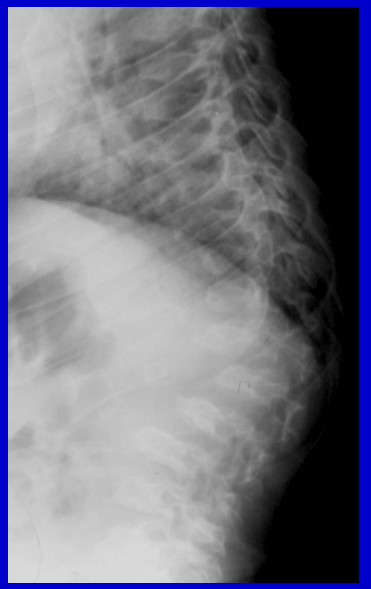
- Categories of Spinal Problems
  - Instability (C1-2, T12-L1)
  - Deformity
    - Kyphosis (C, T, L)
    - Scoliosis
  - Stenosis



- Apply to Cervical, thoracic, lumbar

Common Themes - Deformity

- Bracing rarely arrests deformity
  - Marfan syndrome 17% efficacy
- Exceptions:
  - Type 1 OI
  - Some achon kyphoses
- Use only in small, flexible curves
- Tactically use to delay intervention
- Assess effect on function



Role of "Mehta cast" in Syndromes

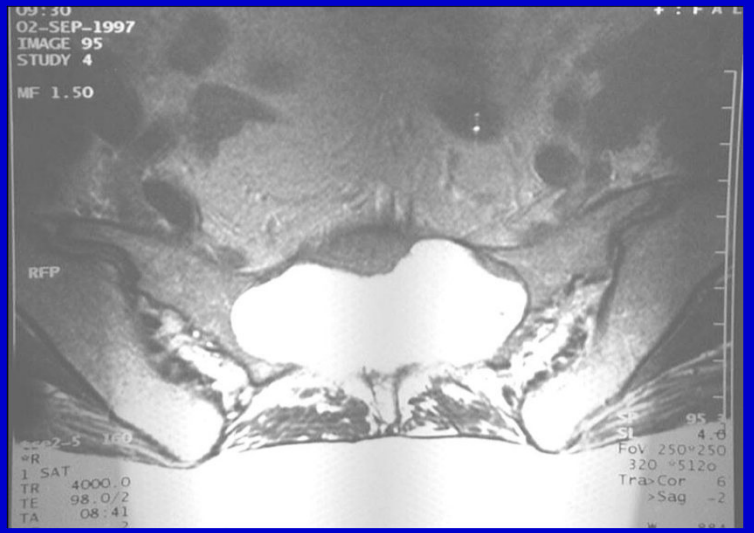
- Reasoning:
  - goal = Delay definitive fusion til > 10 y.o.
  - Growing devices buy ~ 3-4 yrs: delay til 6-7
- "Milder syndromic"
  - some Marfan, nondysplastic NF1, unknown syndromes
    - casting can hold off kids for growing devices until age ~6
- Severe syndromic and profound NM:
  - risks versus benefits of casting versus bracing
  - General anesthesia has risks
  - Make individual decision with family

Common Themes- preop

- Consider “growing” options
  - Growing rod
  - VEPTR
  - others
  - Ideal indications: ~70^{o+} / skeletal age 5~ 9

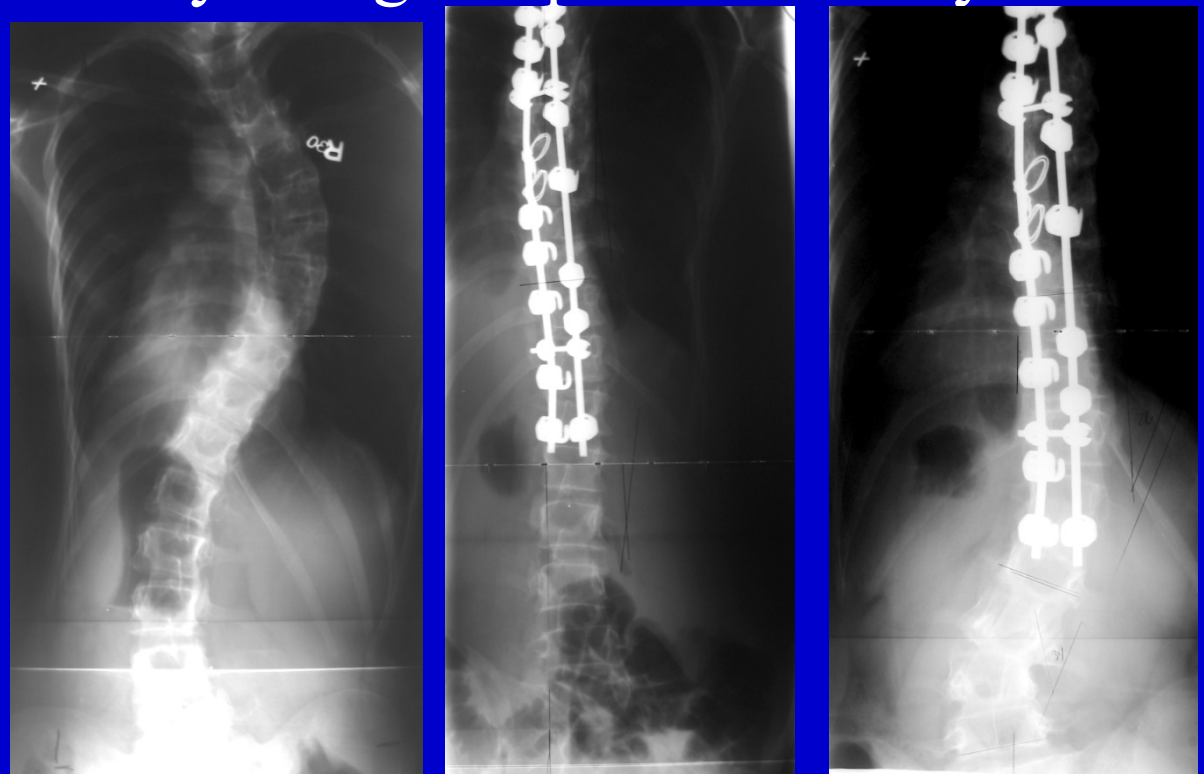
Common Themes- preop MRI

- Usually high yield in syndromes
  - Dural ectasia
  - Cord size, location
  - Stenosis
  - Bony anatomy
- When?
  - Preop or if findings dictate



Common Themes- Operative

- Don’t fix short
  - Neurologic and structural problems prevail
  - Selective fusion not as likely to work
  - Analyze sagittal plane carefully



Common Themes -operative

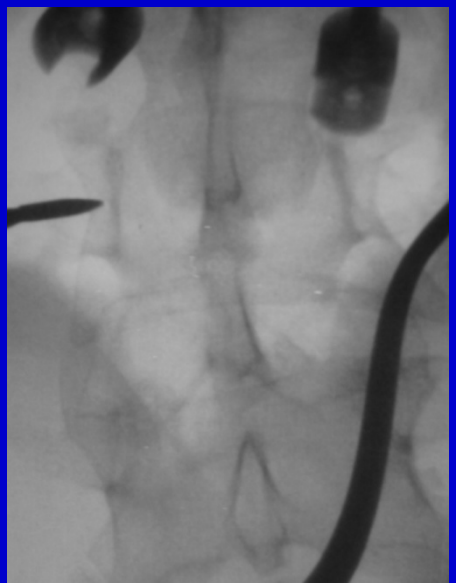
- Bleeding usually more than in idiopathic
  - Amicar / tranexamic acid
  - FFP
  - Use your “first team”

Common Operative T-L Themes

- Increased rate of fixation failure
- Narrow or dysplastic pedicles, laminae
- Suggestions:
  - Obtain good imaging in advance
  - Coned AP plain films
  - CT scans / O-arm
  - Traction films

Screws in thin pedicles

- Measure AP canal diameter
- Outside-in
  - enter lateral pedicle wall at base
  - Then angle medially to cross pedicle cortex

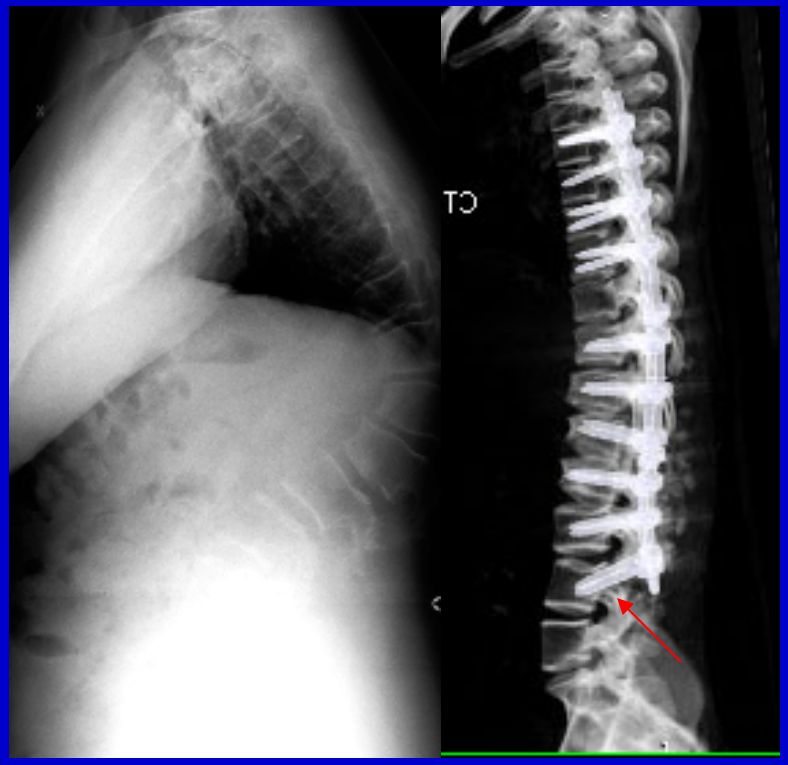


Instrumentation

- Use rib fixation as needed
- Fix all levels
- Range of rod sizes: 3.5, 4.5, 5.5 mm
- Range of screw sizes
  - 3.5, 4.0mm (cervical)
  - Pediatric 4.35, 5mm

