Idiopathic scoliosis during growth. Diagnosis, Decision making and Treatment

Michel G. Diab, M.D.
Assistant Professor
Underwood Family Chair in Pediatric Orthopaedic Surgery
Texas Tech University school of Medicine
Texas Tech Health Sciences Center

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Definition:
  - 3D Structural deformation: Coronal-sagittal-axial
  - Not completely reducible:
    - Postural scoliosis
  - Unrelated to other detectable pathological processes:
    - ≠ 2ary Scoliosis (congenital, Neuro-Musclular, Neurofibromatosis, Marfan,…)

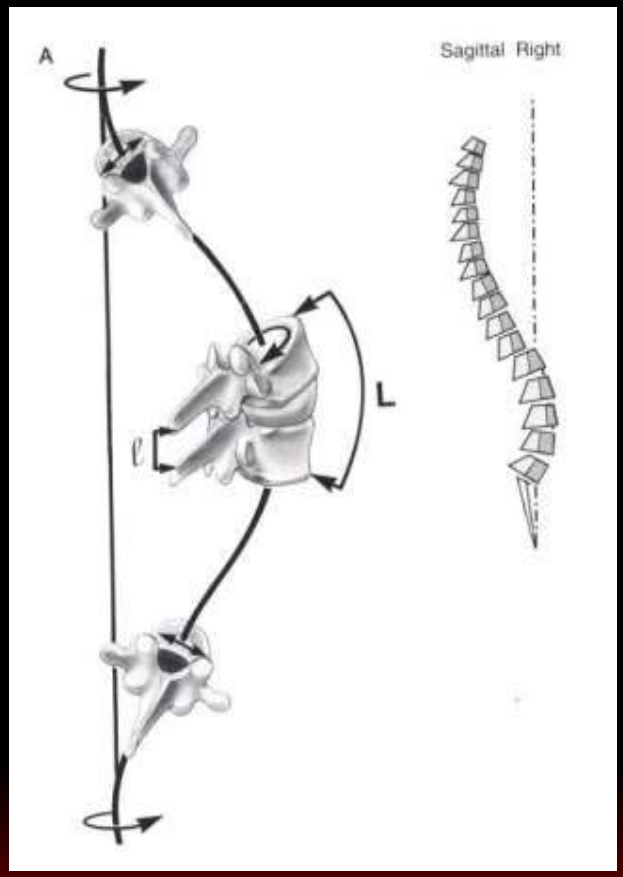
What happens to the spine?

AP

- Deviation from the midline
- Rotation of the apical vertebrae

Lateral

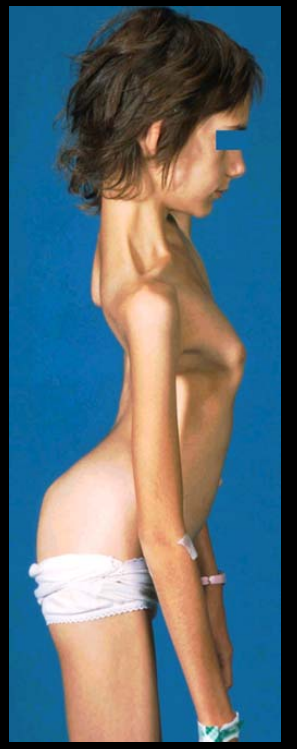
- Flattening of thoracic kyphosis
- Loss of lumbar lordosis



TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Types of Scoliosis

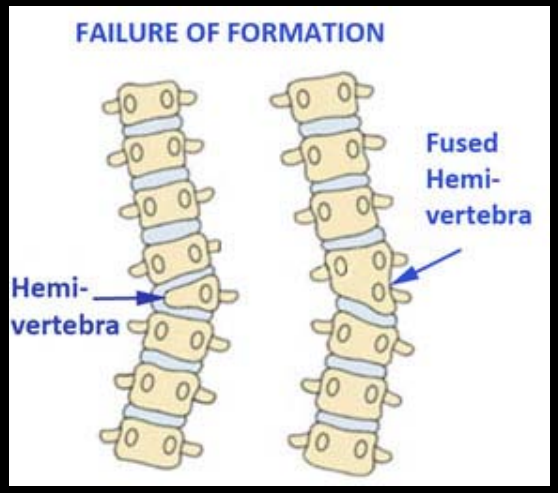


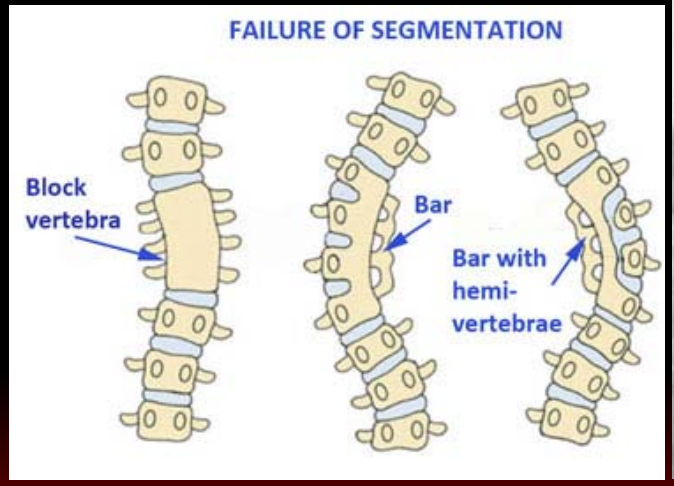
- Congenital
  - Malformation of the vertebral segments
  - Syndromic: Jeune, Jarcolevin
- Neuromuscular
  - Neurological or muscular diseases:
    - Cerebral palsy (BMI)
    - Muscular Dystrophy
    - Polio
- Idiopathic
  - Infantile
  - Juvenile
  - Adolescent
- Neurofibromatosis, Marfan

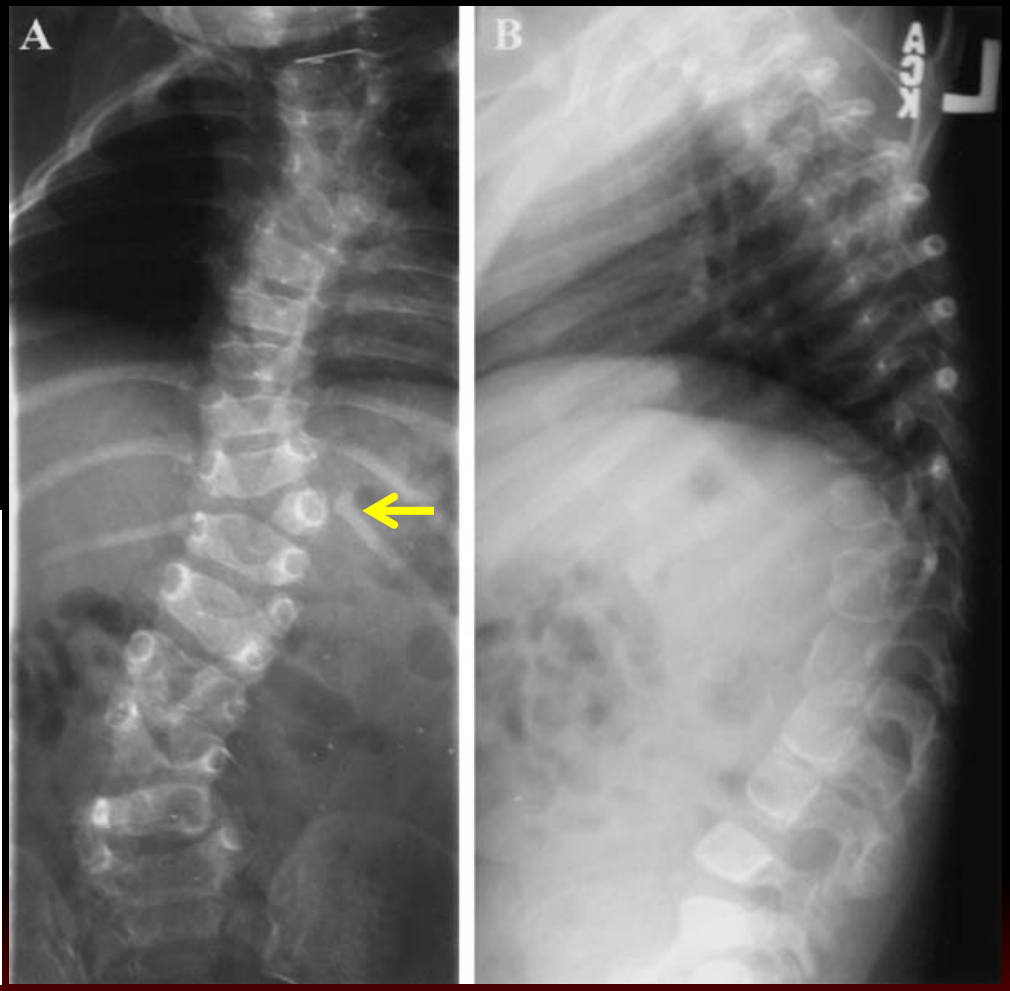
TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Congenital Scoliosis



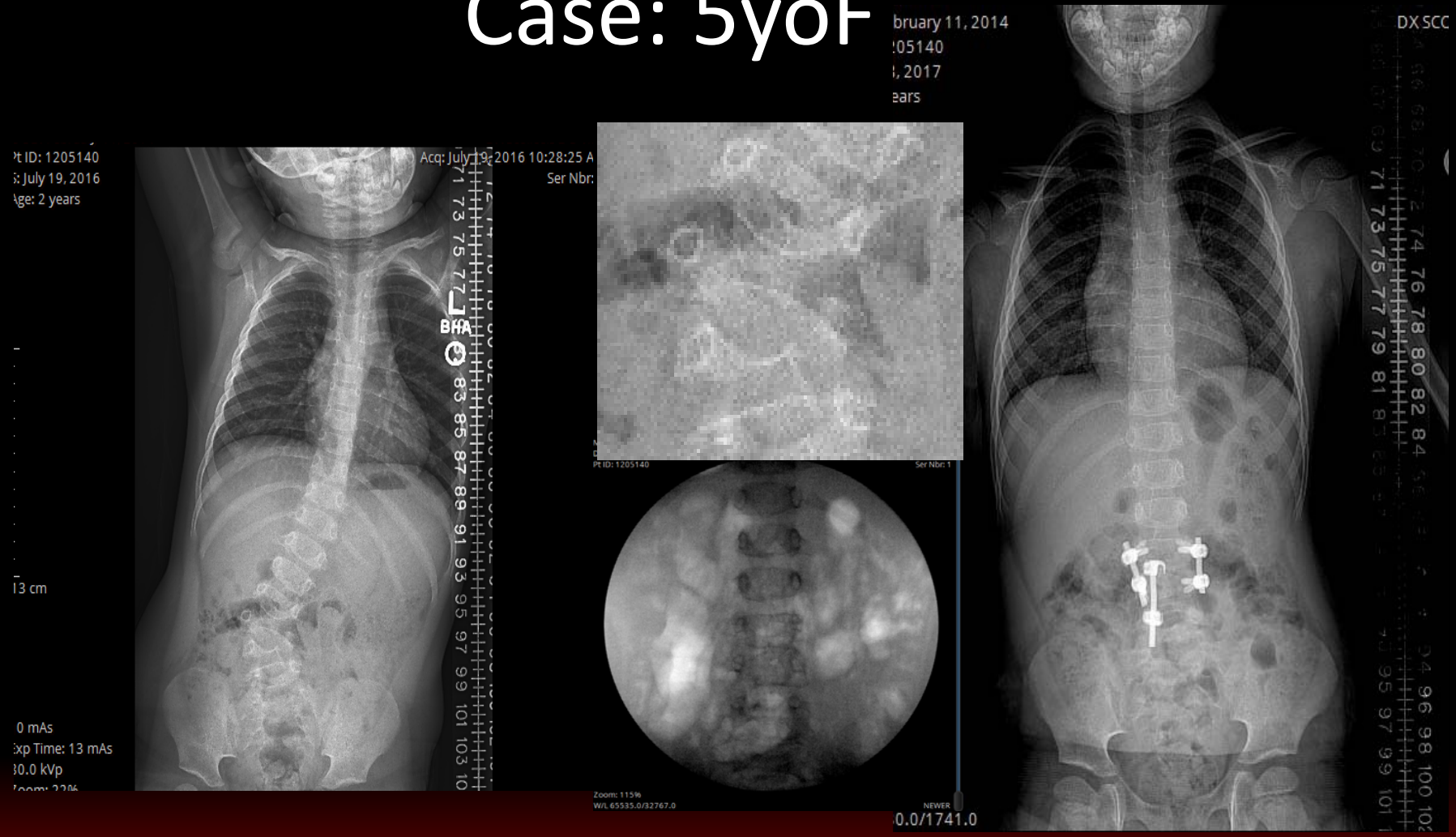




TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

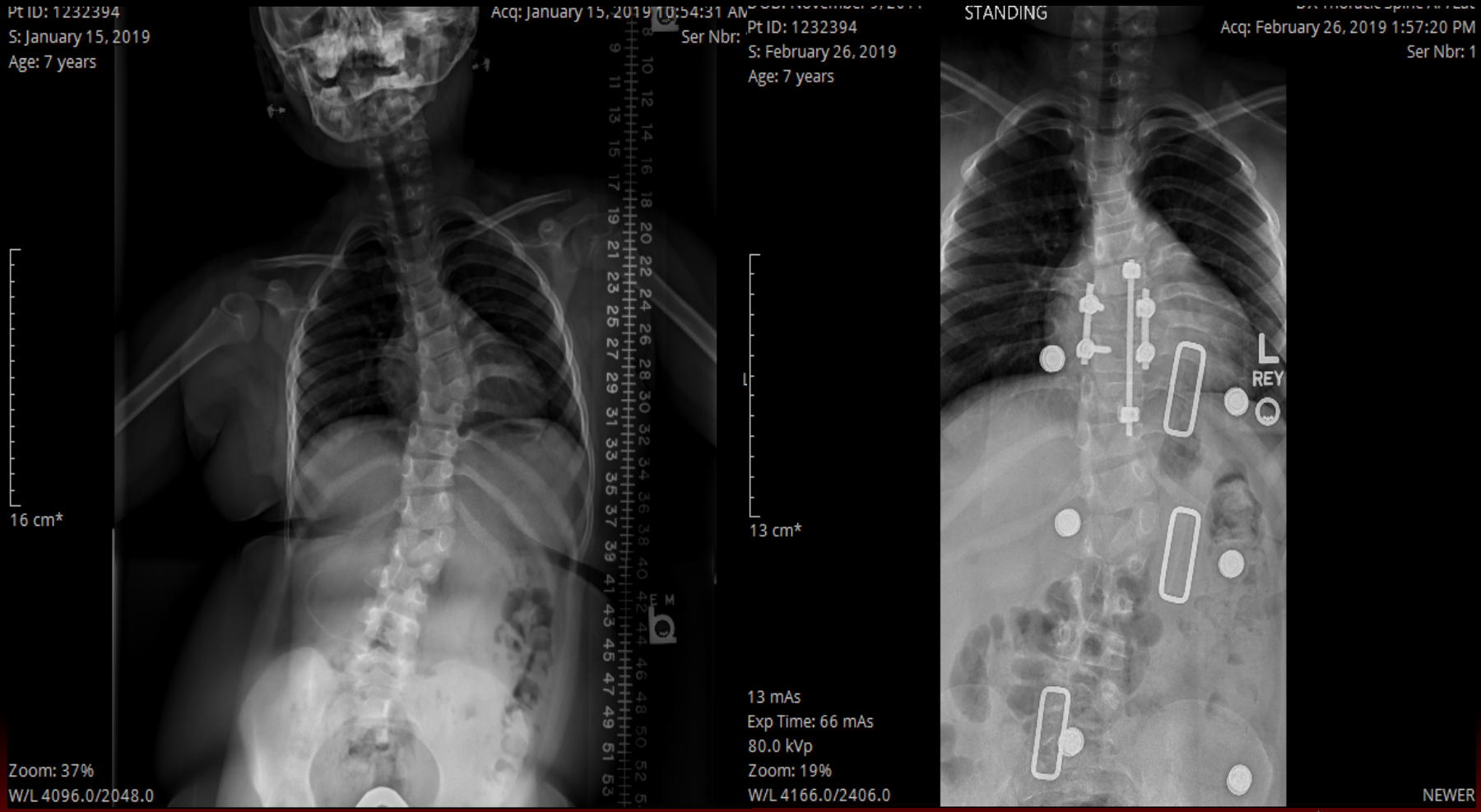
Case: 5yoF



TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Case: 7yo F



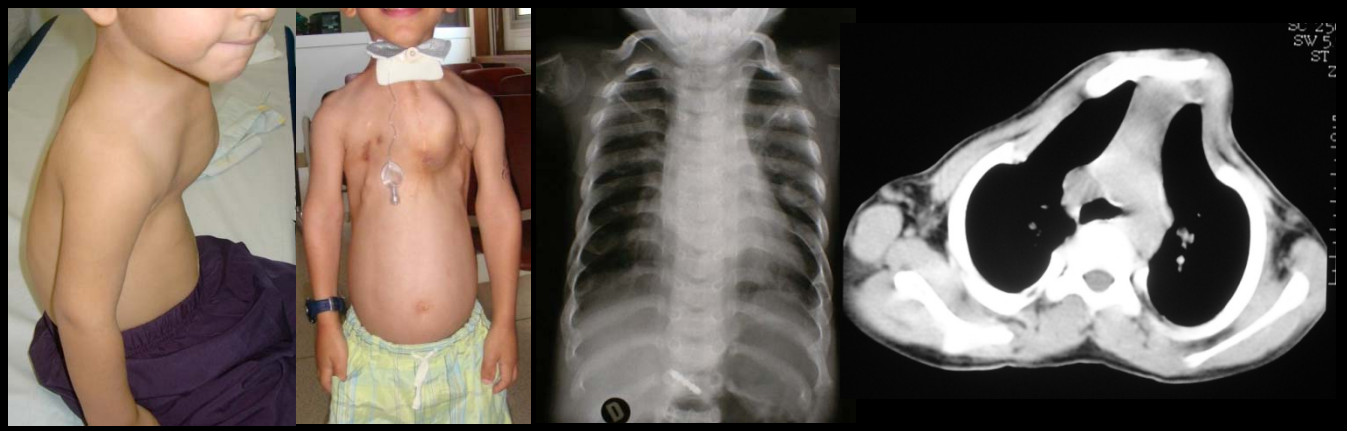
TEXAS TECH UNIVERSITY

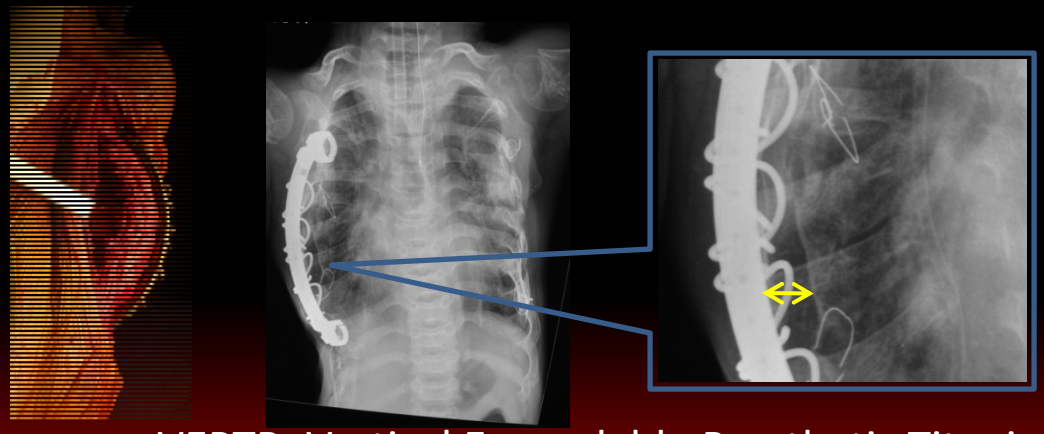
TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Syndromic Scoliosis