Bone density in syndromes

- Decreased in OI, many dysplasias
- Sclerotic/brittle in NF1

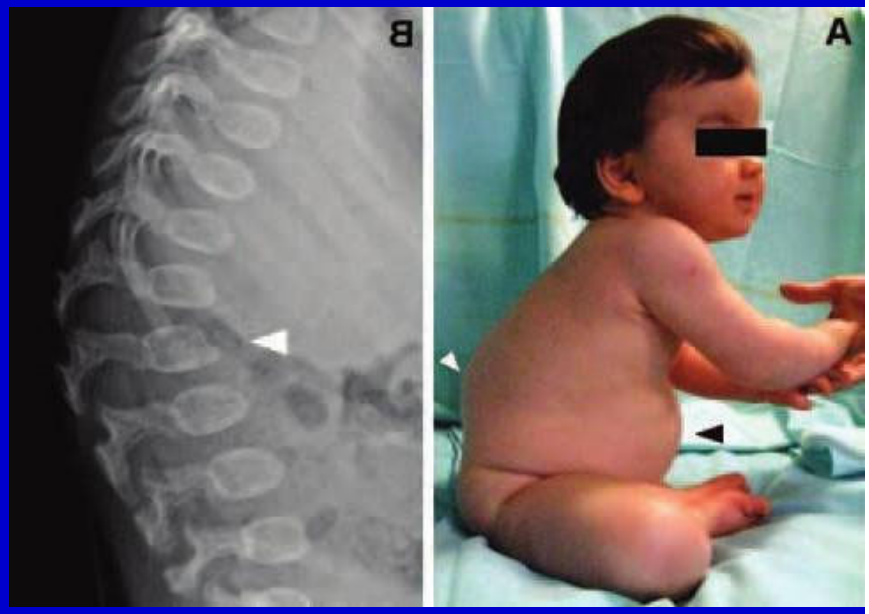


Skeletal Dysplasias

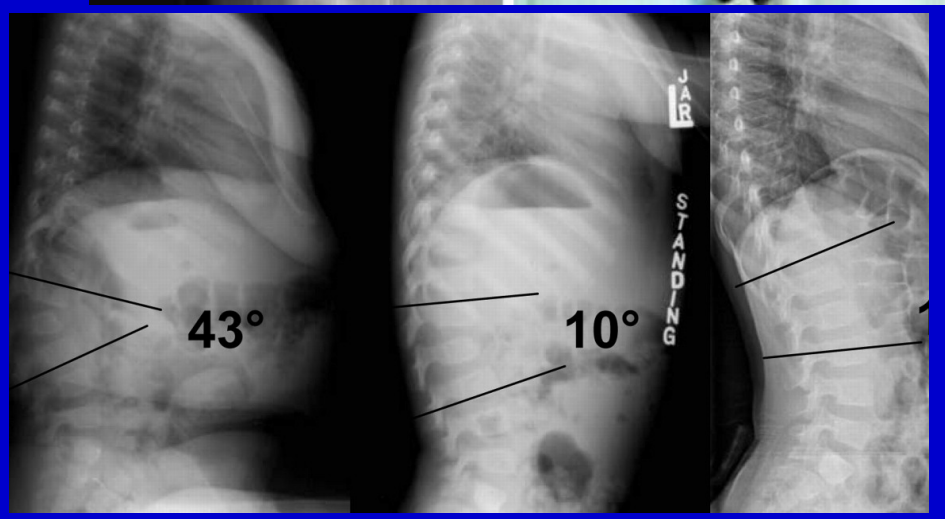
- Upper cervical instability in SED, Kneist, MPS,
- Kyphosis in Larsen, Diastrophic (may improve)
- Stenosis: Achon, chondrodysplasia punctata
- Obtain baseline NM before turn

Early Dx of Hurler

- "hook-shaped vertebra"
  - Baruteau
- Vs benign kyphosis
  - Weinstein – resolving



– Devel delay is a sign

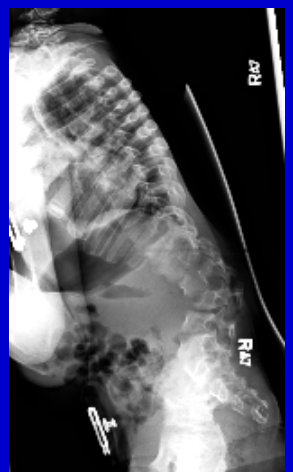
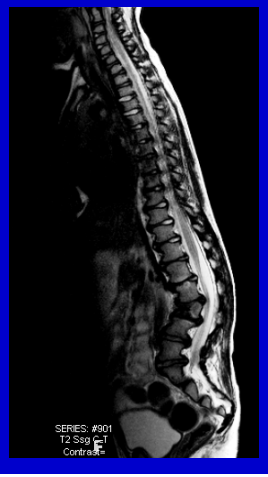
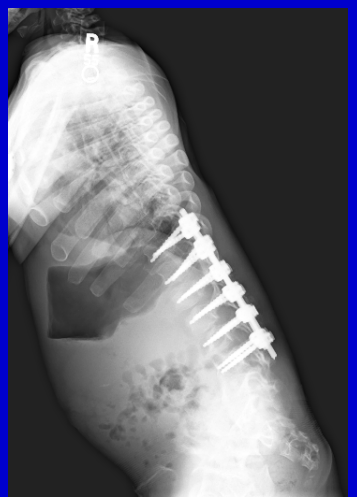
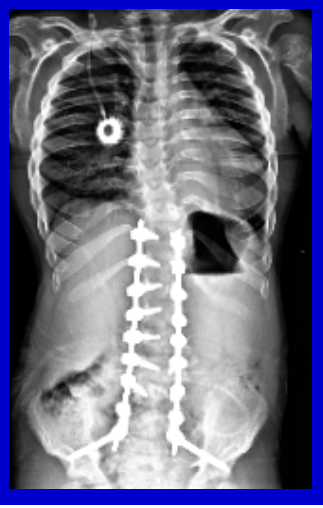
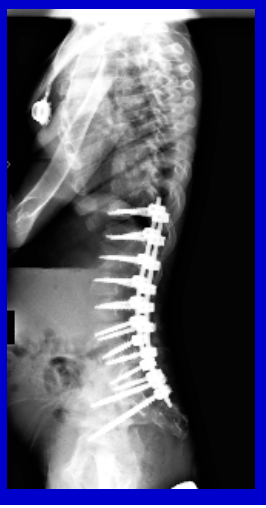


Hurler Syndrome

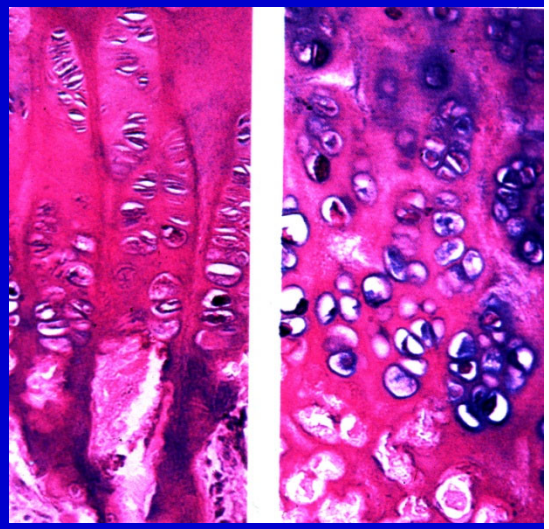
- Beware c-spine
  - 81% odontoid hypoplasia
  - ~80% thoracolumbar kyphosis
  - Not halted by transplantation
- Look for L.E. contractures

Hurler TL kyphosis- indications, technique for fusion

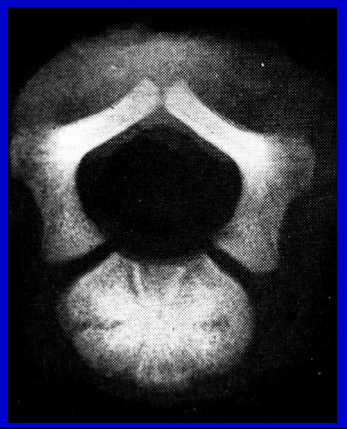
- Significant progression
  - >30 degrees
  - Symptoms at site
  - Neurologic progression
- Anteroposterior vs posterior only

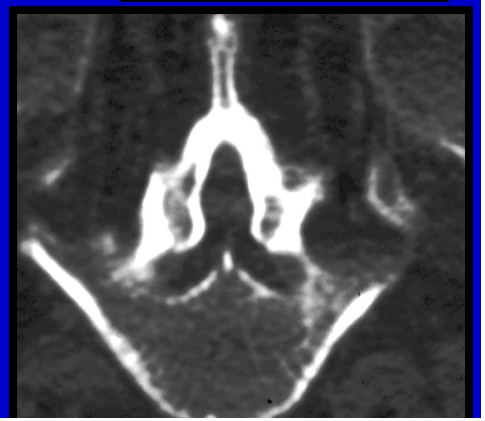






Achondroplasia



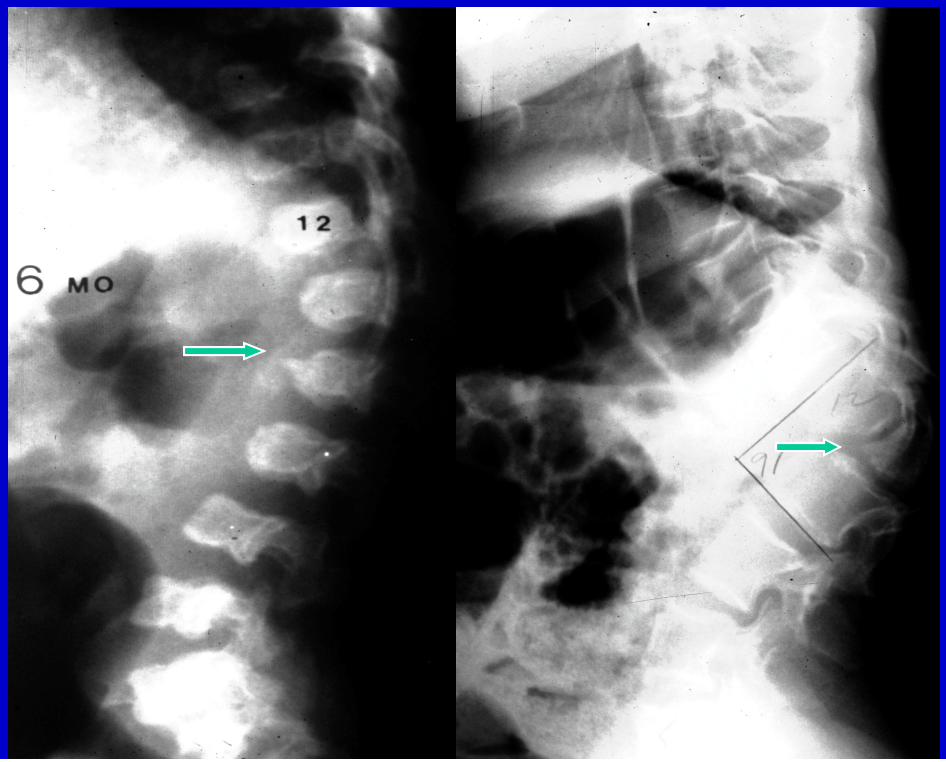
- Defect in FGFR3
- Early-onset foramen magnum stenosis
  - Some improve spontaneously
  - Suspect if sleep apnea, weakness
    - Ach milestones delayed
  - MRI, sleep study to evaluate
  - Foramen magnum decompression





Achondroplasia -Spinal problems

- Thoracolumbar kyphosis before walking
  - usually resolves shortly after walking
  - Use extension TLSO if persists past age 2



Achondroplasia

- Indications for fusion:
  - Any TL decompression for stenosis in immature patient
    - Otherwise will progress
- For deformity alone:
  - Most tolerate mild TL kyphosis

Achondroplasia: Controversies

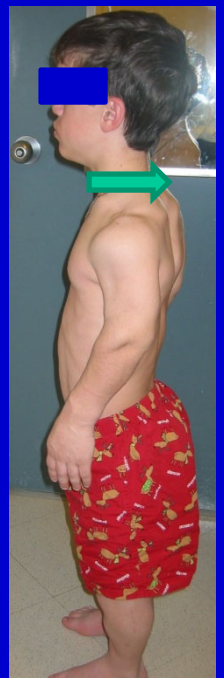
- When to fuse for deformity alone
  - in absence of stenosis Sx?
- My preference:
  - Bracing may work in young children < 45^{o}
  - Fuse Kyphosis over ~45-60^{o}
    - Age over ~6
- Should you to fuse to sacrum ?
  - Lower re-stenosis; trend to difficulties with personal care

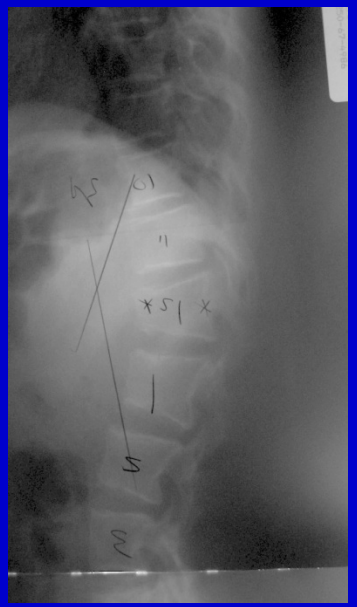
Achondroplasia-techniques

- High risk of signal changes (~30%)
- Avoid Hooks, instruments in canal
  - Use burr
- Pedicle length ~15mm; screw <35mm
- 4.35-5 mm screws usually sufficient
- High risk of dural violation
  - Nerve roots seem pressurized

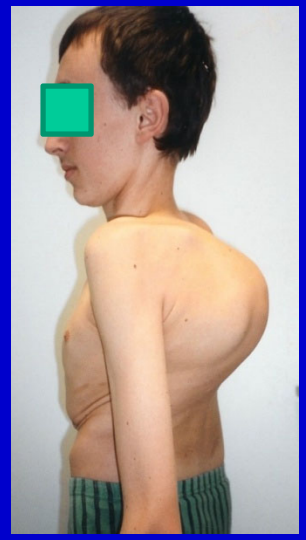
Achondroplasia- techniques

- Correct kyphosis only to best bend
- Focal Kyphosis: ?VCR- few cases, high risk

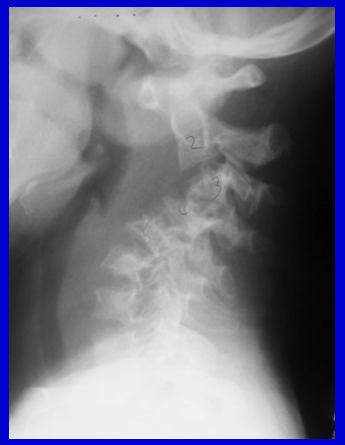


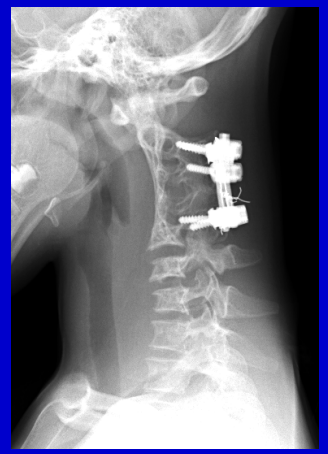


NF-1



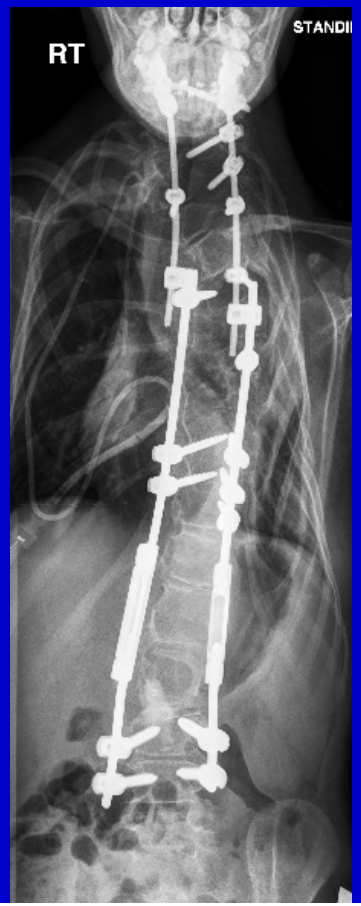
- Early-onset deformity
  - untreated- severe, high risk deformity
  - ~20% need Tx for spine Deformity
- May affect all regions
  - And all planes!



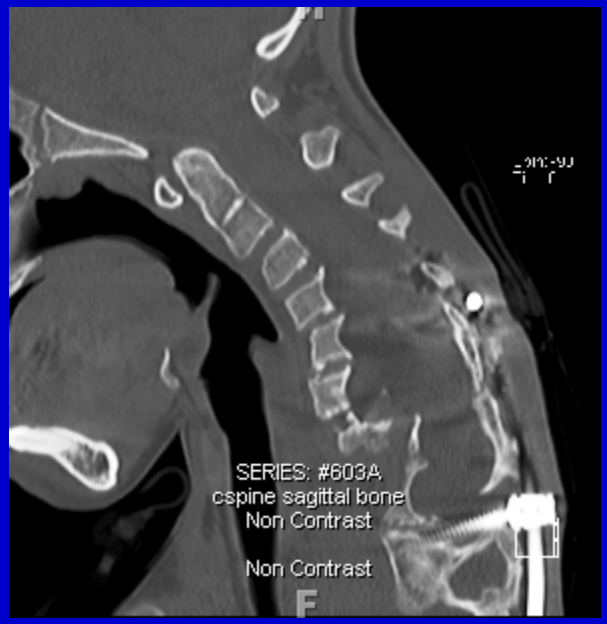


NF1

- Dystrophic spine and DE are EOS challenges
  - Jain, SRS/ICEOS 2011 – 14 patients
- Definition: $\geq$ 3 of:
  - Rib pencilling
  - Vertebral scalloping, wedging
  - Widened neuroforamina
  - Thin TP
  - Focal rotation



NF1-issues



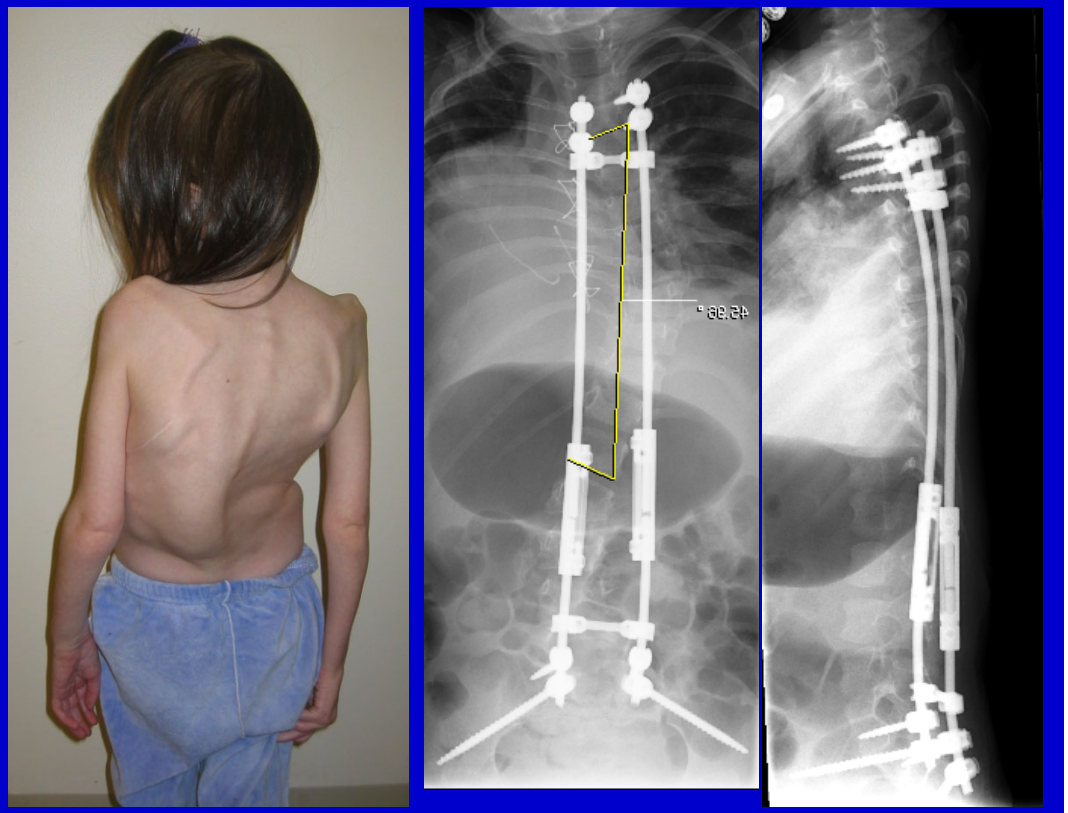
- Failure of fixation
  - Sclerotic pedicles;
  - Dural erosion
- Suggestions:
  - Avoid ending in dystrophic areas
  - Manage CSF issues by avoidance, layered closure, recumbency, lumbar drain, diamox
- GR may prevent need for A&P fusion
- Circumferential fusion if severe focal deformity