Thoracic Insufficiency Syndrome

Jeune syndrome: Asphyxiating Thoracic Dystrophy





VEPTR: Vertical Expendable Prosthatic Titanium Rib

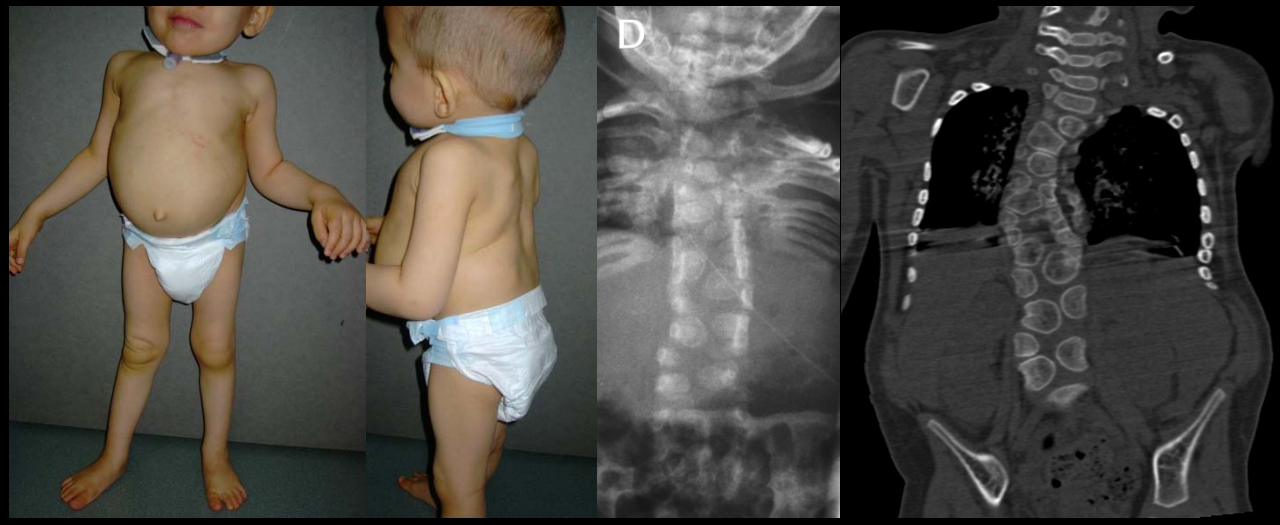
TEXAS TECH UNIVERSITY

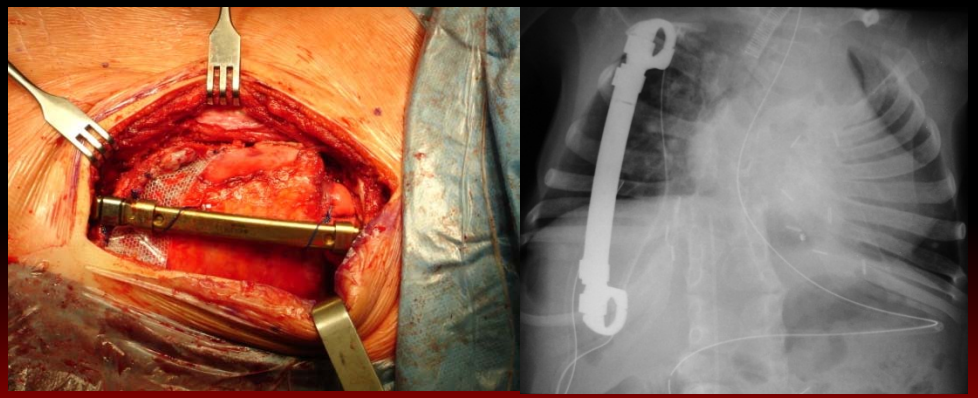
TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Syndromic Scoliosis

Thoracic Insufficiency Syndrome

Jarcho-Levin Syndrome



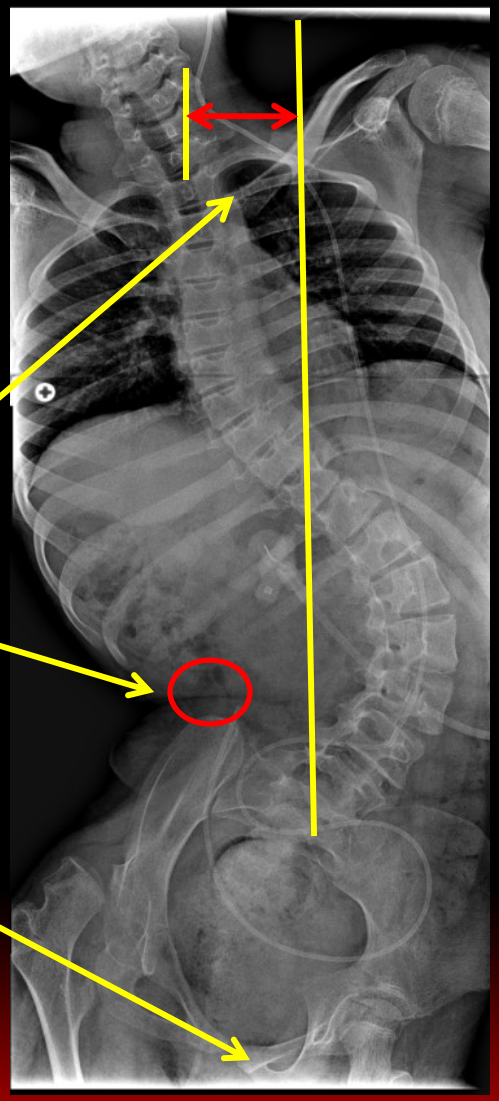


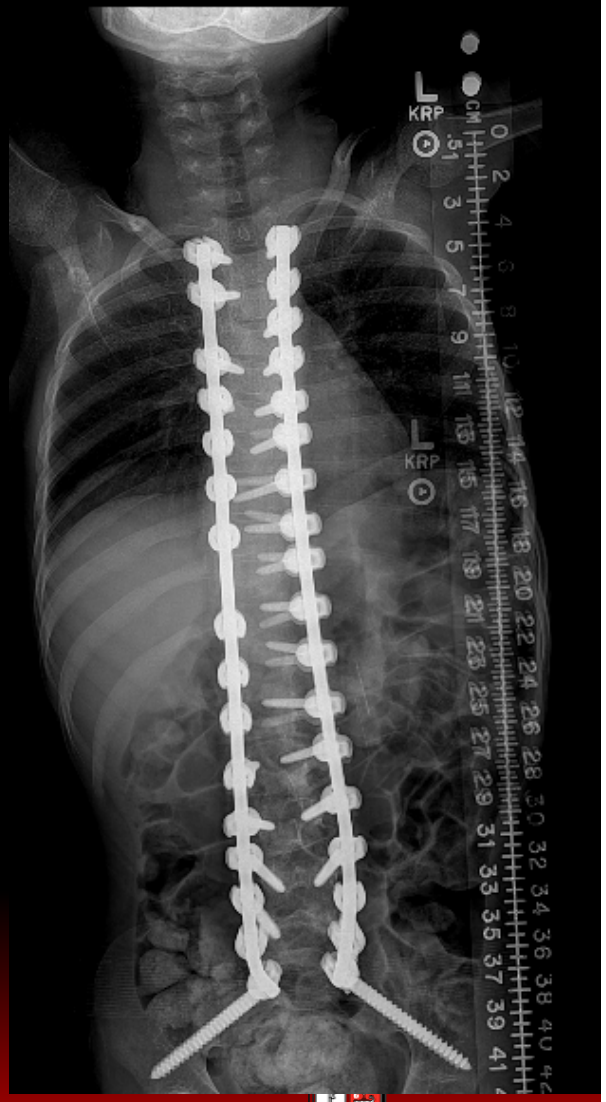
TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Neuromuscular Scoliosis

- Characteristics:
  - Long C shaped curve
  - Pelvic obliquity
- Indication of surgery:
  - ~~Curve magnitude~~
  - Sitting imbalance
  - Ribs-iliac crest impingement
  - Severe chest collapse
  - Pressure ulcer





TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

Idiopathic scoliosis

James 1957 et al.

- Infantile (0-3 years)
  - Boys> Girls
  - 80% resolutive without treatment
- Juvenile (3-9 years)
  - Girls = Boys
- Adolescent (> 10 years)
  - 80% girls

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

Idiopathic scoliosis

- Early and Late onset scoliosis:
  - Early onset scoliosis:
    - Before age 5ys
    - All etiology included.
  - Late onset scoliosis:
    - After age 5ys
  - Based on lungs development and cardiopulmonary complications.

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

Normal growth of the chest, spine and pulmonary system:

- Number of alveoli: Birth-Adulthood: x10 (8y++)
- Gth of lung parenchyma // Gth of spine and chest
- 2/3rd of spine and chest final dimension: by age 5y

Idiopathic scoliosis during growth

Cardiorespiratory failure

- <u>Scoliosis during 1st 5 years:</u>

Inhibition of growth of both alveoli and pulmonary arterioles

↓

Ventilation defect (restrictive)

↓

↓ Vital cap. & TLC

↓

Alveol hypovent

↓

Hypoxic vasoconstriction

↓

PA hypertension & Cor pulmonale (when VC <40%)

Directly related to:
- Age of onset (<5y)
- Severity of deformity

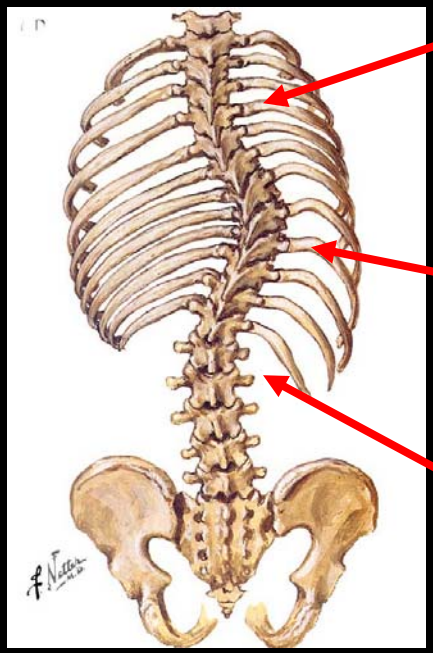
Cardiopulm. Complications:
- Develop rarely when curve begins in adolescence

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Description of curves:
  - Locating the apex (T, TL, L)
  - Angle (Cobb angle):
    - Severe, angular, short
    - Long, regular



Proximal thoracic curve L.

Main thoracic curve R.

Lumbar curve L.

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Clinical Examination:
  - Examination of the trunk:

    Affirms and defines scoliosis.
  - General review

    Eliminates a possible etiology.
  - Assessment of growth and bone maturation:

    Assess the risk of progression of the deformity.

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- History:
  - H/o personal
  - H/o family scoliosis
  - The date and circumstances of discovery
  - Functional and psychological impairment
  - Radiographs and previous treatments. Surgery, Bracing.

TEXAS TECH
UNIVERSITY.

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Examination of the trunk:
  - From Back:
    - Overview:
      - Curvature
        - » R. Thoracic
        - » L. Lumbar
      - Pelvic Balance
        - » Pelvic obliquity
        - » LLD

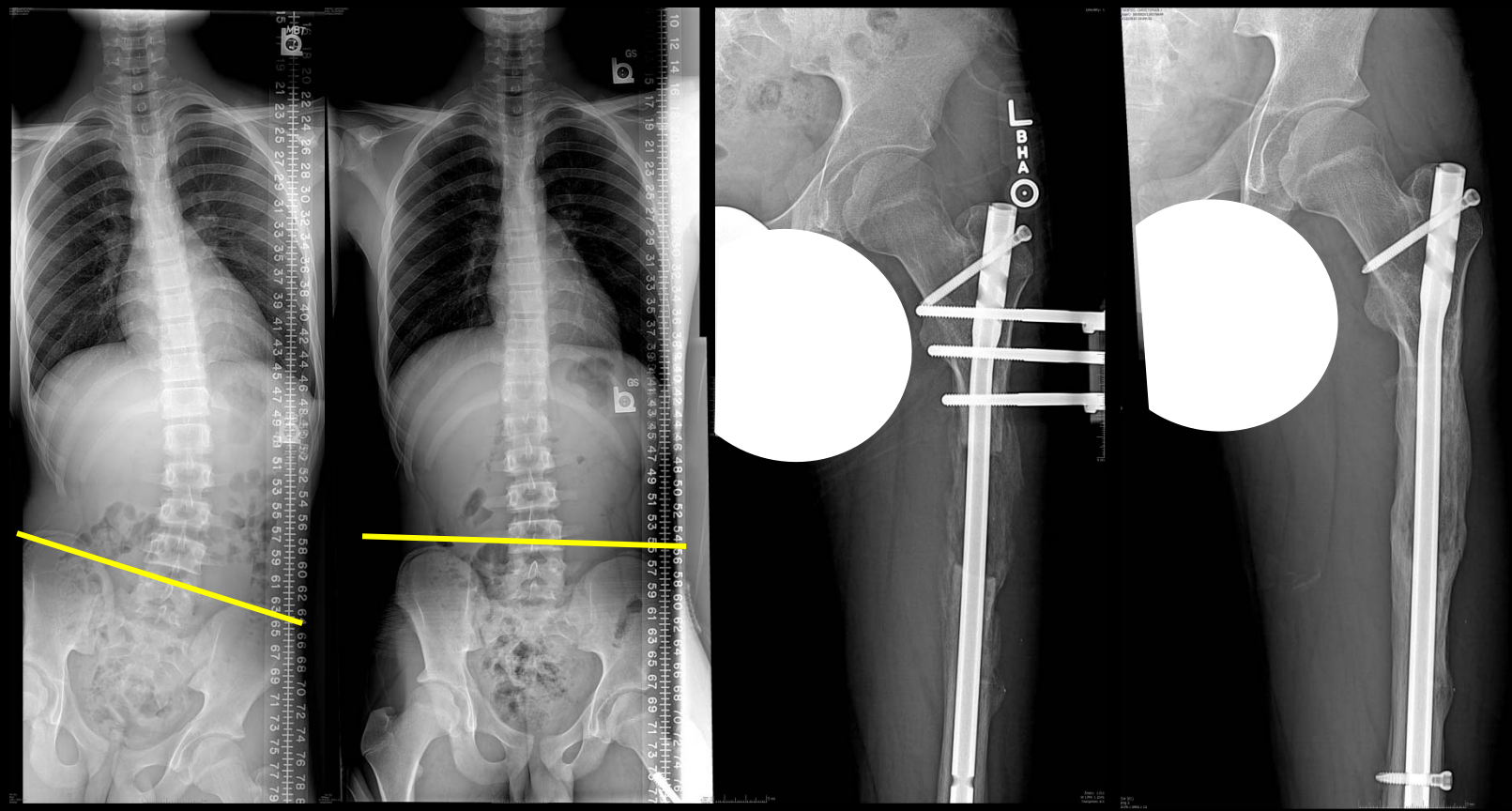
Compensation under the short leg.

- Shoulders level
  - Horiz. or oblique
- Waistline
  - Asymmetric, reflecting the existence of a deviation of the thoracolumbar or lumbar spine

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth



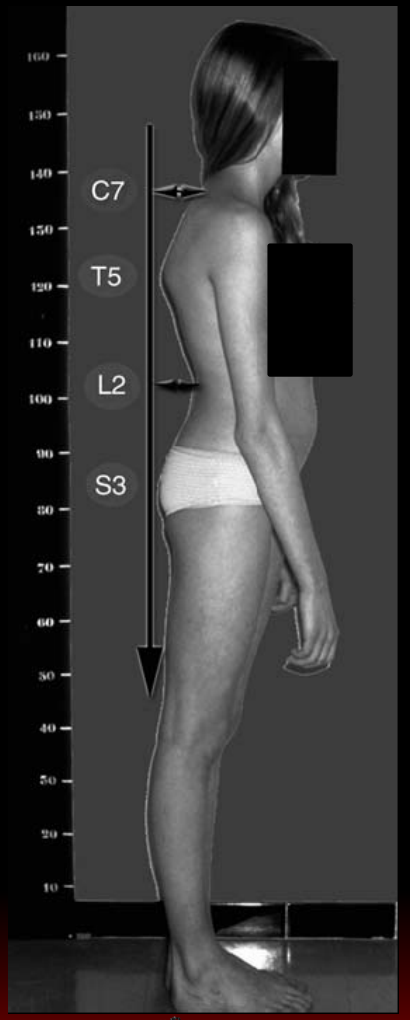
Scoliosis secondary to LLD

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Lateral vue:
  - Sagittal spinal curvatures:
    - Plumb-line
      - The most common defects:
        - Hypokyphosis or thoracic lordosis
        - Thoracolumbar kyphosis
        - Lumbar kyphosis

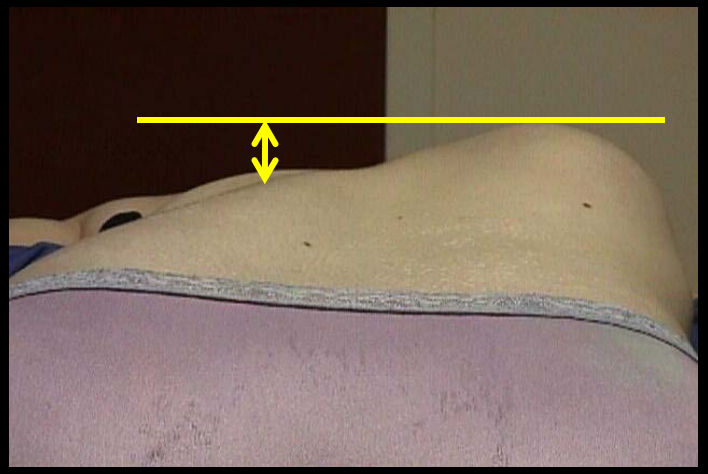


TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Standing leaning forward
  (Adam FW bending test):
  - The rib hump:
    - Pathognomonic clinical signs
      of scoliosis
    - Secondary rotation of vertebral bodies.
    - Elevation difference between
      the most prominent point of the hump and
      point symmetrical to it on the CTL side.