Infantile Scoliosis in Marfan

- Neonatal MFS is the most severe
  - usually neg. family history
- Delayed walking
- Increased early Cardiovascular mortality
- Suggest delaying surgery until CV stable

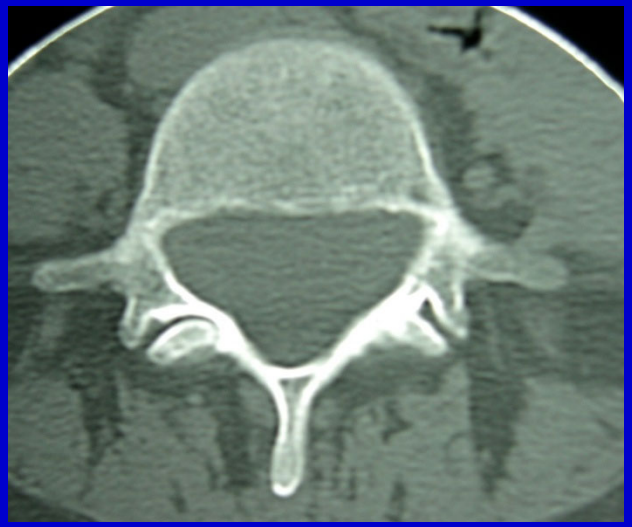
3 yr old Marfan

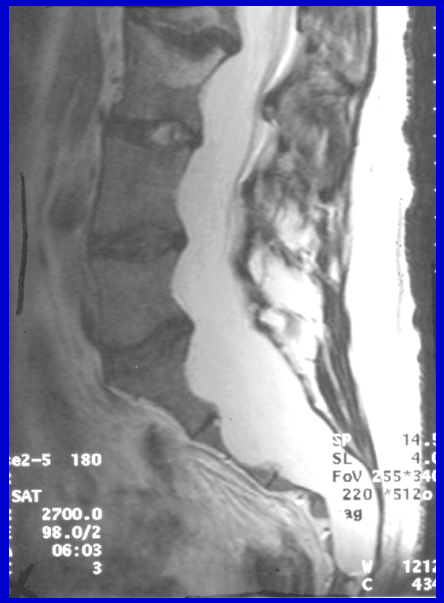
- pelvic fixation if:
  - Distal ldysplasia
  - Distal kyphosis

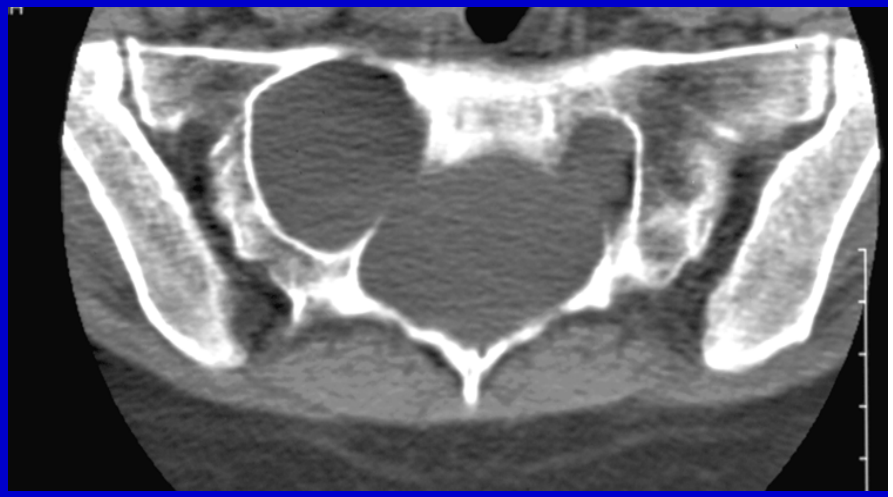


Bony changes from Ectasia

- Pedicles thin
  - Dysplastic looking
- Laminae thinned
- Vertebrae scalloped

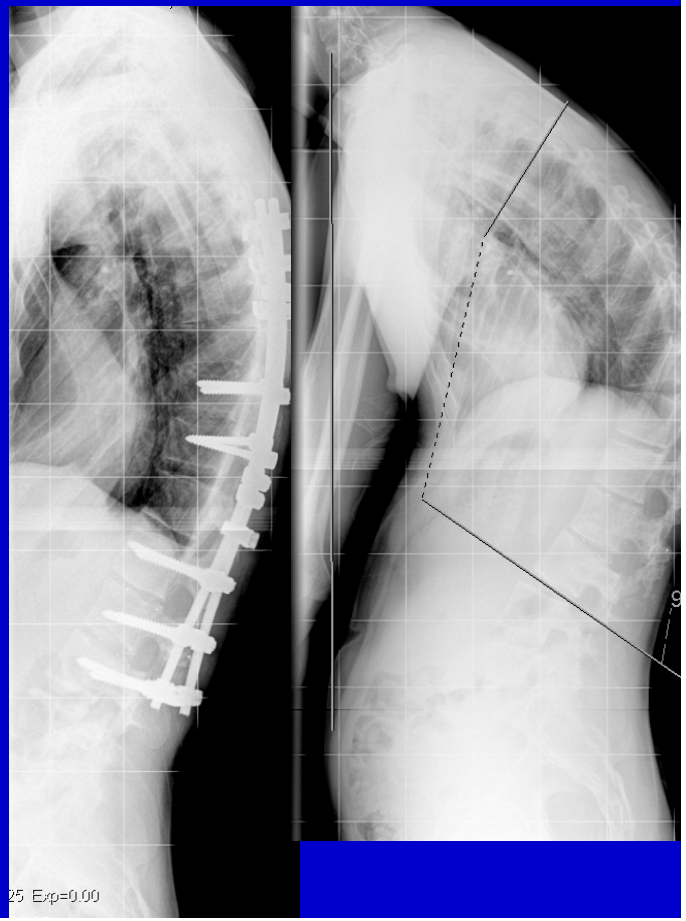






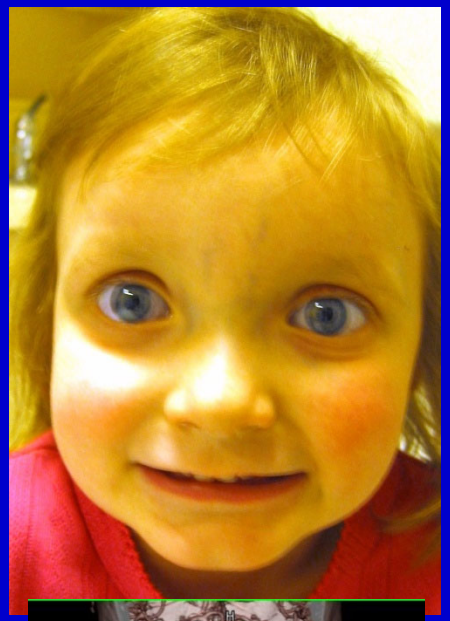
Failure of Fixation: major message!

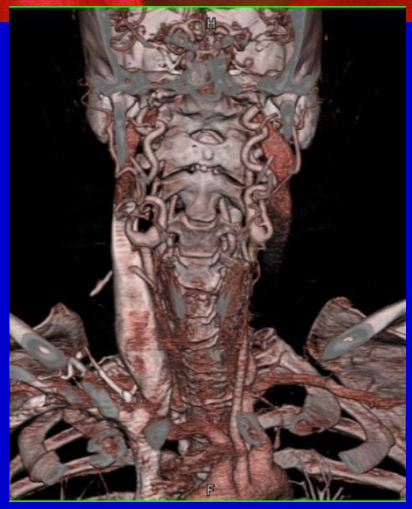
- Avoidance:
  - imaging in difficult pedicles
  - Add hooks if needed (3rd rod)
  - Minimal rod contouring
  - Add another level

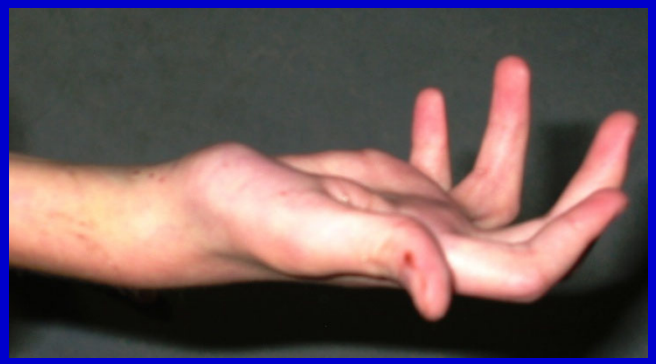


"New" Syndrome: Loeys-Dietz (LDS)

- TGF beta receptor abnormality
  - Treat aggressively
- Arterial tortuosity and aneurysms
- Hypertelorism
- Cleft palate and uvula