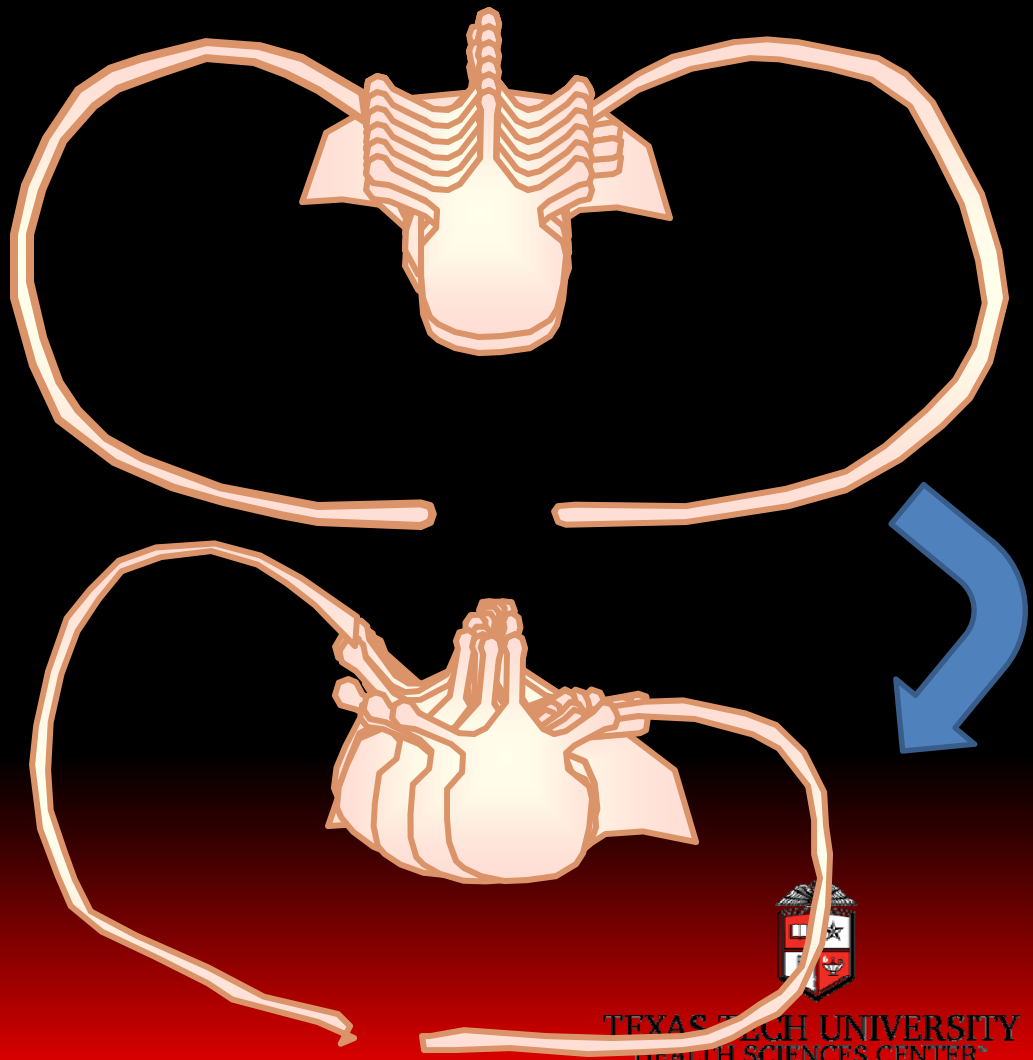
TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Gibbosity

Thinking in 3D:
Rotary displacement
Lateral displacement
Sagittal displacement



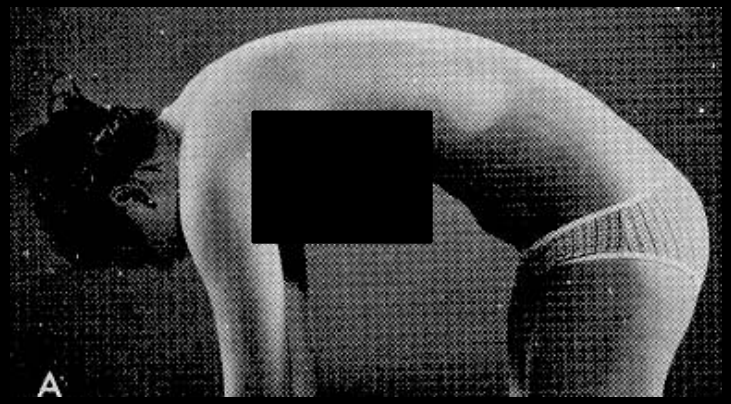
- Posterior hump
- Ant. thoracic hump

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- The dynamic examination
  - Flexibility and reducibility.
    - Hands-ground distance
    - Lateral tilting

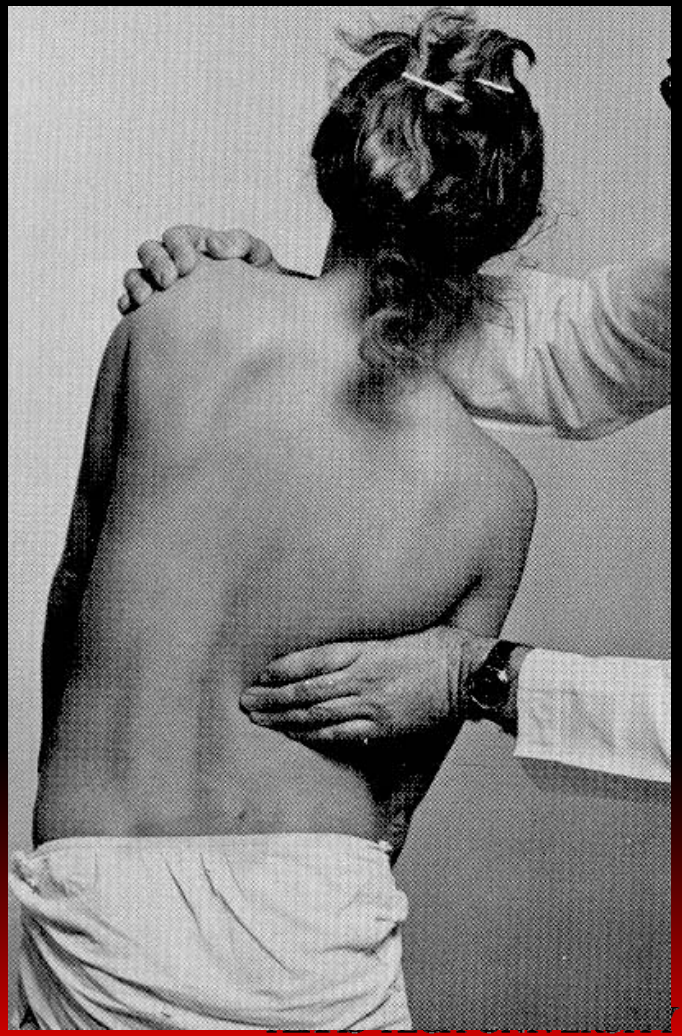


TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- The dynamic examination
  - Flexibility and reducibility.
    - Hands-ground distance
    - Lateral tilting



TEXAS TECH UNIVERSITY.

HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Sitting position
  - Rule out: Postural scoliosis secondary to LLD
  - Non-ambulator patients: Infants, neuromusc.

Idiopathic scoliosis during growth

- Etiological investigation:
  - Causes:
    - 70 to 80% of scoliosis are idiopathic (unknown,..)
    - Other:
      - Obvious or known before the onset of scoliosis
      - DMD, CP, NF1, Marfan.

TEXAS TECH
UNIVERSITY.

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Etiological investigation:
  - Morphotype analysis:
    - Abnormal height
    - Hyperlaxity
    - Facial dysmorphism

Marfan syndrome

Positive thumb (Steinberg) sign

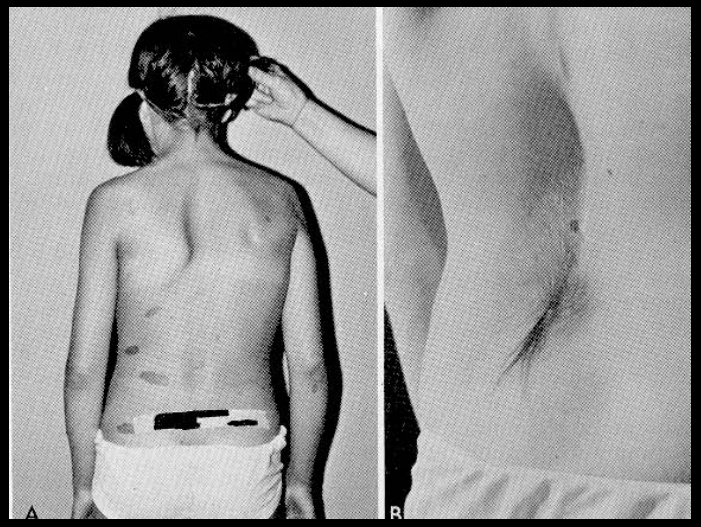
Arachnodactyly

TEXAS TECH UNIVERSITY

HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Skin examination:
  - Spots "café au lait"
    Neurofibromatosis.



Back midline birth mark:
- Abnormal hair patch
- Angioma or lipoma
  of the sacral region

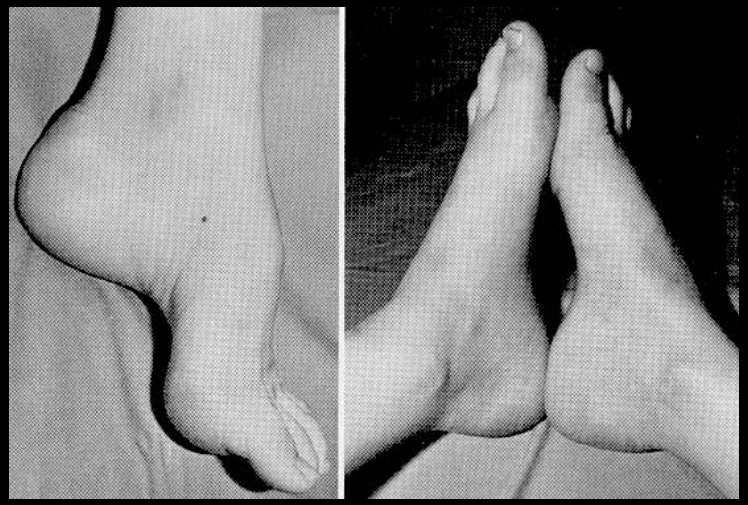
Underlying Vertebro-medullary malformation (spinal dysraphism)

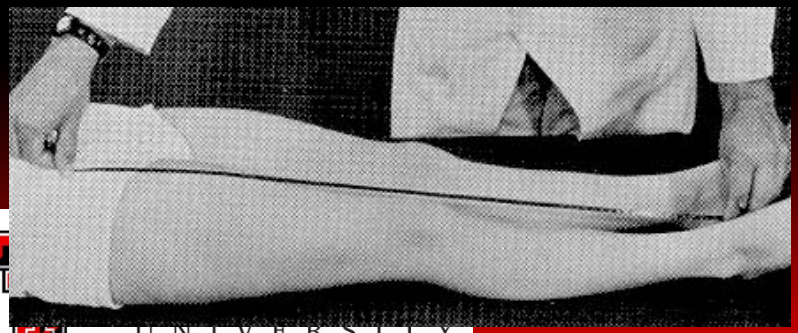
TEXAS TECH UNIVERSITY

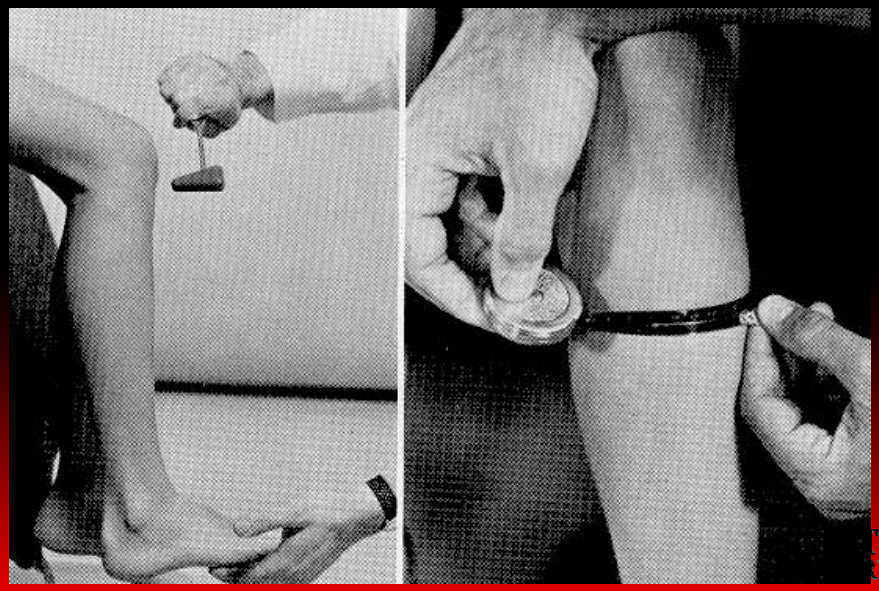
TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Neurological examination:
  - Motricity
  - Sensitivity
  - DTRs
  - Abd reflexes.
  - Walking on heel and toes.
  - Muscle atrophy
  - LLD.







Idiopathic scoliosis during growth

- Medical imaging:
  - Radiological diagnosis of scoliosis
  - Radiological monitoring.
  - Preoperative radiologic work up.

Idiopathic scoliosis during growth

- Medical imaging:
  - Radiological diagnosis of scoliosis
    AP view:
    - Standing, balanced pelvis, on a large cassette 30 × 90 cm
      Vertebrae: End vertebrae, and apical.
      Cobb angles.

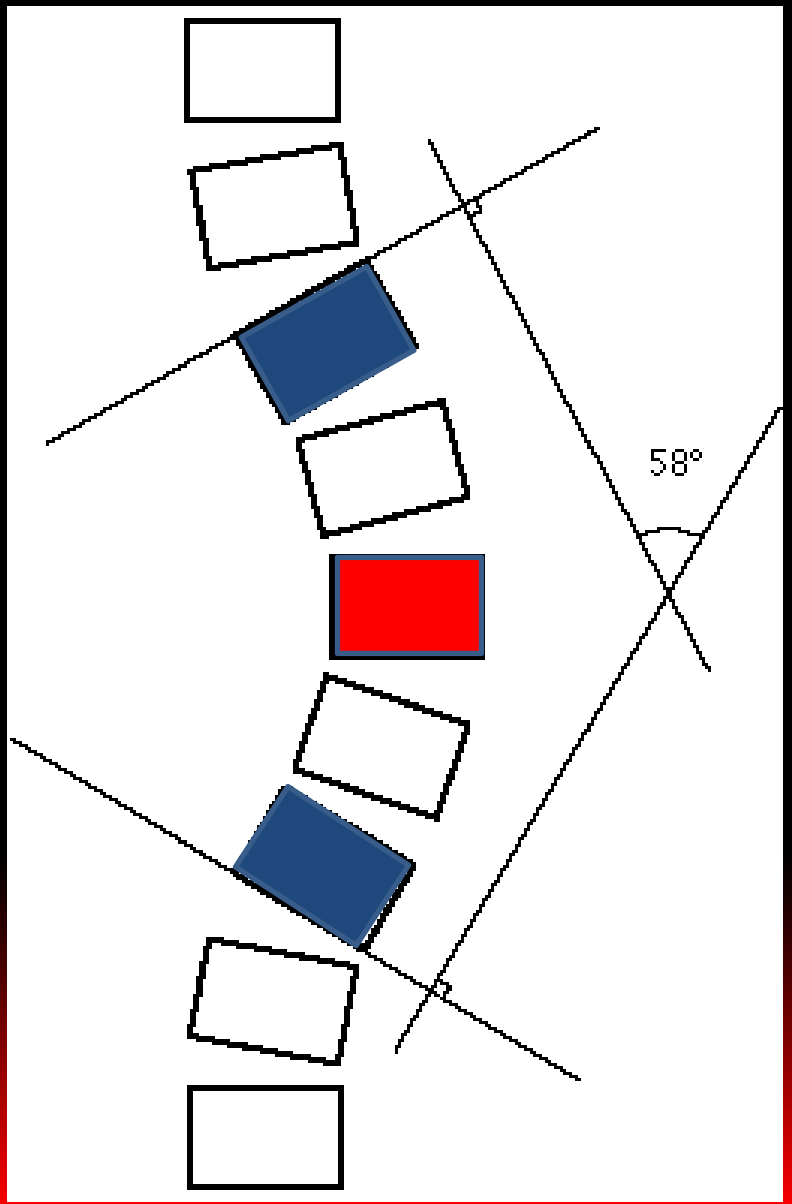
Cobb Angle: Top of the Top; Bottom of the Bottom

Curve Apex and Location

- Body most deviated from vertical axis

End/Terminal Vertebrae (EV)

- Cephalad/Caudal vertebra whose Superior/Inferior surface tilts maximally toward curve
- Degrees not percent!