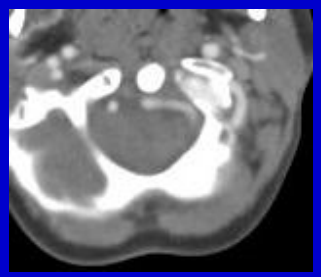


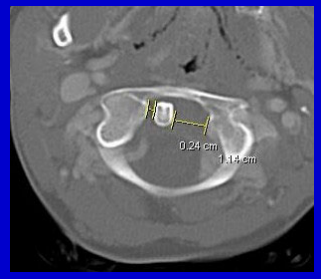


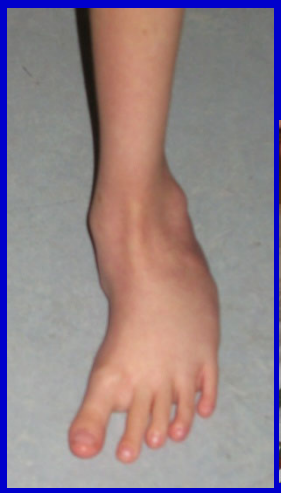


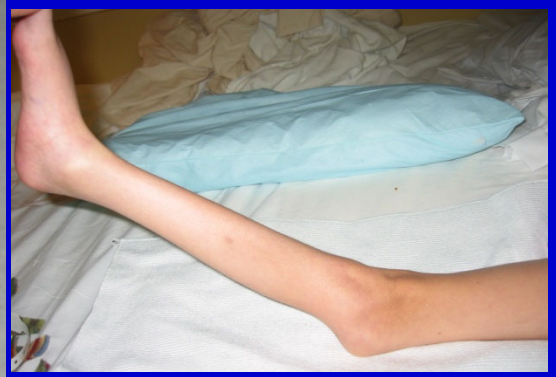
LDS: Orthopaedics

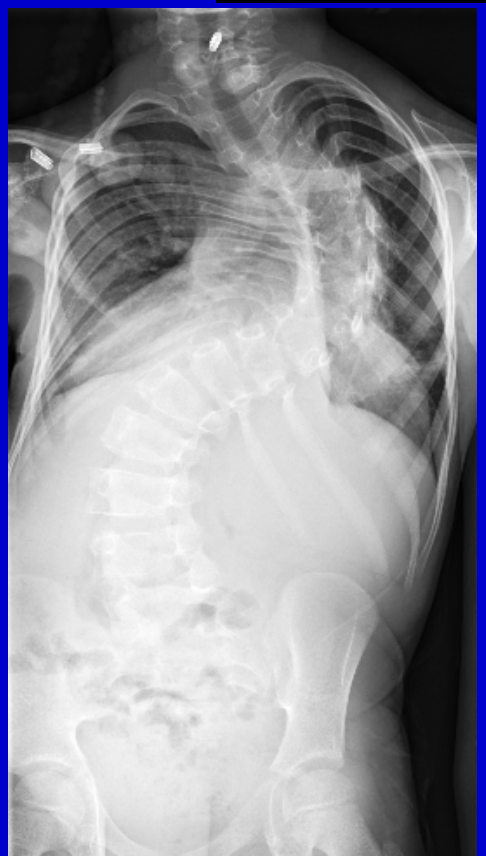
- Cervical bifida/ instability
- Scoliosis
- Clubfoot
- Ligamentous laxity

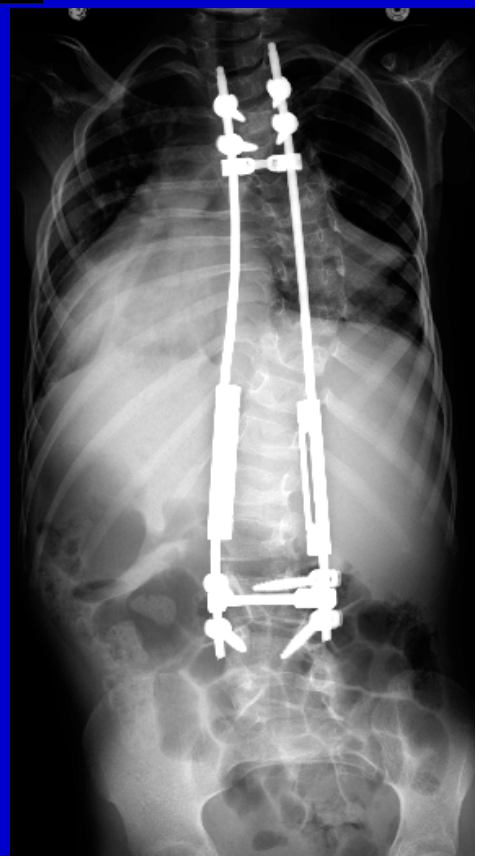












Ehlers Danlos Syndrome (EDS)

- Defects in collagen or its processing
- Classical (Types 1&2; abn COL5)
  - most severe
- Hypermobility (type III; ? Defect)
  - No spinal implications
- Kyphoscoliosis (type VI abn LH)
- Arthrochalasis (type VII; abn COL1)

EDS
-surgical points

- High complication rate
- Avoid anterior approach if possible
  - Vascular fragility
  - "growing" approaches help avoid this
- Increased risk of PJK/DJK
- Increased bleeding risk
  - Antifibrinolytics
- ? Wound infection risk

Prader-Willi Syndrome

- Missing paternal chromosome 15
- 1:15,000
  - 3:1 male
  - 30-50% TL spine deformities
- GH improves prognosis
- High complications:
  - Neuro change
  - Failure of fixation
  - infection

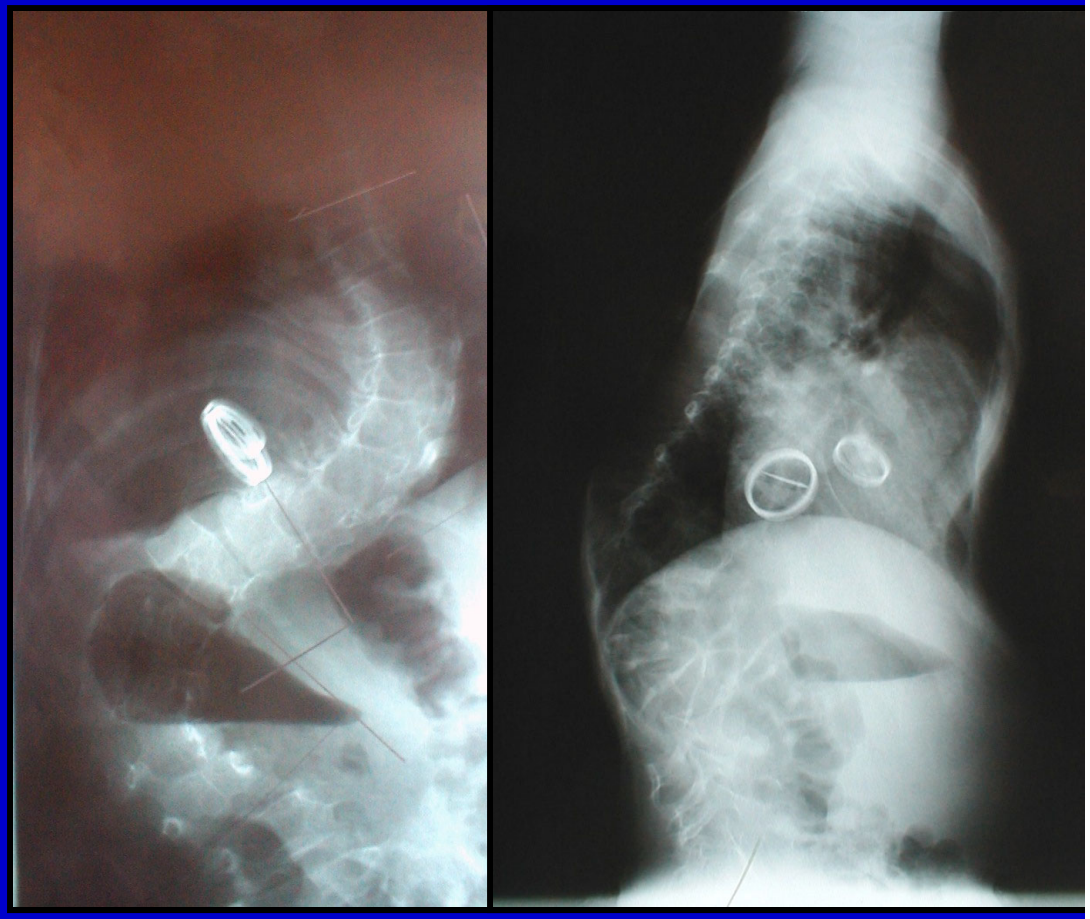
What Have we learned about syndromes

- Syndrome findings vary
  - Genome modifies mutation
- Diagnosis important for specific issues

- Surgery: a few differences
  - Natural history important to understand for all genetic disorders

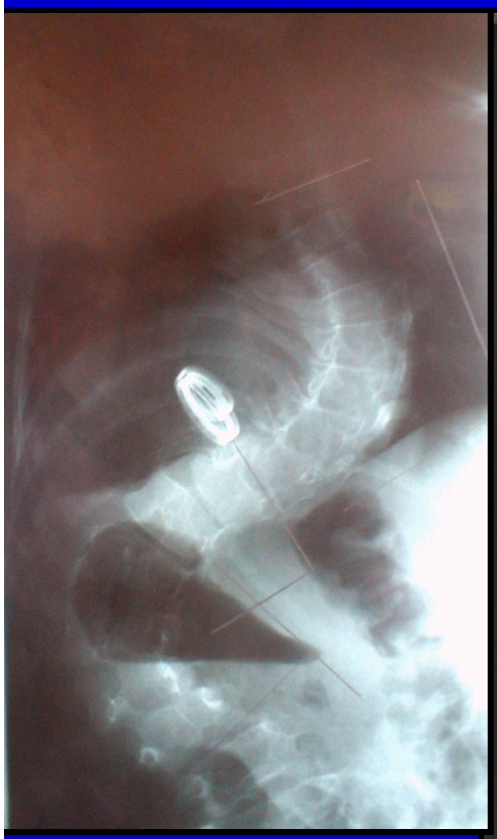
Infantile Marfan Syndrome

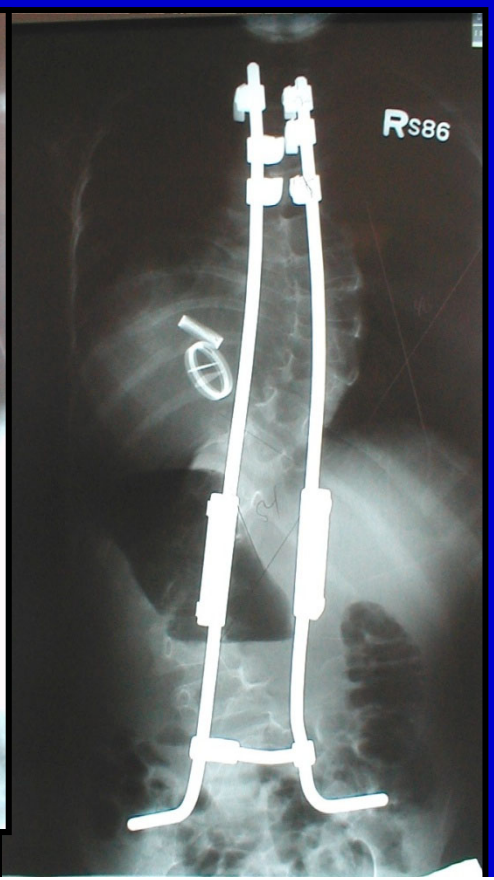
- 4+3 yrs old
- 3 valves replaced
- Prior brace
- 90^{o} thoracic
- 105^{o} lumbar
- 60^{o} TL kyphosis