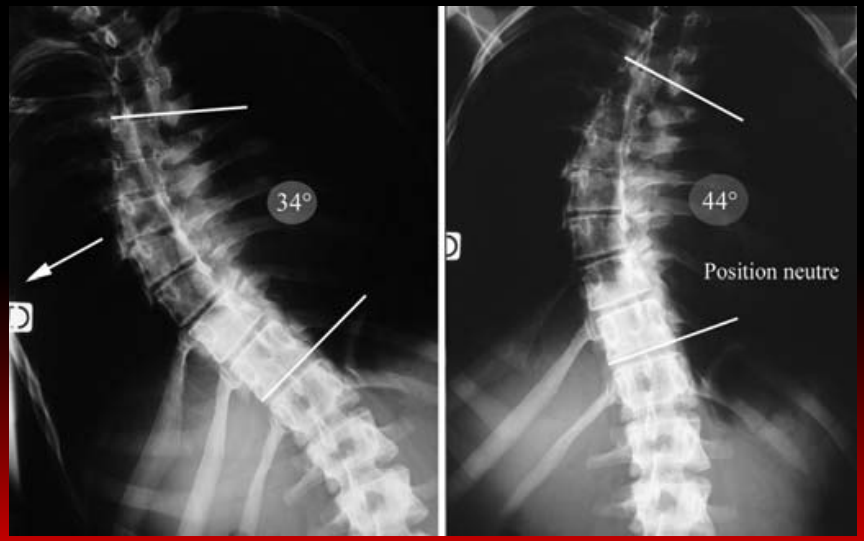
TEXAS TECH UNIVERSITY

Idiopathic scoliosis during growth

- Radiological monitoring:
  - AP view shot on large plate 30 × 90 cm, standing balanced pelvis.
  - Postero-anterior xray , decreases breast irradiation.

Idiopathic scoliosis during growth

- Preoperative xray:
  - Benders
  - Study of the reducibility: flexibility or stiffness of the deformation
  - AP views: inclinations right and left sides



TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Technology in Scoliosis/Kyphosis surgery

EOS machine

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- MRI:
  - Not a systematic exam to do when dealing with idiopathic scoliosis, even if surgical indication
  - Essential in the presence of certain signs of doubt of the idiopathic character of deformity.

Idiopathic scoliosis during growth

- MRI indications:
  - Abnormal neurological examination:
    - Weakness or muscle atrophy
      signs of upper motor neuron dysfunction:
    - Hyperreflexia, Babinski +
  - Severe pain
  - Infantile or juvenile scoliosis / curvature> 20 °
  - Atypical scoliosis:
    - Left thoracic curve
  - Congenital scoliosis

Idiopathic scoliosis during growth

- Neurological abnormalities:
  - Diastematomyelia,
  - Syringomyelia
  - Arnold-Chiari malformation
  - Tethered cord

Idiopathic scoliosis during growth

- Natural History:
  - Progression:

Risk of progression during growth

TEXAS TECH
UNIVERSITY.

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER®

Idiopathic scoliosis during growth

- Natural History:
  - After skeletal maturation:
  - Progression:

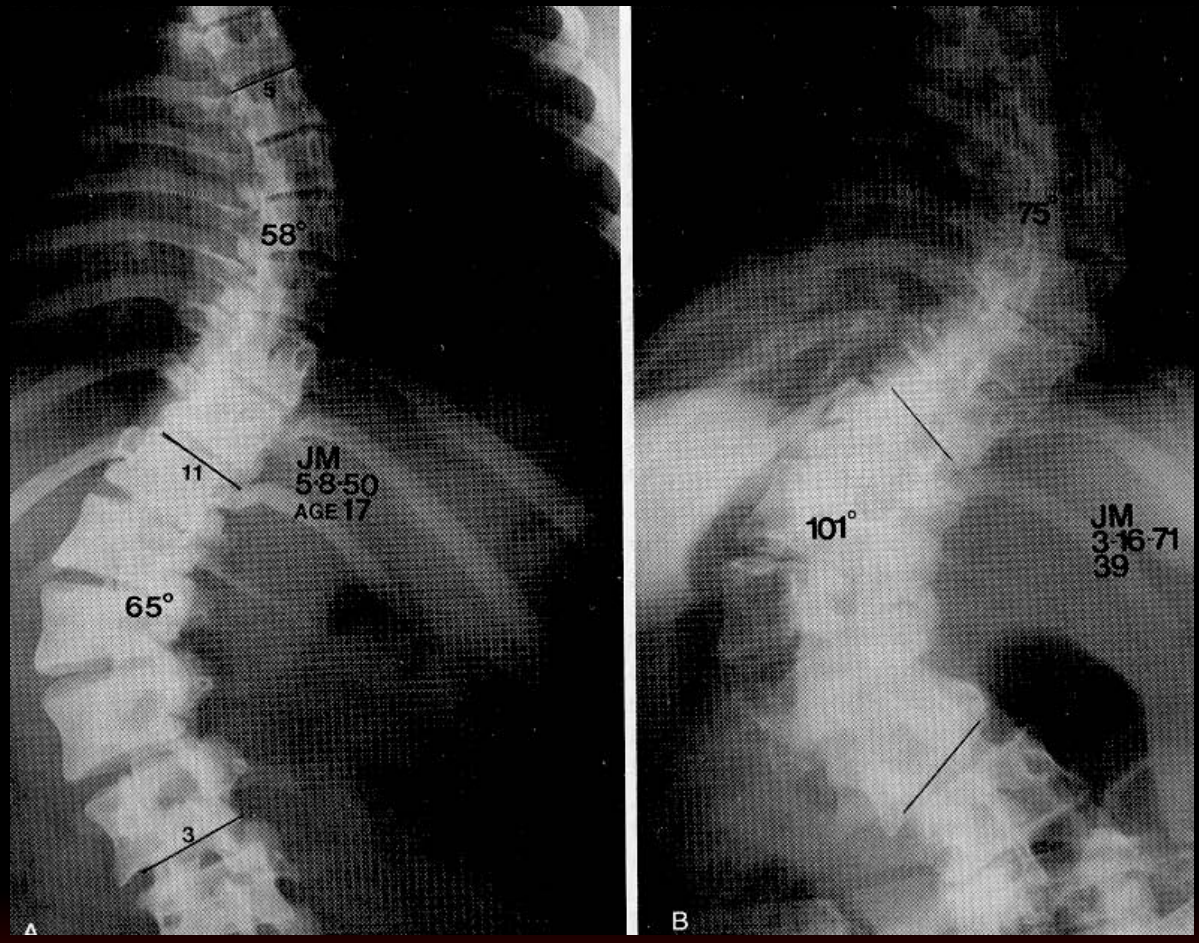
    Residual curvature:

    > 45(L)-50(T) °: - Increase of 1 ° / year.

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth



17 yo F, Risser 4 **At Age 38 y**

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Curve ≥ 50 °:
- Increase of 1 °

- Curve> 90 °:
- Limited respiratory function, not noticed by the patient.

- Curve> 100 °:
- Limited respiratory function, noticed by the patient.

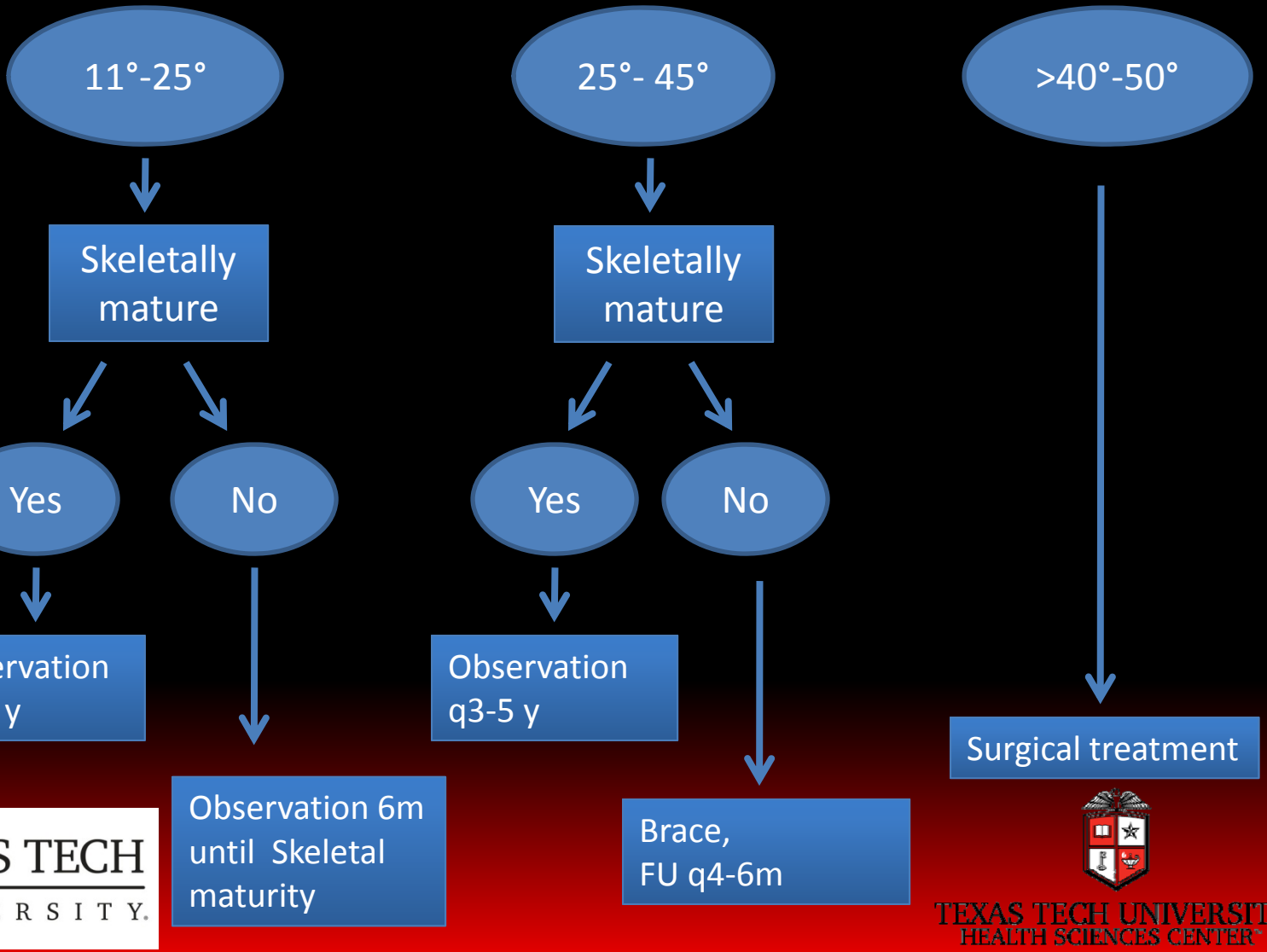
- Cor pulmonale

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Traitement: Indications



TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Brace:
  Thoraco-Lumbo-Sacral Orthosis (TLSO)
  Goal: Prevent progression
  during growth → Chirurgie

- Indication:
  Curves between 25-45 deg in growing child

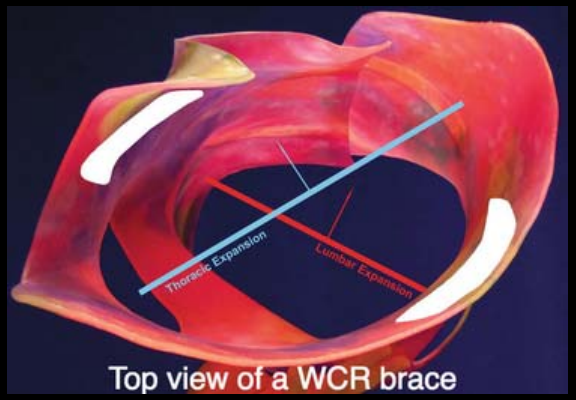
- Efficacity: Dose-dependent relationship:
  Time Corset/24h (16-22 hours/day)

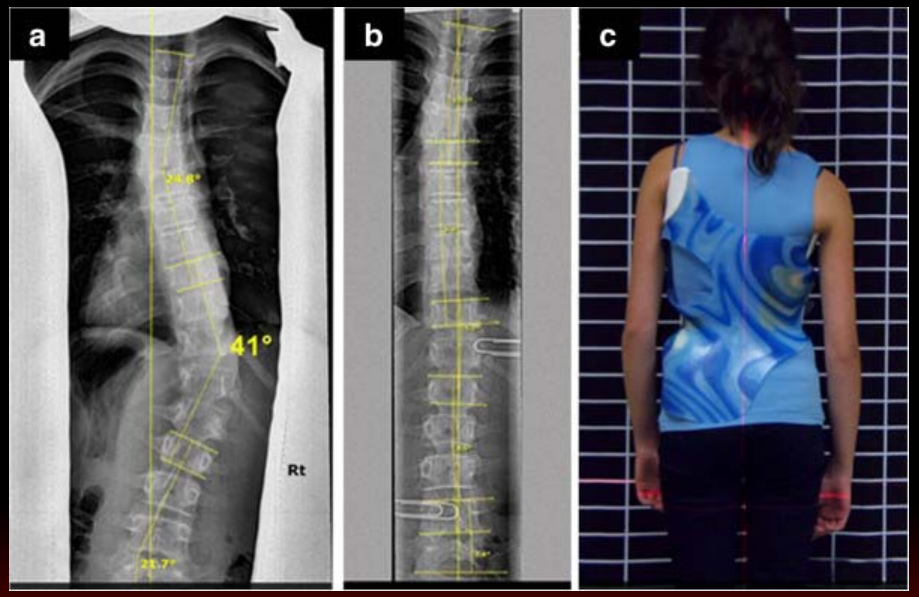
TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Technology in Scoliosis/Kyphosis surgery

Brace: WCR better than TLSO or Boston Brace. W: Wood (USA), C: Chenneau (France), R: Rigo (Spain)





TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

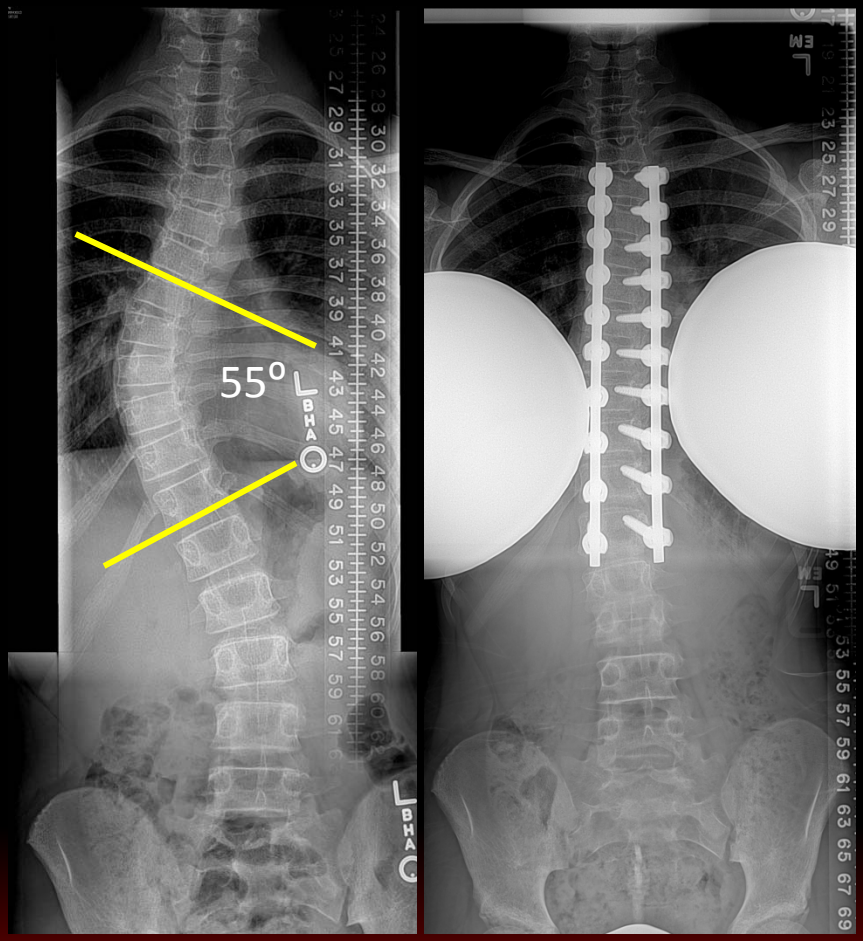
Technology in Scoliosis/Kyphosis surgery

Schroth Method: South Plain Rehab, UMC

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Posterolateral fusion with instrumentation

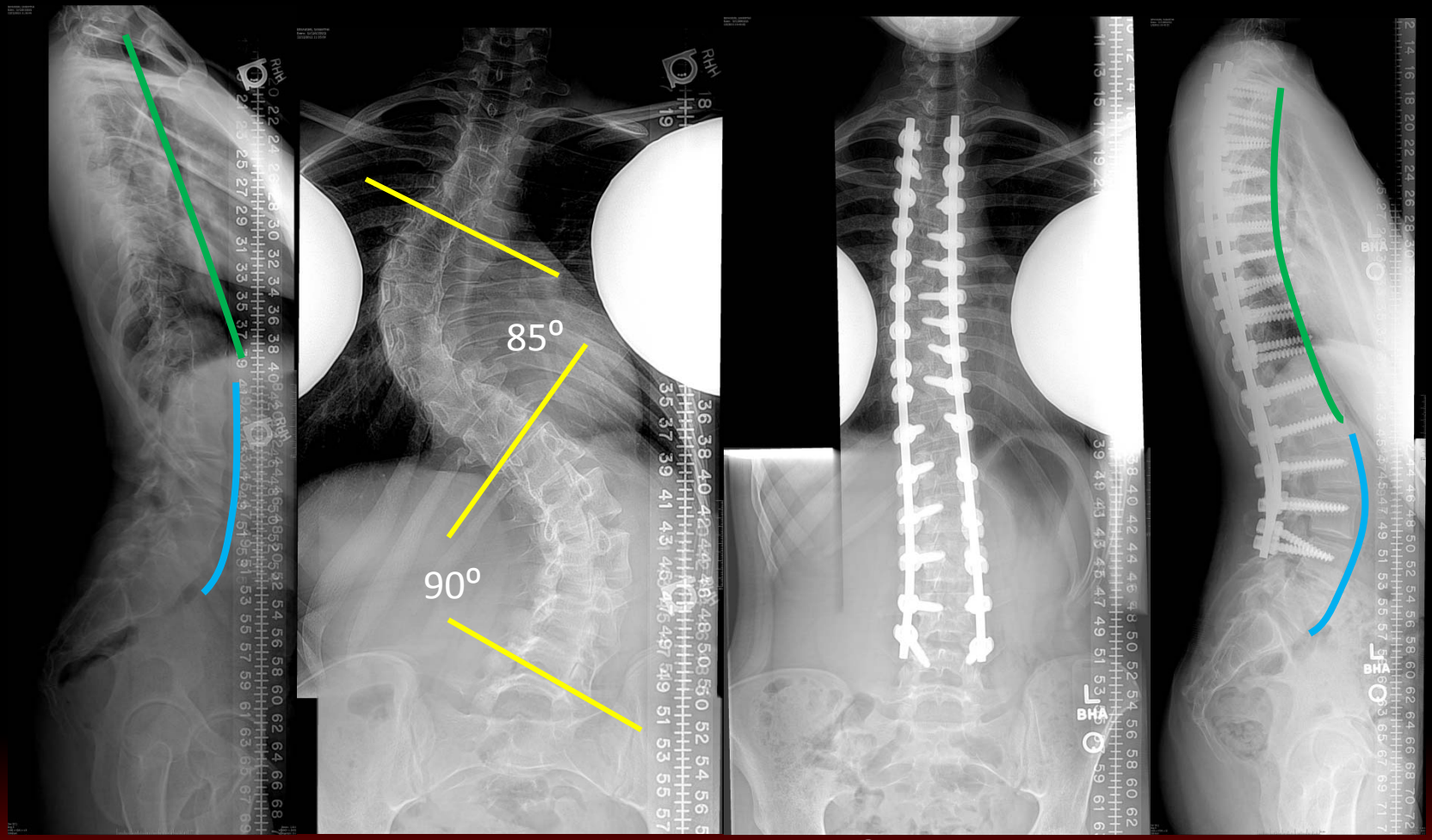


12 yo F, AIS

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Posterolateral fusion with instrumentation

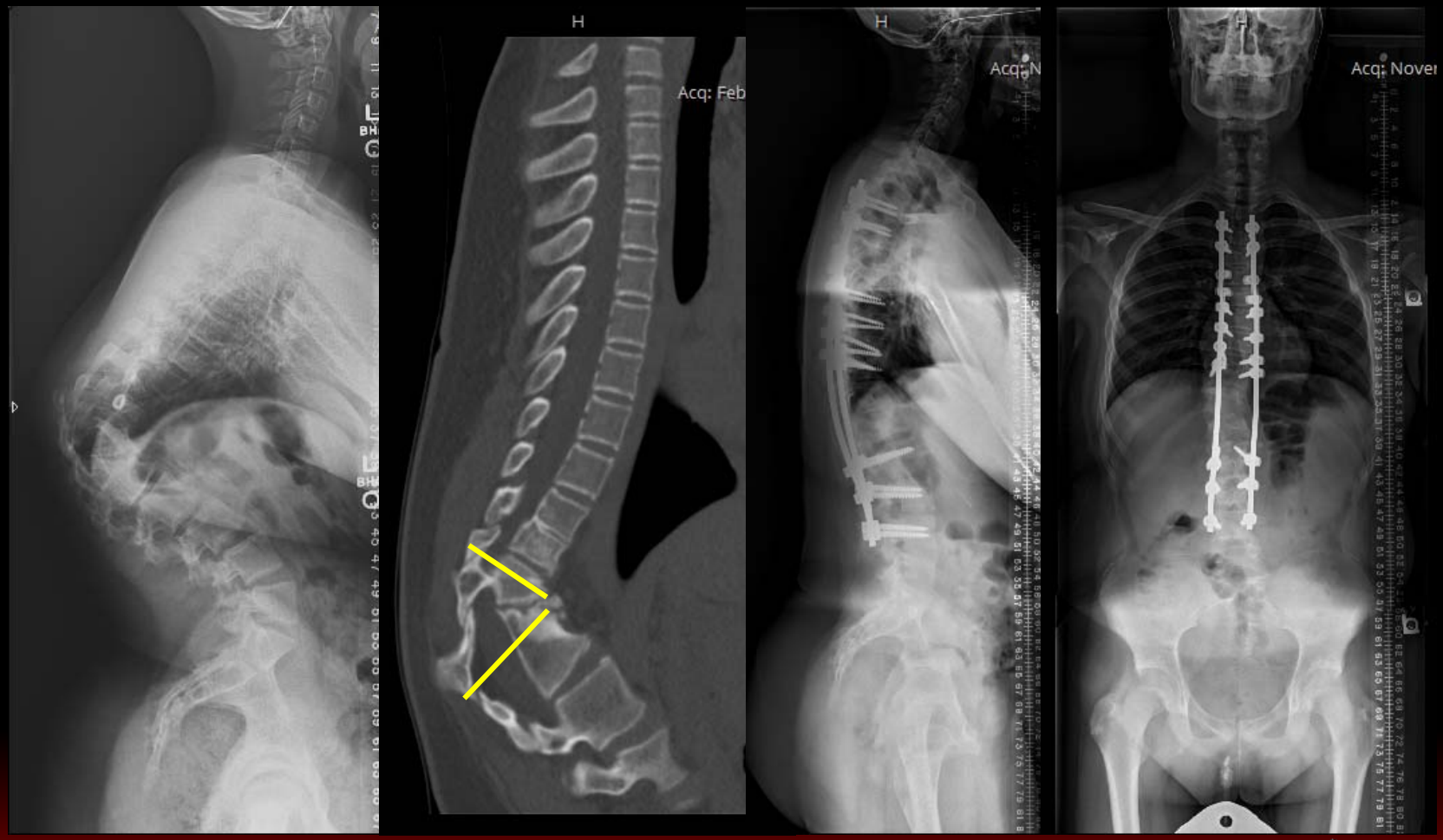


17 yo F, AIS

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Case: 14 yo M VCR



TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Technology in Scoliosis/Kyphosis surgery

Scoliosis: Pedicle Screw Navigation:

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

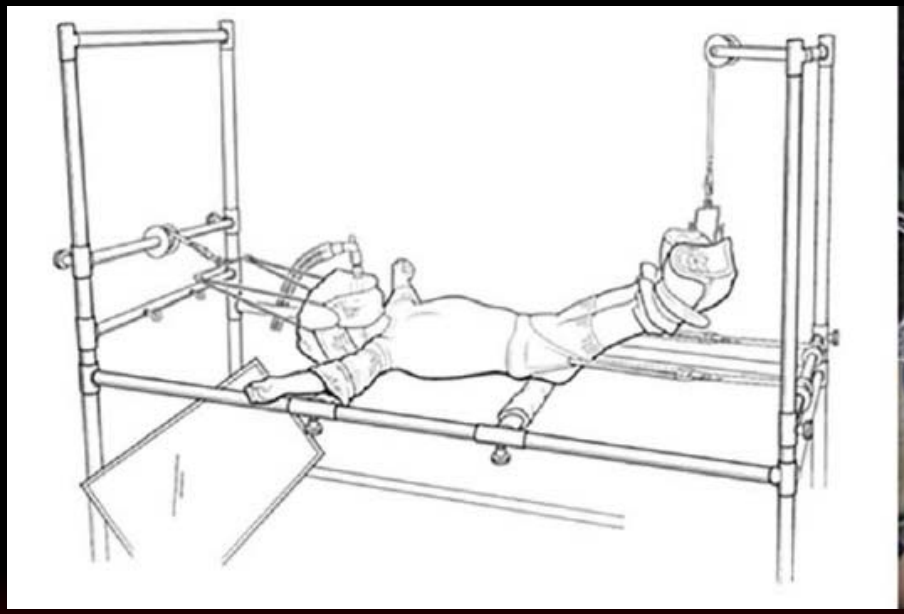
Technology in Scoliosis/Kyphosis surgery

Neuromonitoring: IOPM: MEPs, SEPs and EMG

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

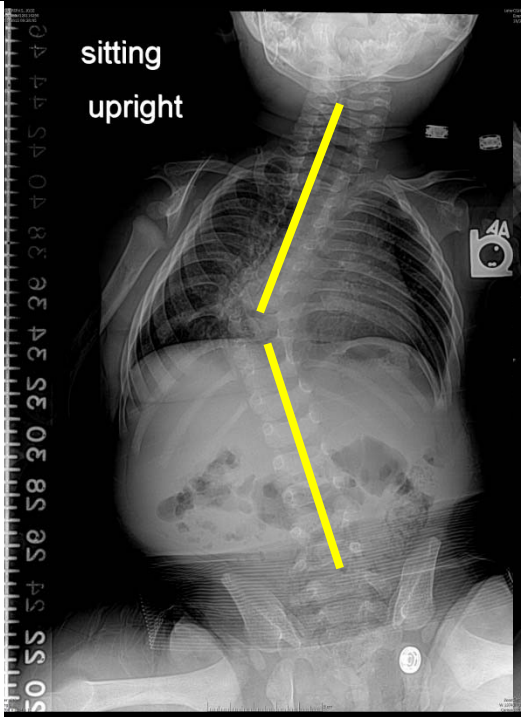
Body casting for infantile scoliosis

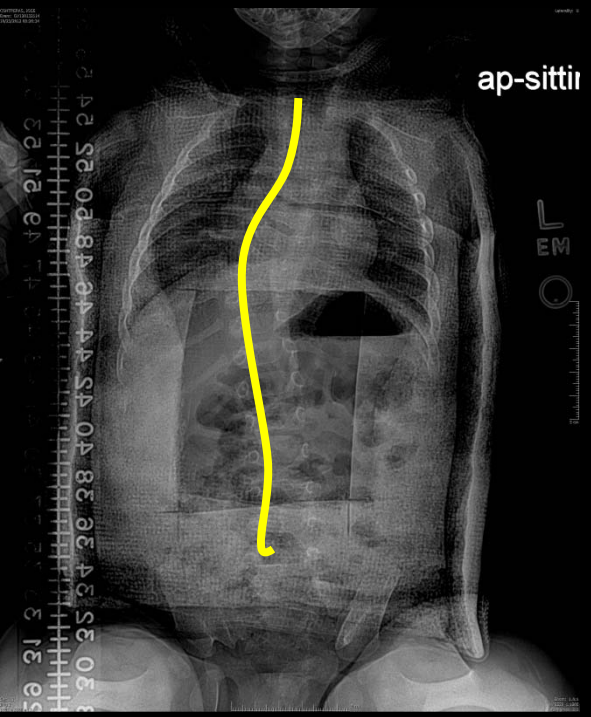


TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Casting for Early Onset Scoliosis

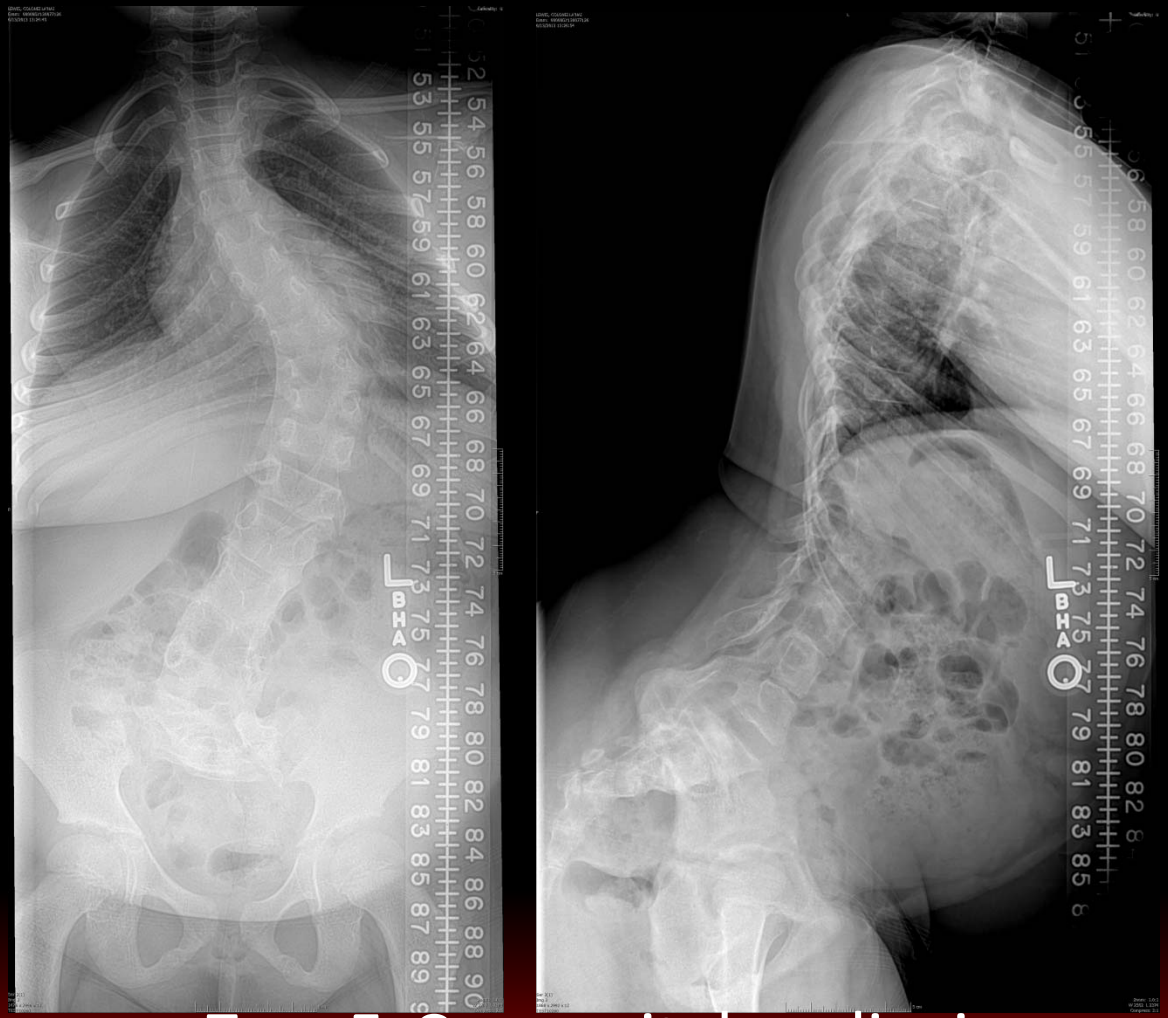




TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Non-fusion spine surgery

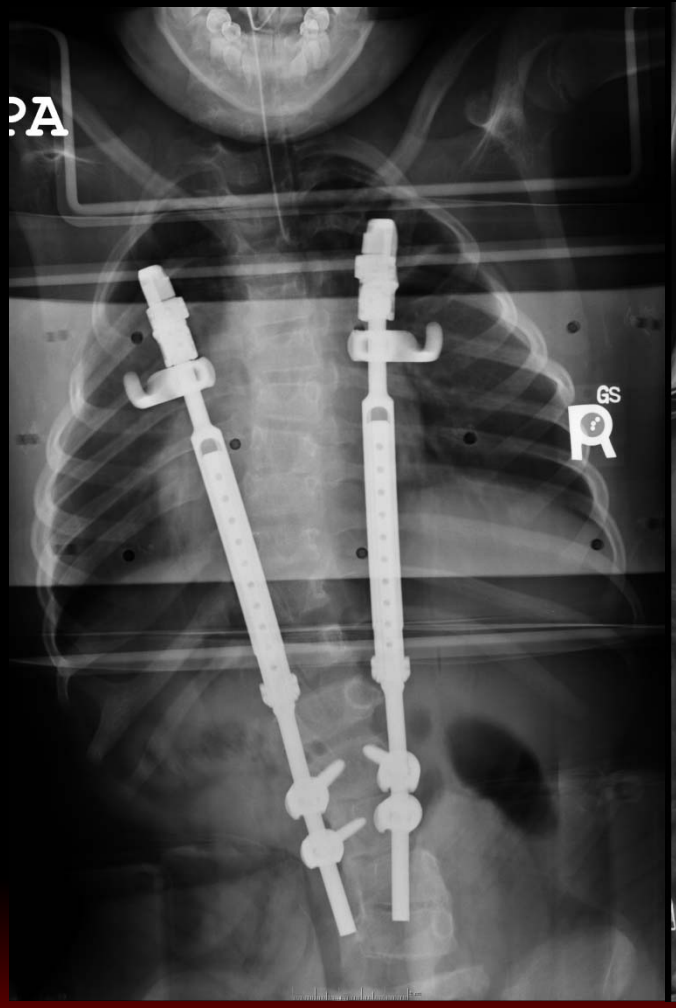


7 yo F, Congenital scoliosis

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Non-fusion spine surgery

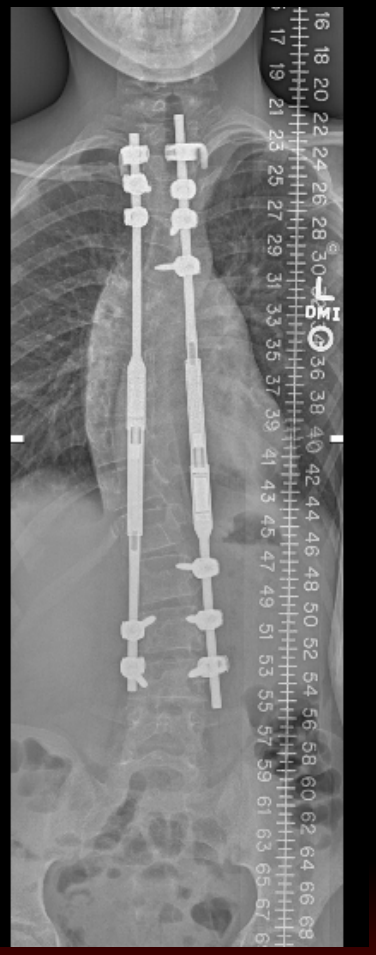


TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Technology in Scoliosis/Kyphosis surgery