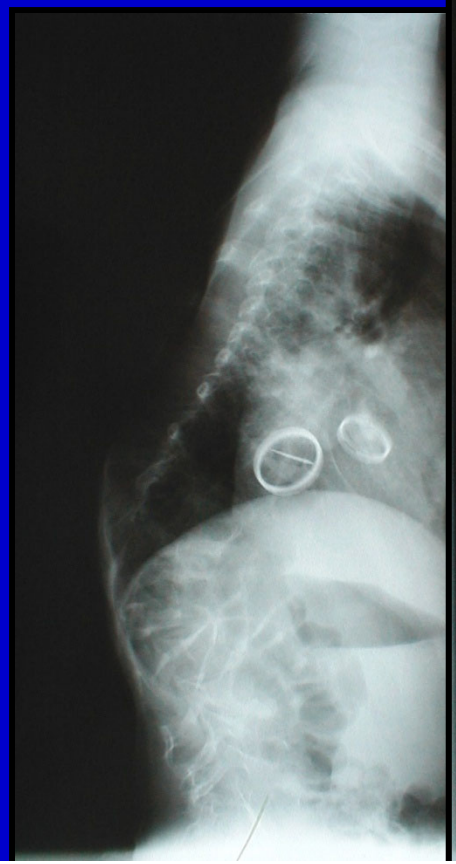


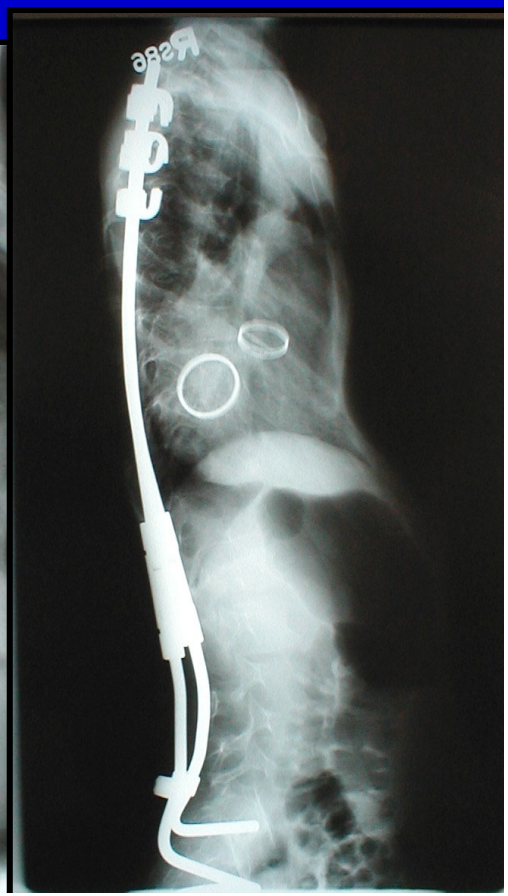
Follow-up

- 4 heart valves!
- Yearly distraction
- 9 cm gain in height



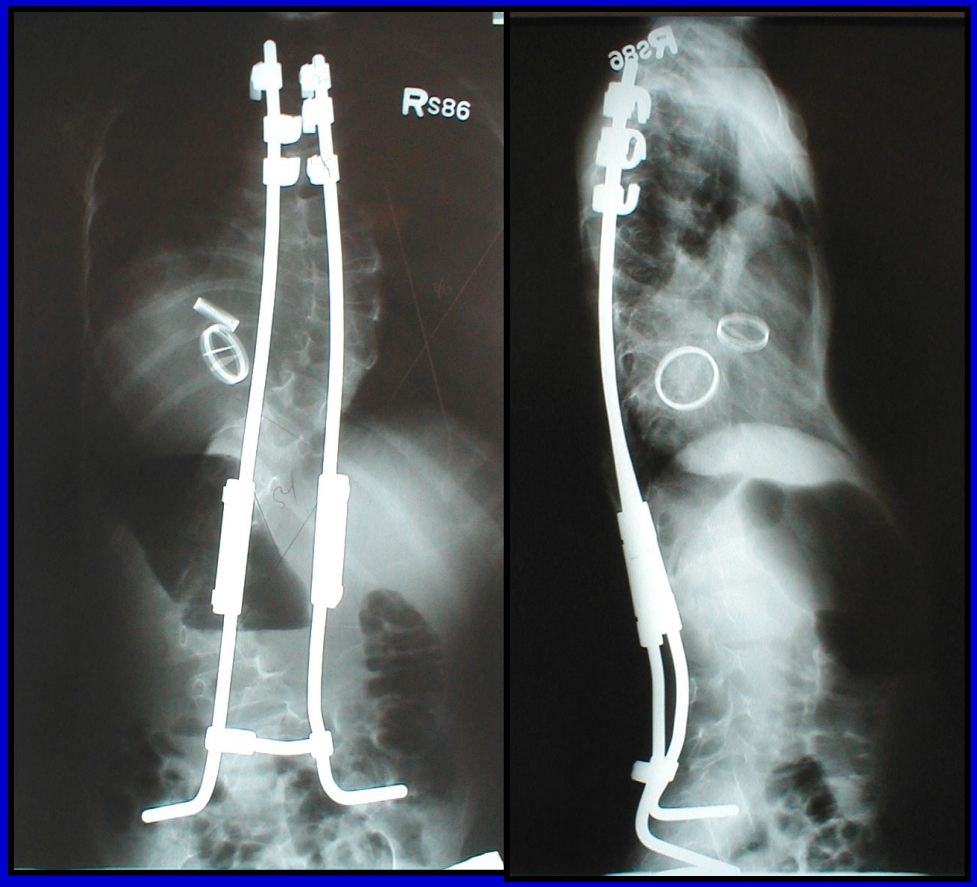






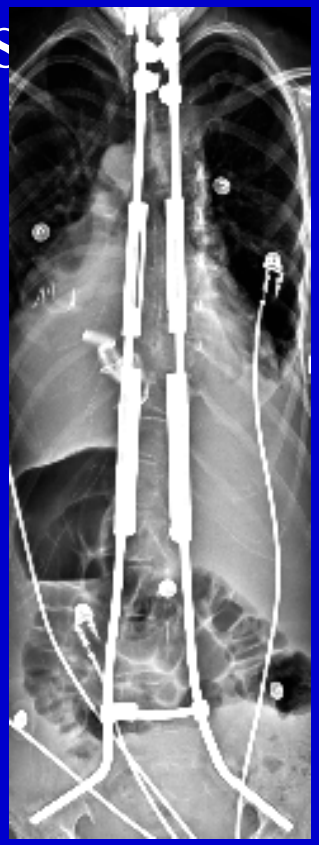
Growing rods

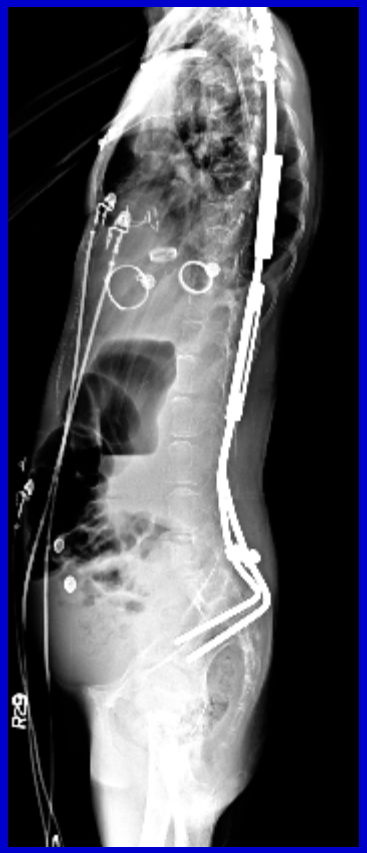
- T3- pelvis
- 7 lengthenings
- 11 cm so far
- CSF pocket



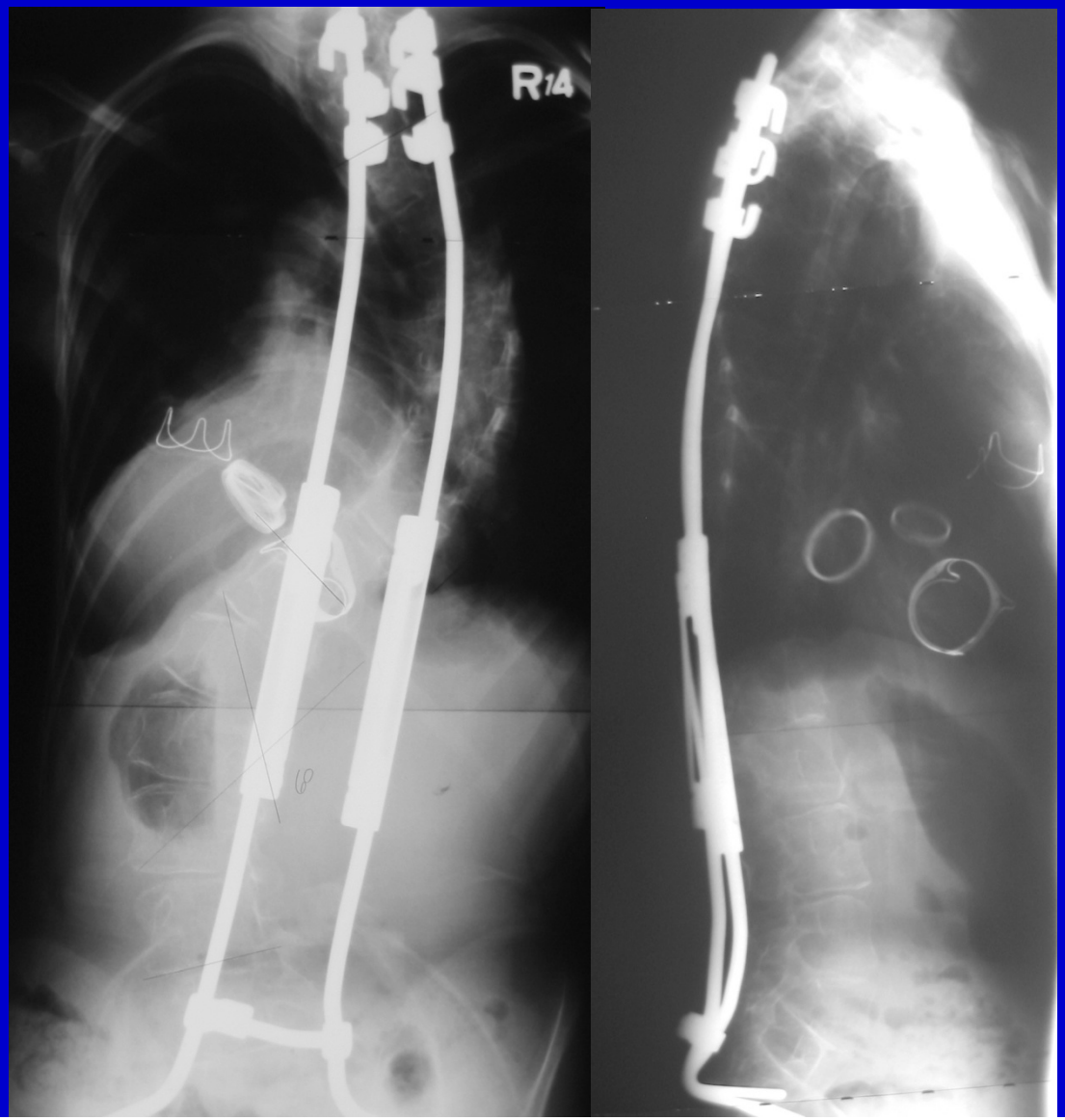
Marfan

- Now with 4 heart valves
- Cantilever bend
  - At last procedure

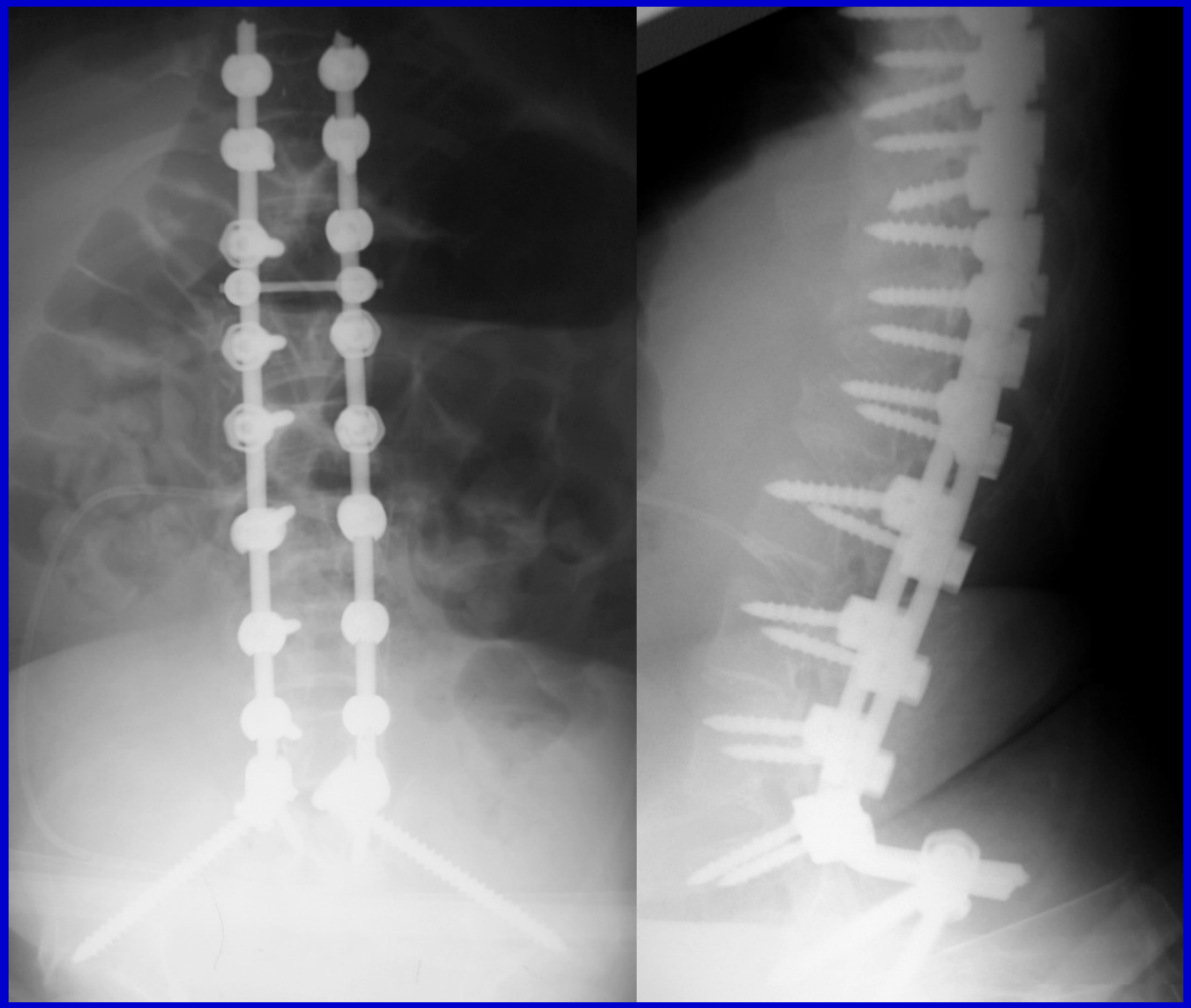




5 yr follow up

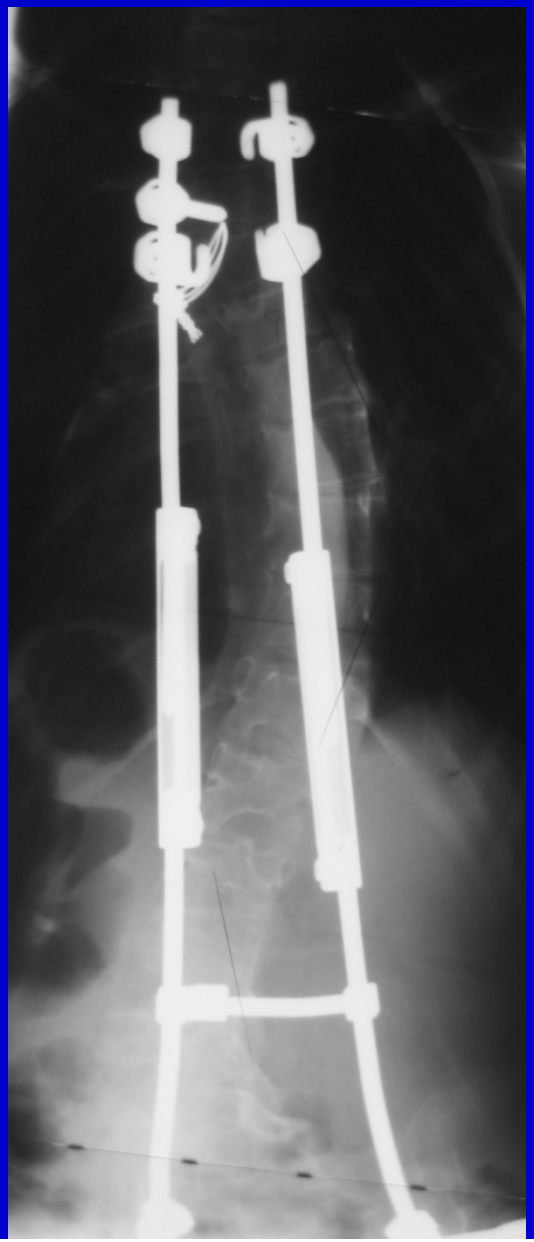


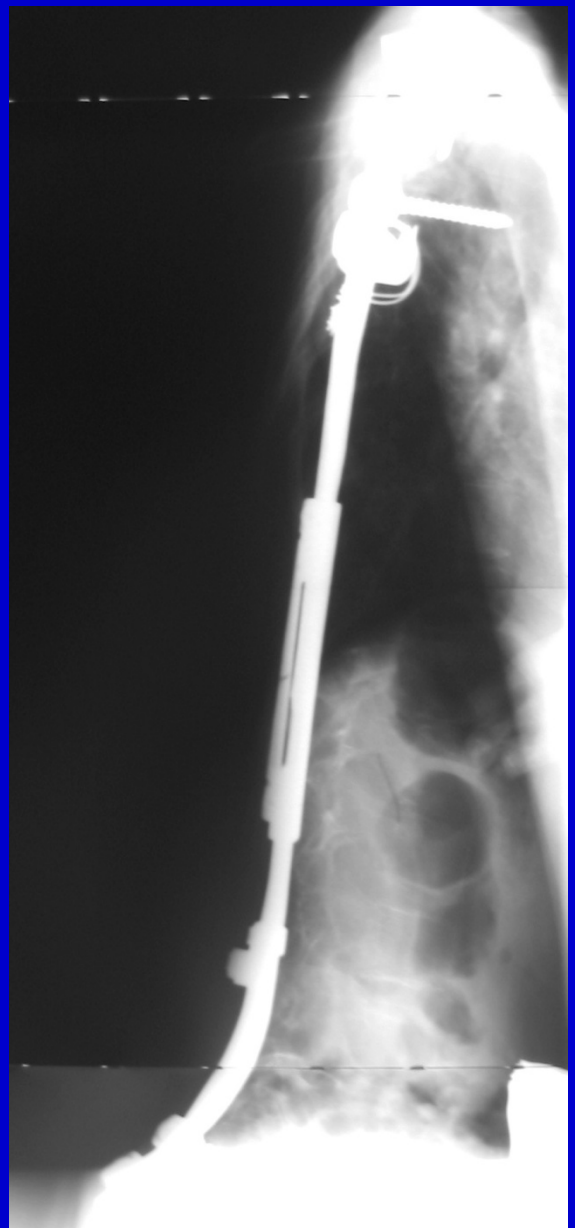
- Function?