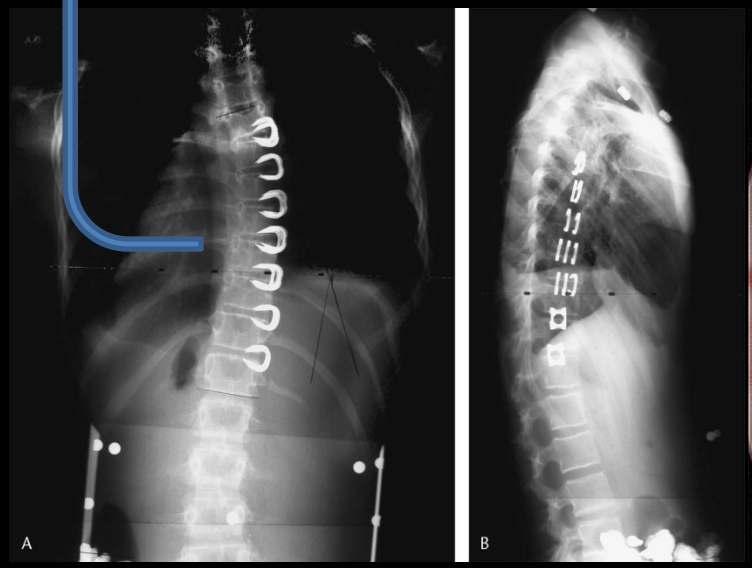
Magec growing spine rod:

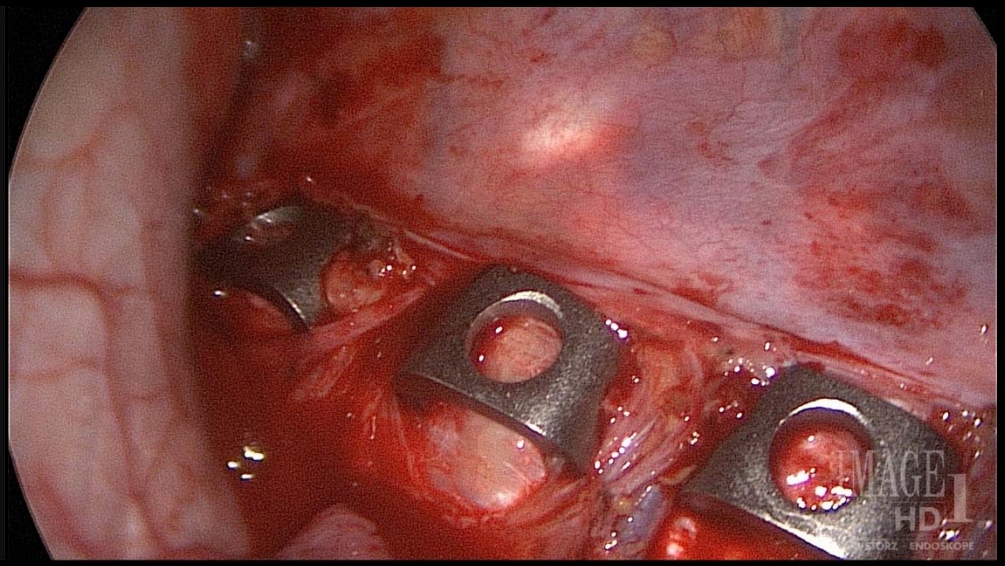


TEXAS TECH UNIVERSITY

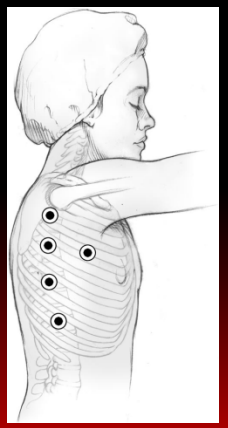
TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Non-fusion spine surgery





Vertebral Body Stapling

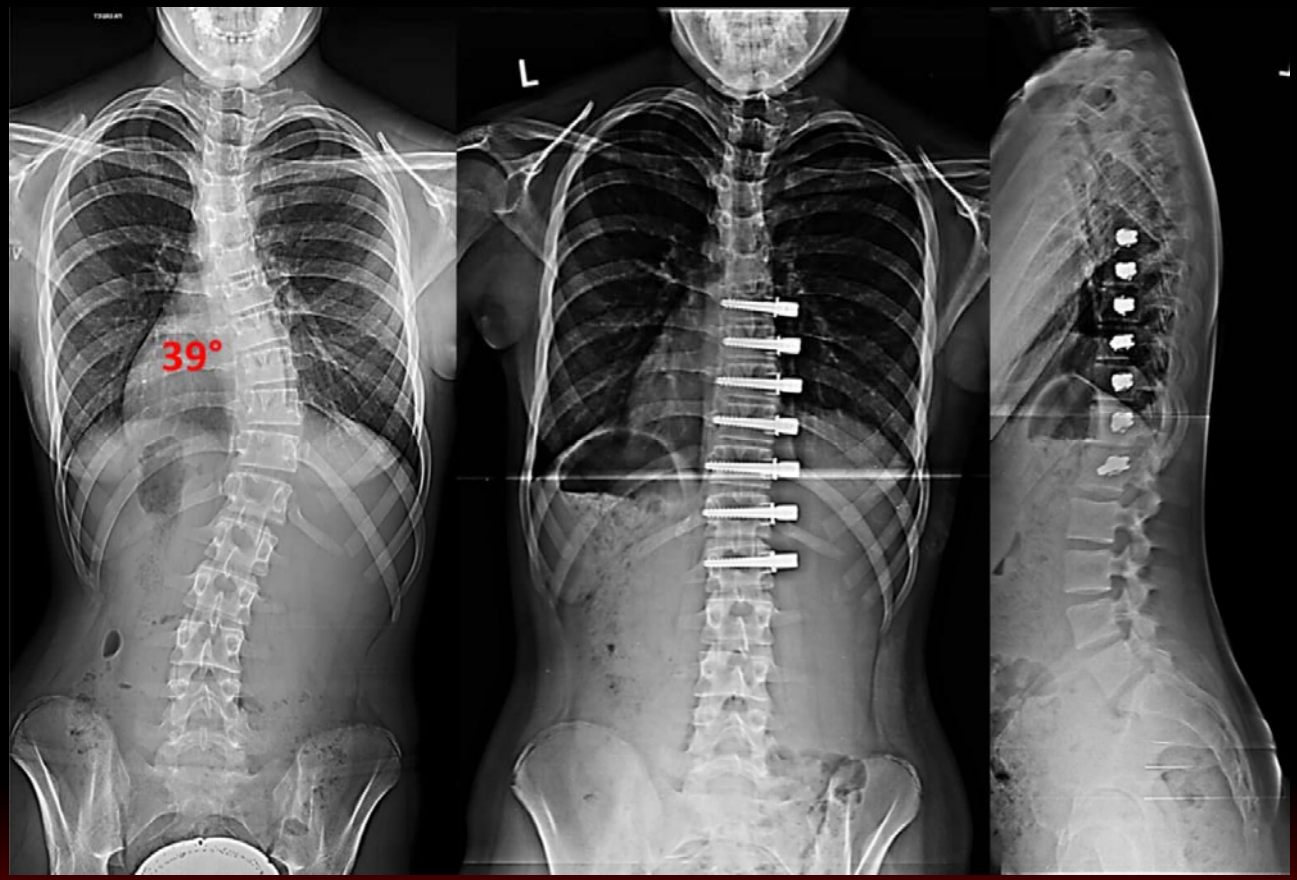


TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Vertebral body tethering

Non-fusion Corrective Scoliosis Surgery

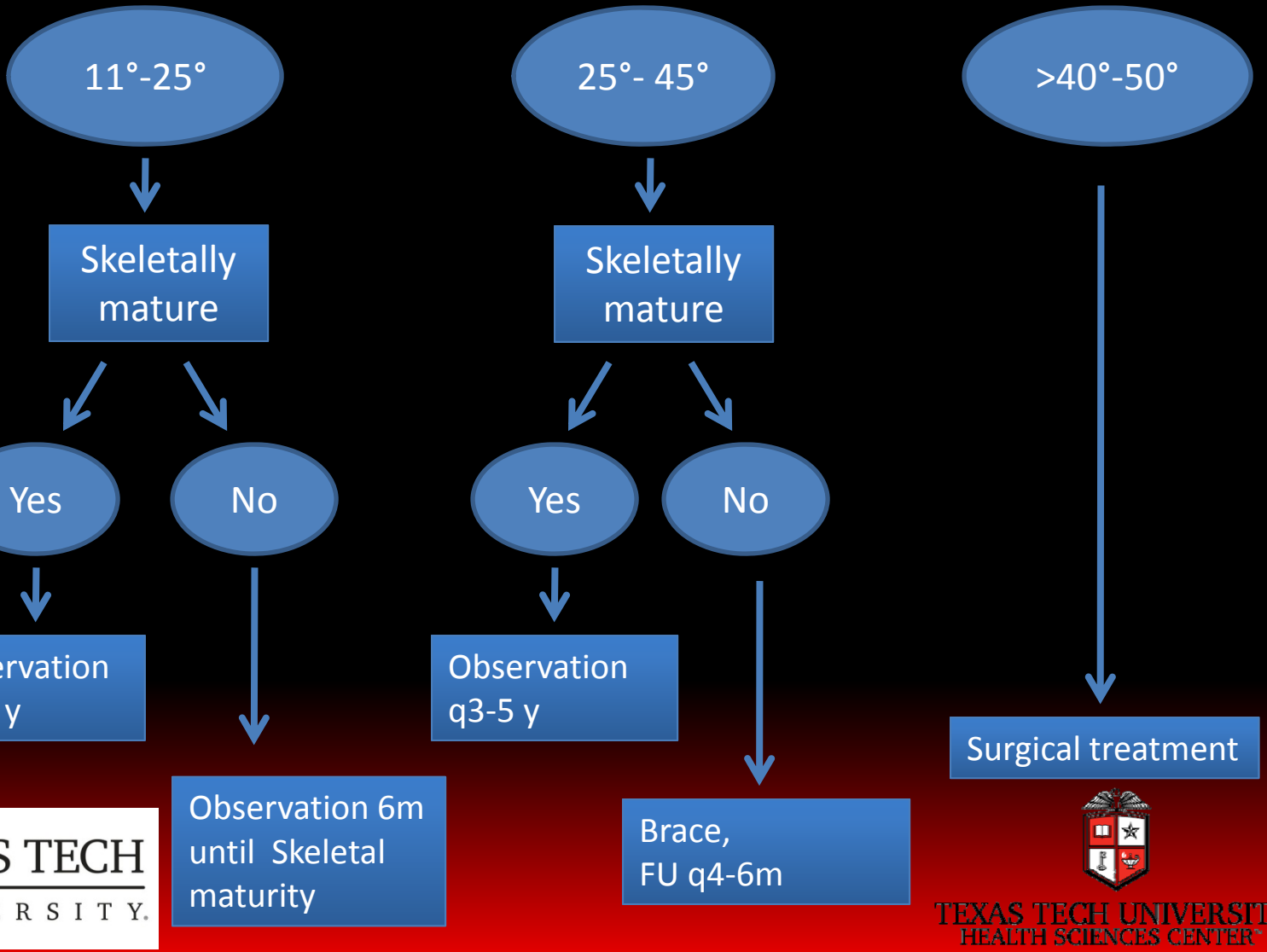


TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Traitement: Indications

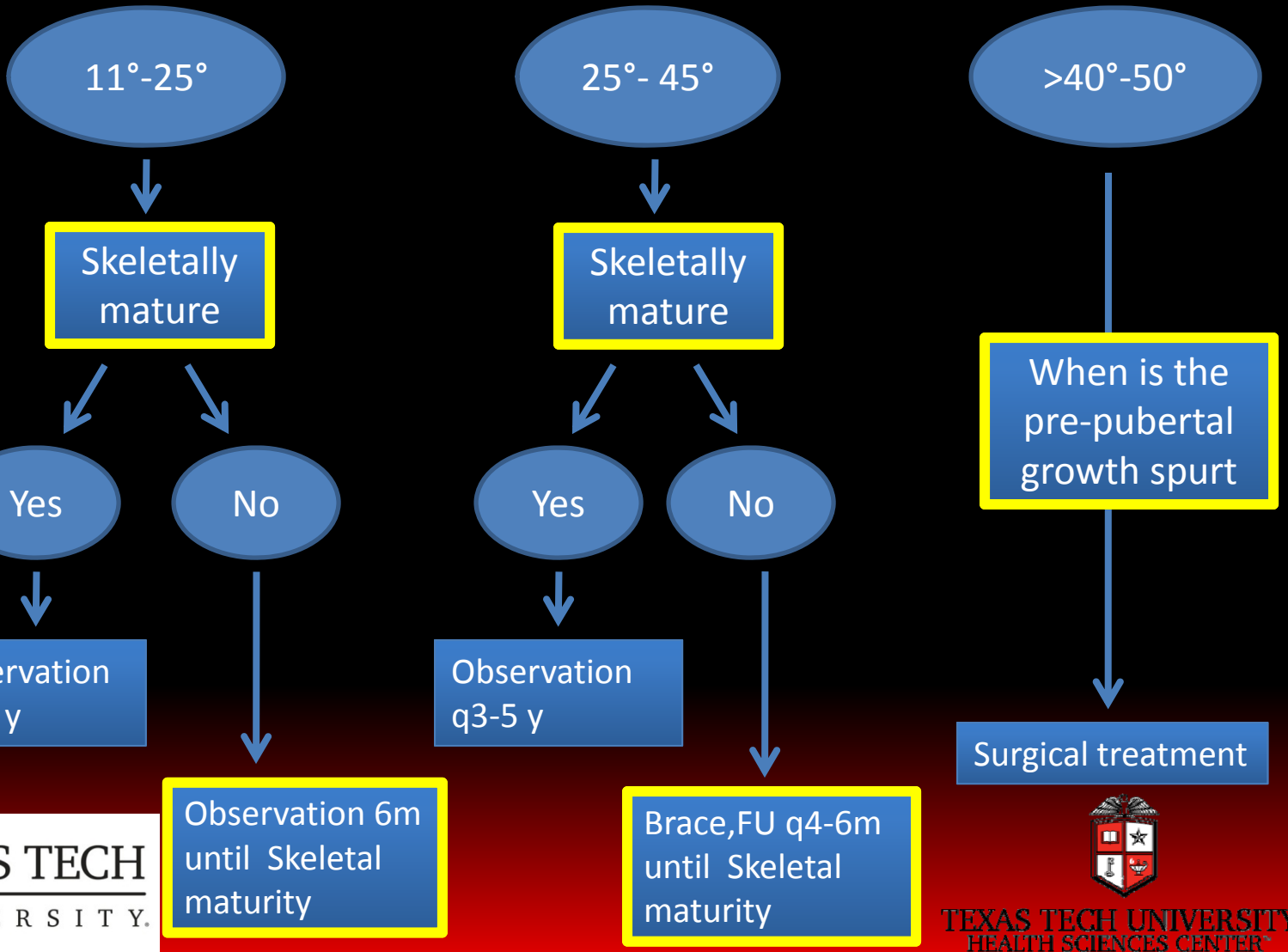


TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Idiopathic scoliosis during growth

- Traitement: Indications

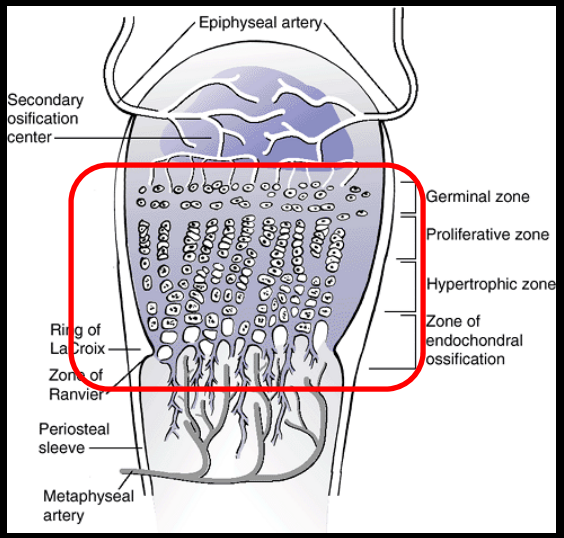


TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Normal growth in children

Growth:



Pediatric Orthopedics

V/S

Adult Orthopedics

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Normal growth in children

Orthopedic Disorders + Growing child

Treatment plan: Assumptions about future or remaining growth

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Normal growth in children

When do we need to think about ***future growth***?

1. Scoliosis before skeletal maturity
2. UE & LE deformity or length problem

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Normal growth in children

Parameters of growth:

- Normal values
- Measurement
- Significance

Timing:

- Epiphysiodesis in LE
- Spine fusion

Height loss after 10 thoracic levels fusion

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Scoliosis and Growth

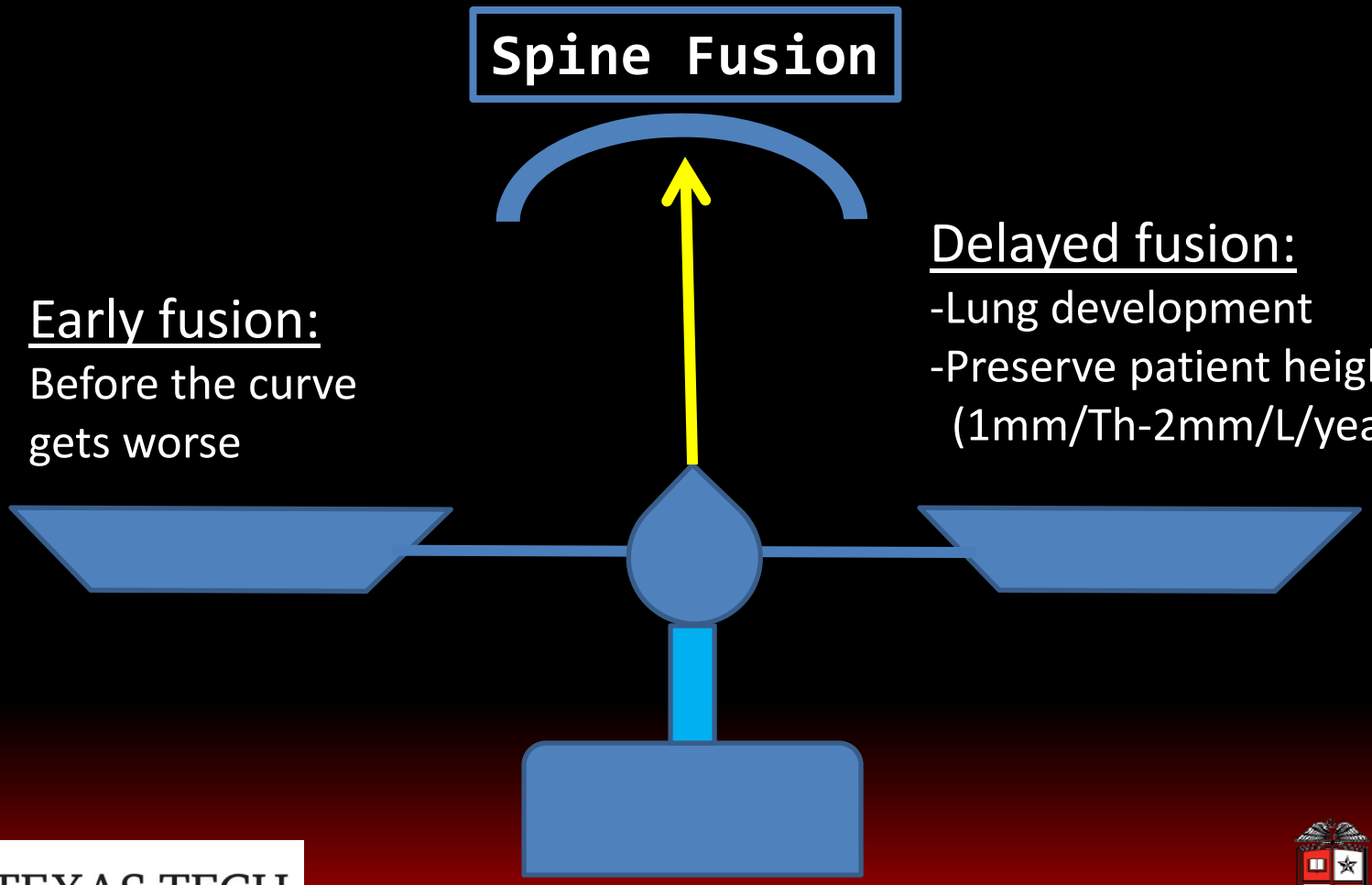
Risk of Progression

Timing of Fusion

TEXAS TECH
UNIVERSITY.

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER®

Scoliosis and Growth



Early fusion:
Before the curve gets worse

Delayed fusion:
-Lung development
-Preserve patient height (1mm/Th-2mm/L/year)

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

The Prediction of Curve Progression in Untreated Idiopathic Scoliosis during Growth*†

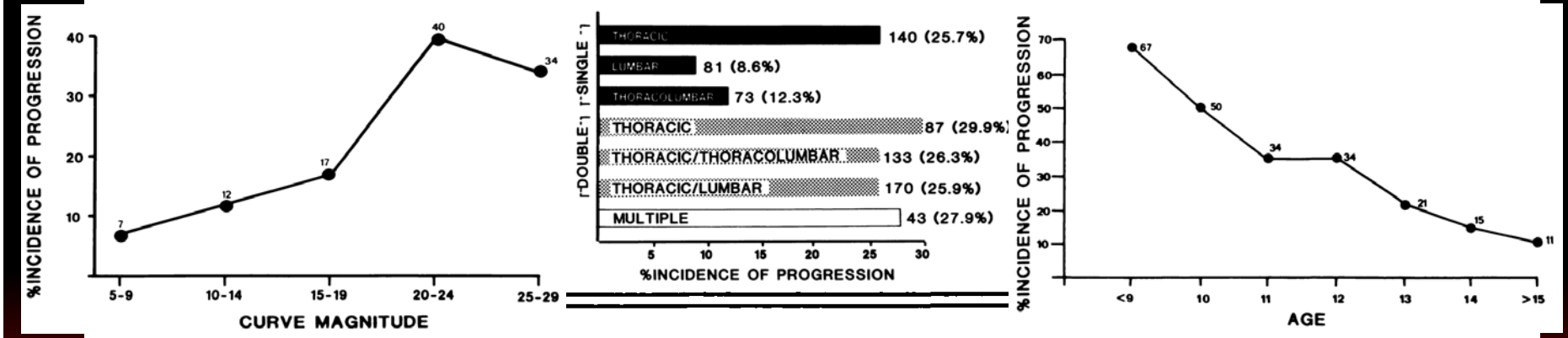
BY JOHN E. LONSTEIN, M.D.‡, MINNEAPOLIS, AND J. MARTIN CARLSON, M.S.§, ST. PAUL, MINNESOTA

From the Twin Cities Scoliosis Center, Minneapolis, and Gillette Children's Hospital, St. Paul

Factors related to curve growth

TABLE II

INCIDENCE OF PROGRESSION AS RELATED TO THE MAGNITUDE OF THE CURVE AND THE RISSER SIGN



TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Progression Risk of Idiopathic Juvenile Scoliosis During Pubertal Growth

Yann Philippe Charles, MD,* Jean-Pierre Daures, PhD,† Vincenzo de Rosa, MD,* and Alain Diméglio, MD*

Spine • Volume 31 • Number 17 • 2006

At onset of puberty

Curves ≤ 20°

15.6% progressed > 45° and were fused

Curves of 21°to 30°

The surgical rate increased to 75.0%

progressed significantly during peak growth velocity

Curves > 30°

100% fused

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

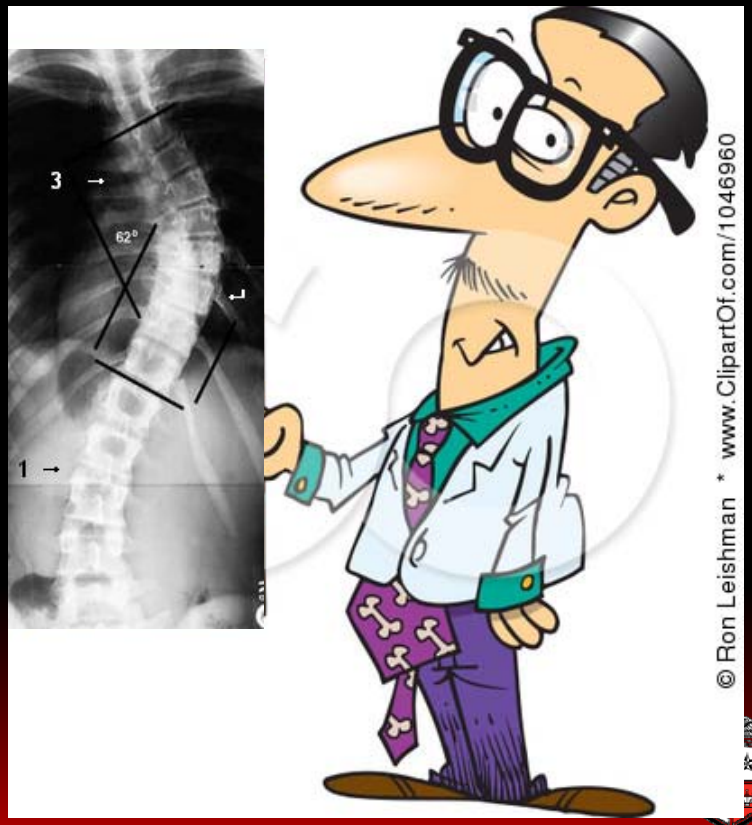
Scoliosis and Growth

- Adolescent Idiopathic Scoliosis:

Monitoring

↓

Decision Making



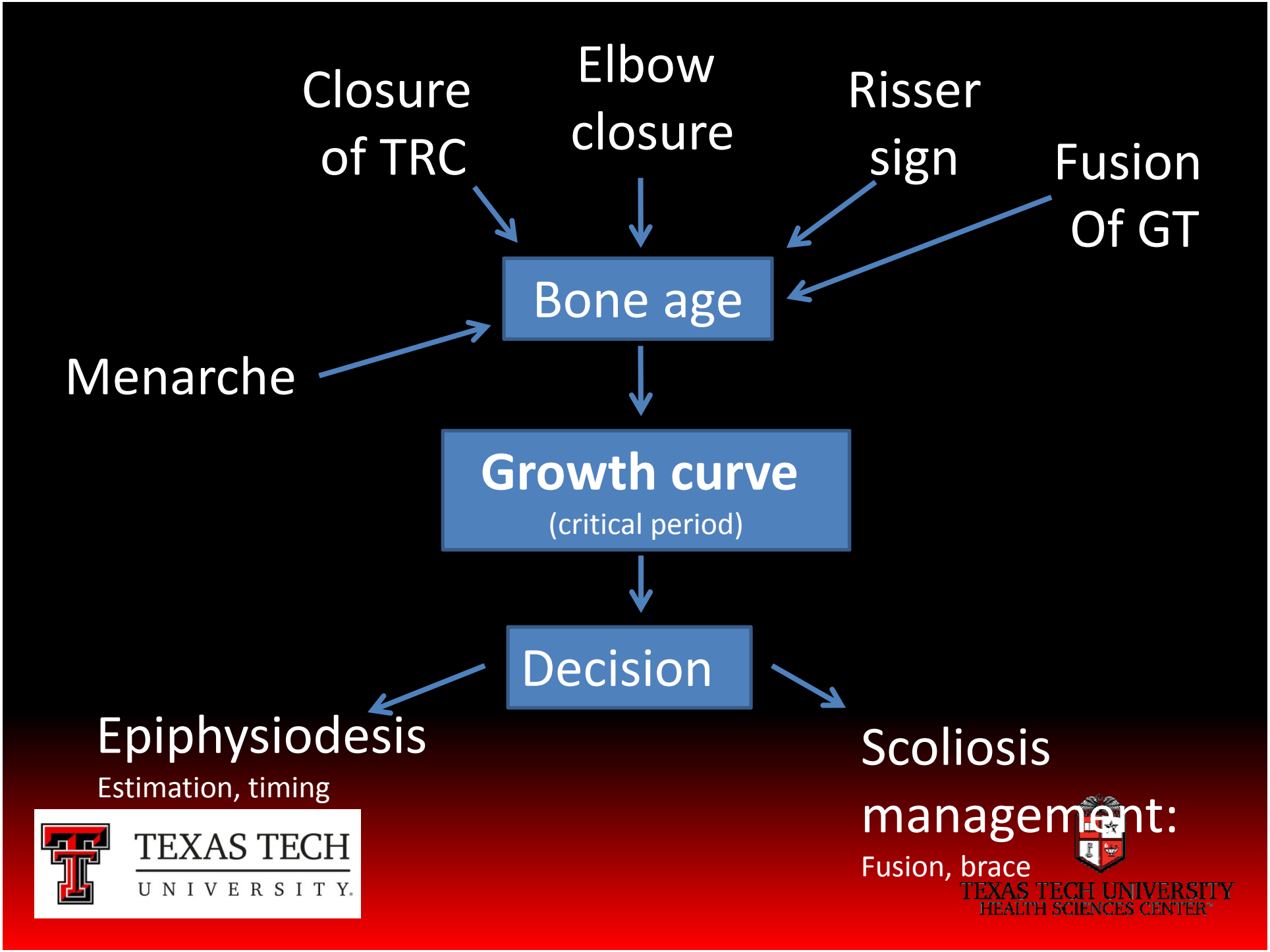
TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

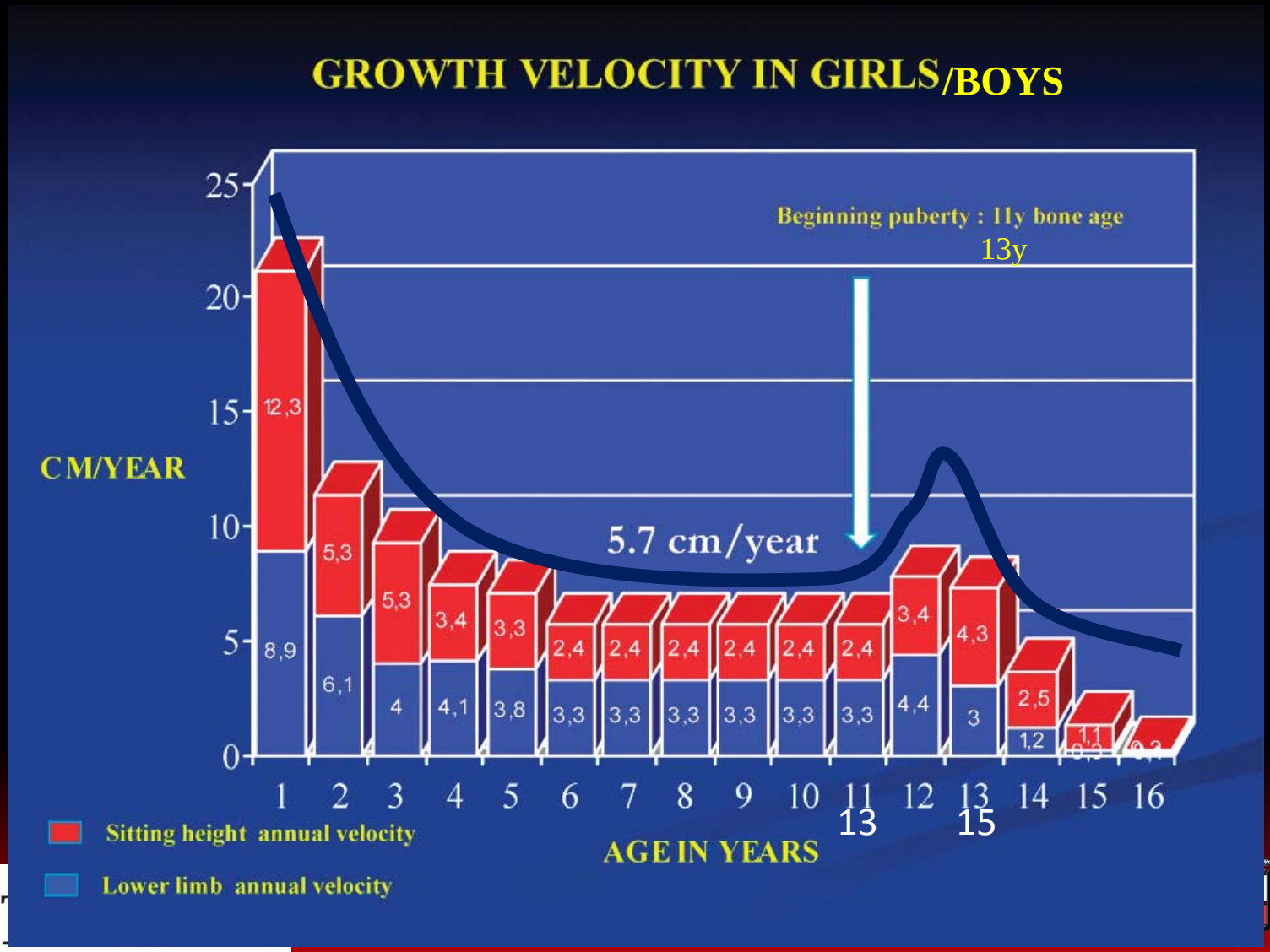
Normal growth in children

Growth Parameters:

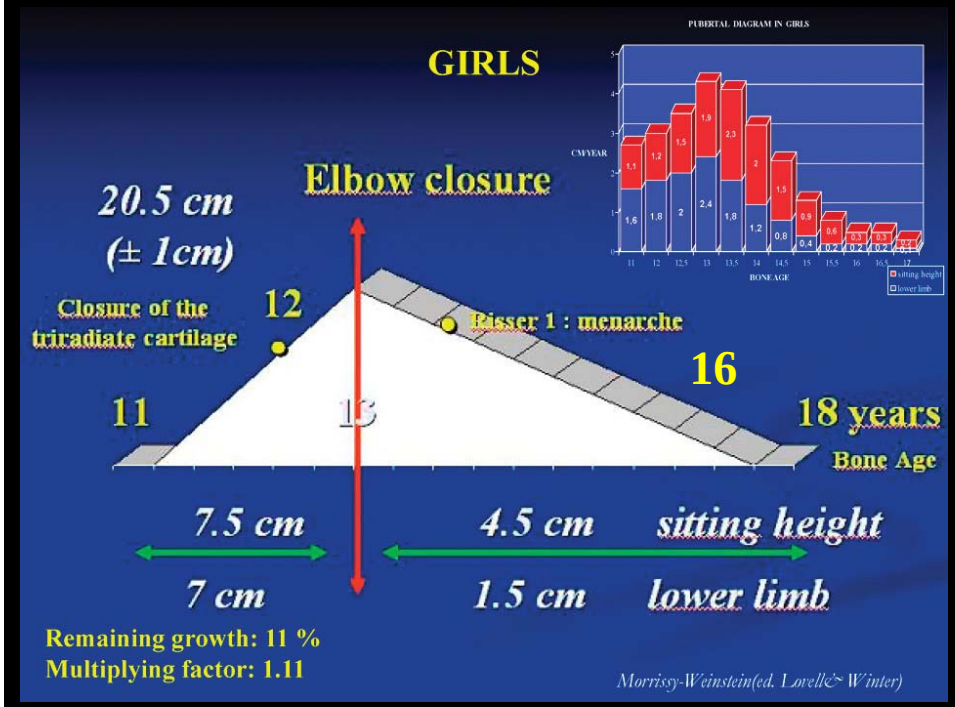
- Bone age
- Tanner classification

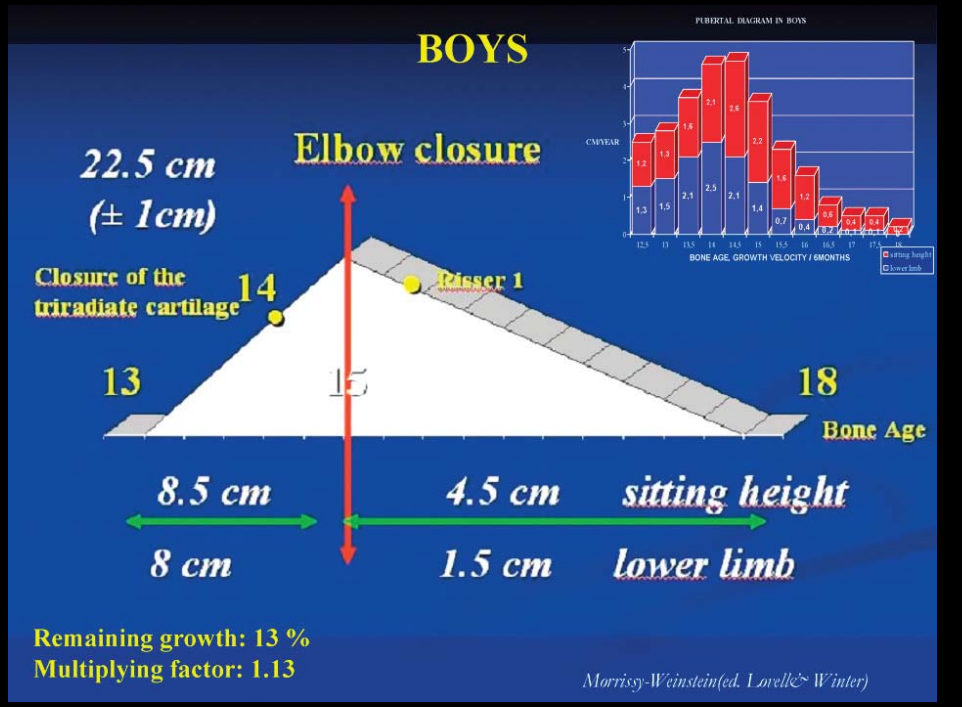

Closure of TRC
Elbow closure
Risser sign
Fusion Of GT
Bone age
Menarche
Growth curve
(critical period)
Decision
Epiphysiodesis
Estimation, timing
Scoliosis management:
Fusion, brace
TEXAS TECH UNIVERSITY
TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Normal growth in children