Revision

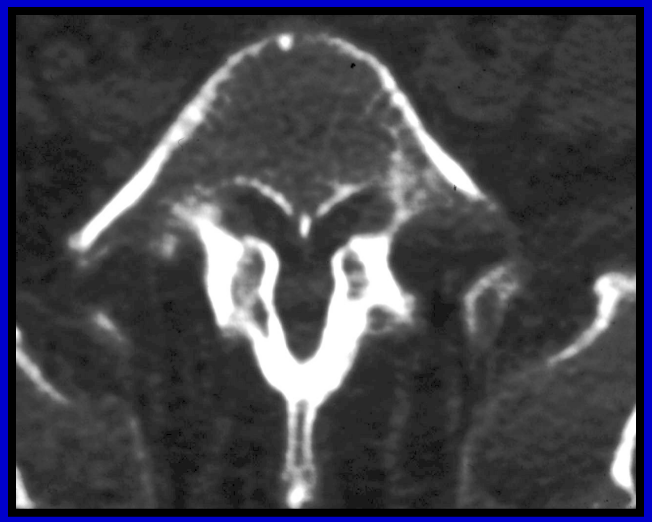
- To pelvis





Achondroplasia: controversies

- 3. How far to fuse?
  - Extent of laminectomy (usually L4)
  - Down to sacrum?
    - If Lami to L5?

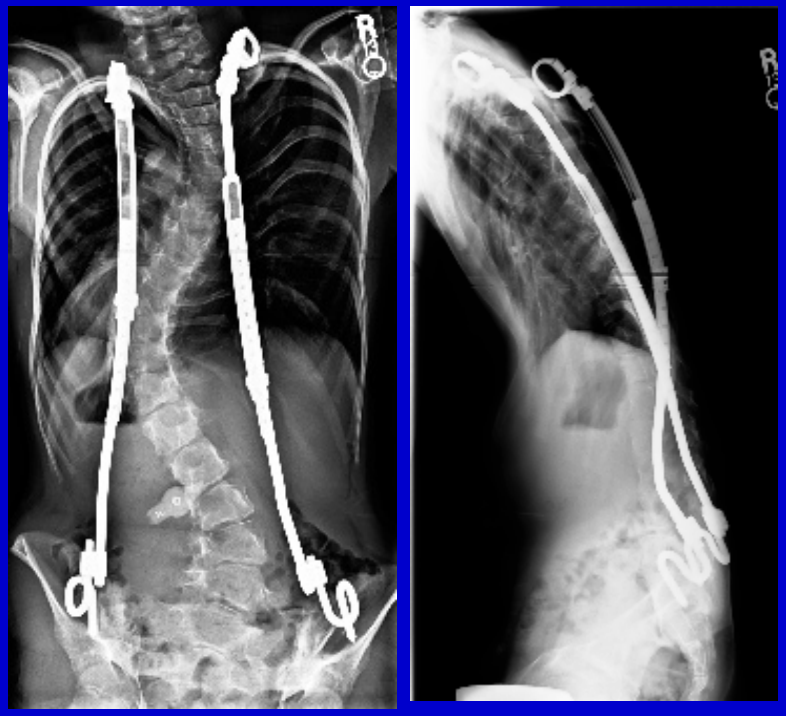


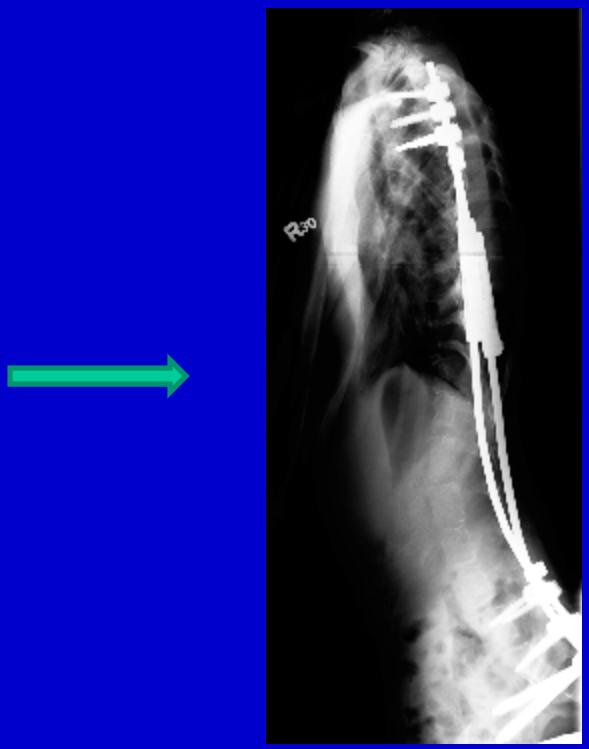

Thanks!
18

Thank You

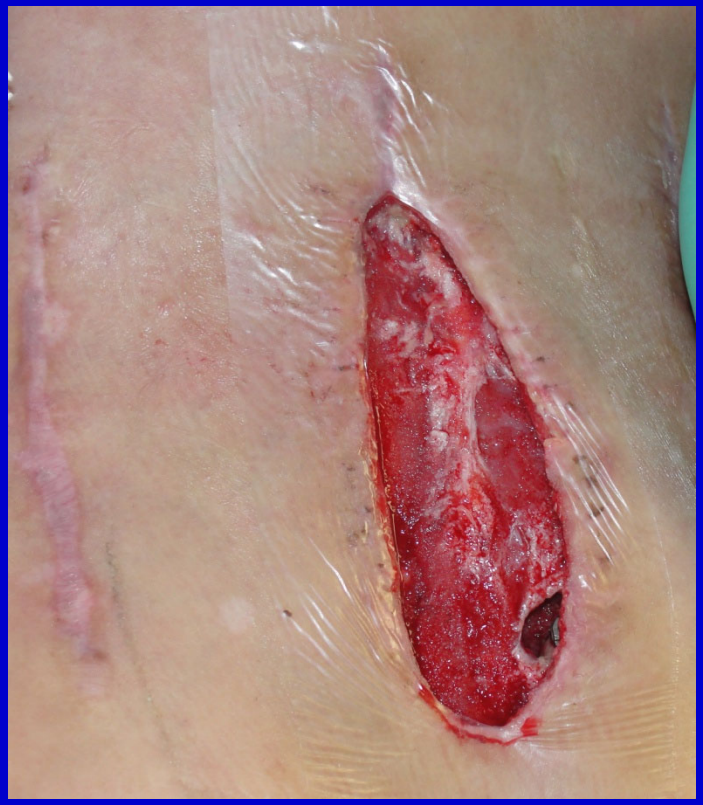
VEPTR in Marfan

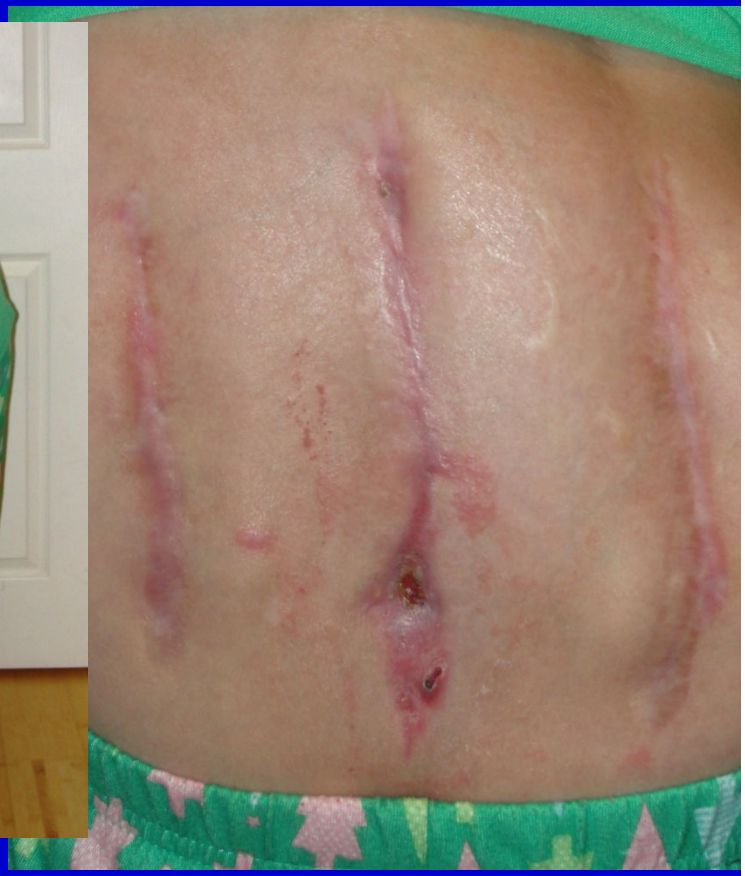
- Forward lean progresses





VEPTR in Marfan



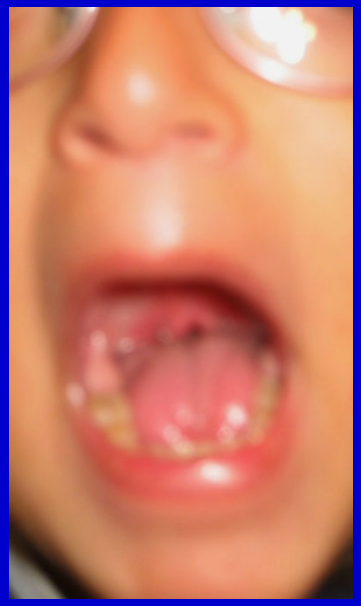


Stickler Syndrome

- Mutations found in COL 2,9, 11
- Kyphosis, Scoliosis, endplate changes
- DJD
- Be aware of ocular risks

Loeys-Dietz Syndrome

- Aneurysms treated aggressively
- Prediction: It will be frequently recognized
- Clubfoot, scoliosis, arachnodactyly: Open the mouth!



Textbooks

- L&W
- Goldberg: The Dysmorphic Child