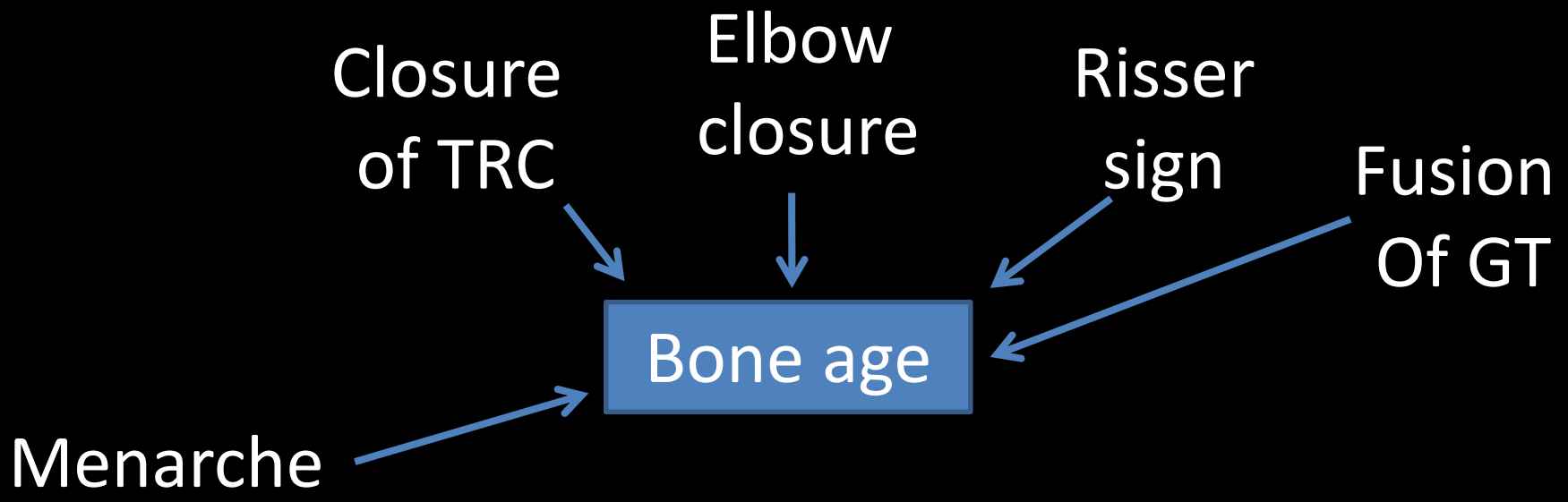
Normal growth in children





TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER



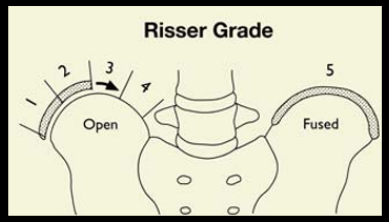
TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

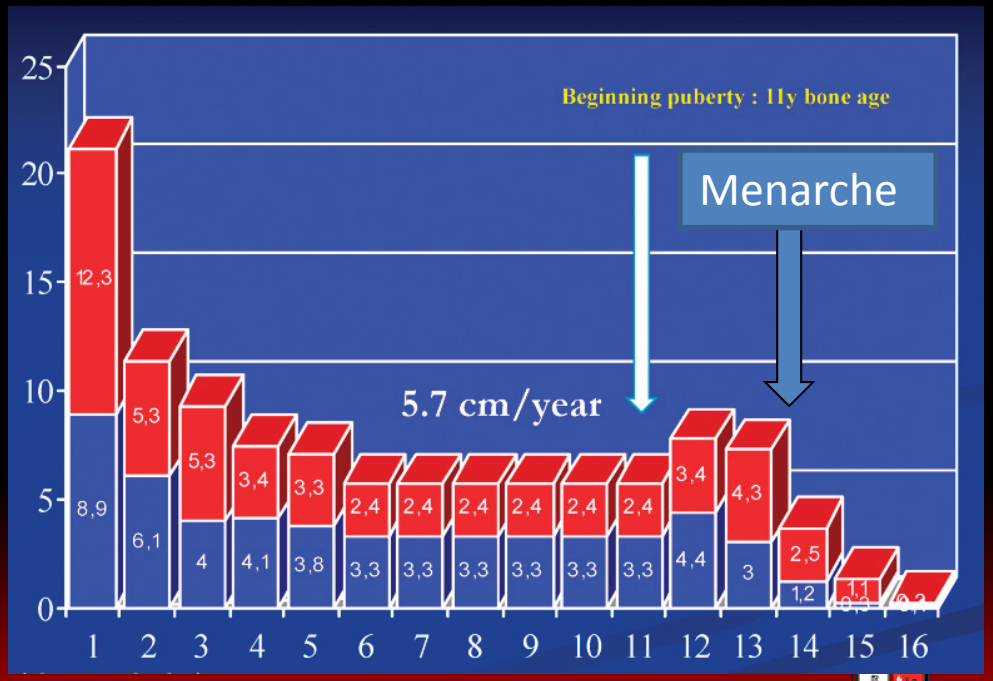
Normal growth in children

Menarche When?

Risser sign: Bone age
- R1: 13y 6m
- R2: 14y
- R3: 14y 6m
- R4: 15y
- R5: 15y 6m



Problems:
- 2 years after beginning of puberty
- Variable onset
  - 42% at Risser 1
  - 31% at Risser 2
  - 13% at Risser 3
  - 8% at Risser 4
  - 5% at Risser 5



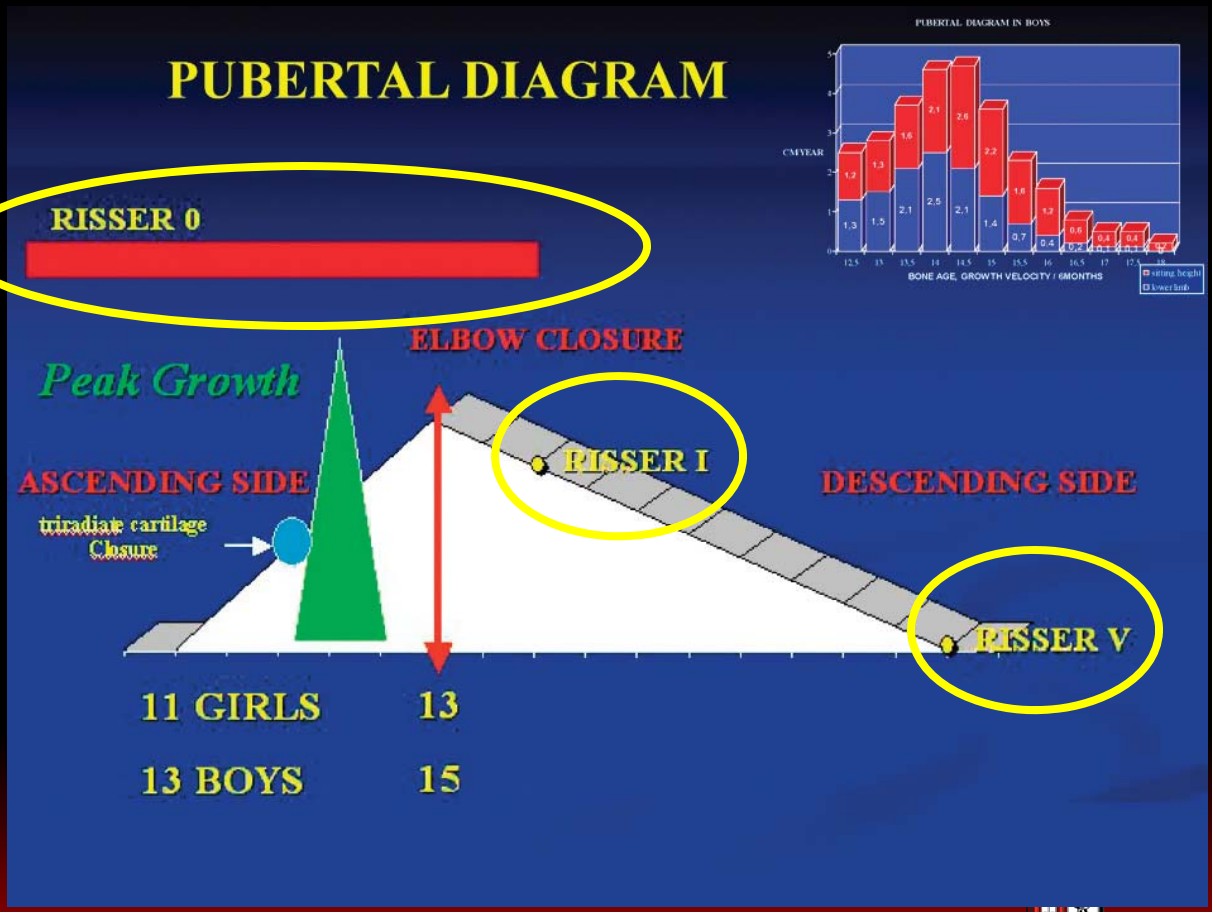
TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Normal growth in children

Risser sign:

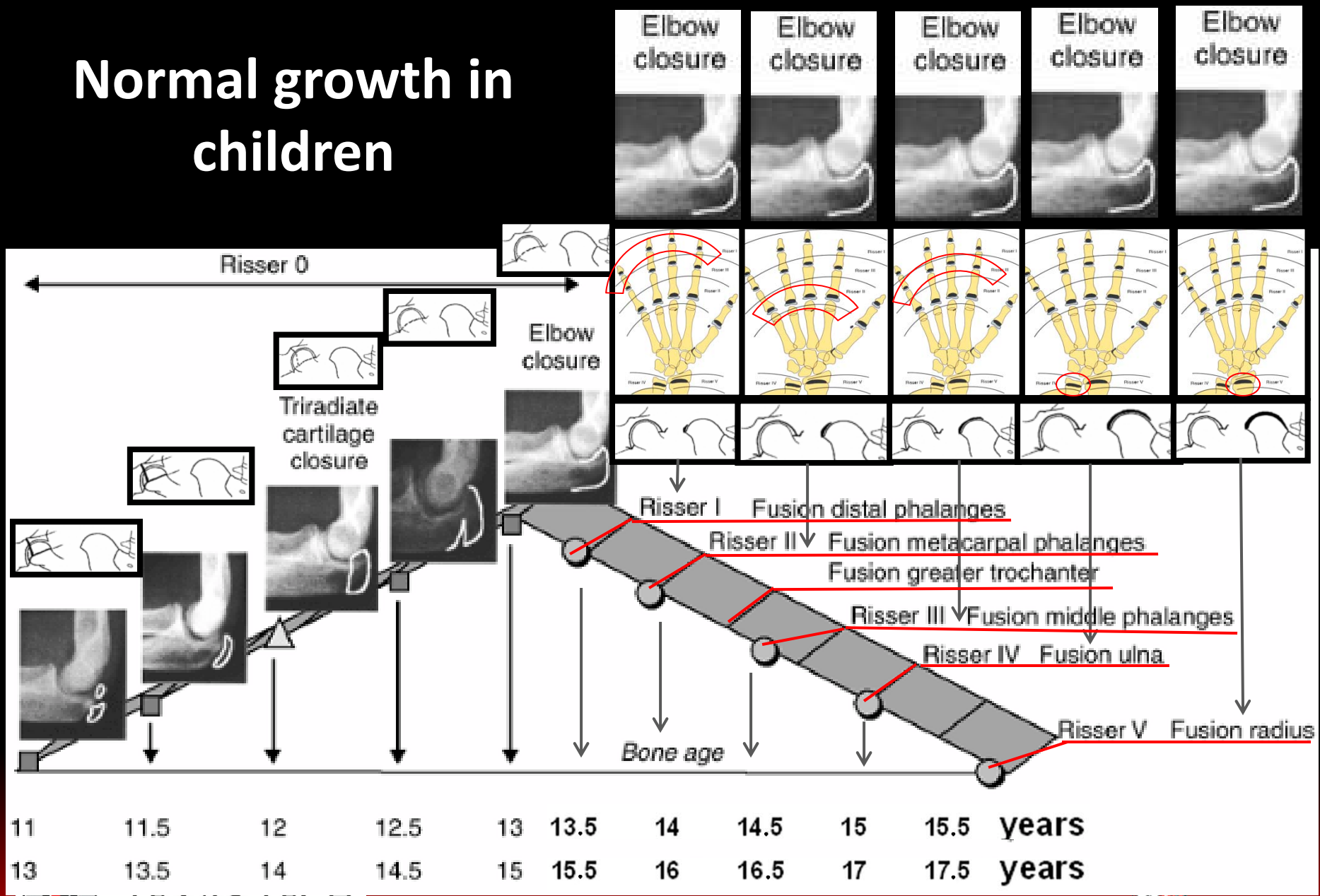
Is it reliable?



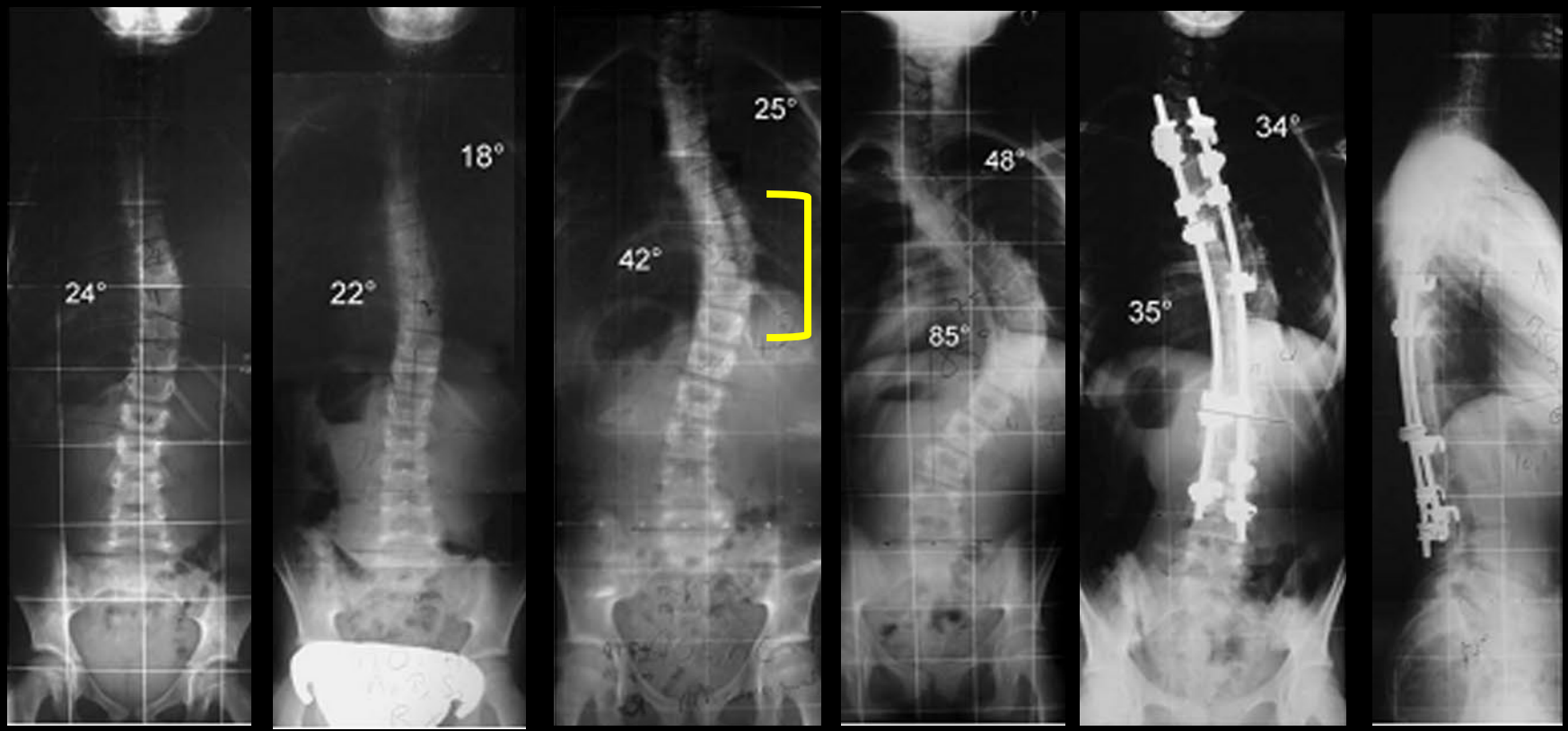
TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

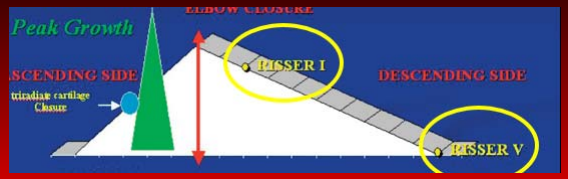
Normal growth in children



Scoliosis and growth



6 Y + 7 M | 11 years | 12 years | 13 years

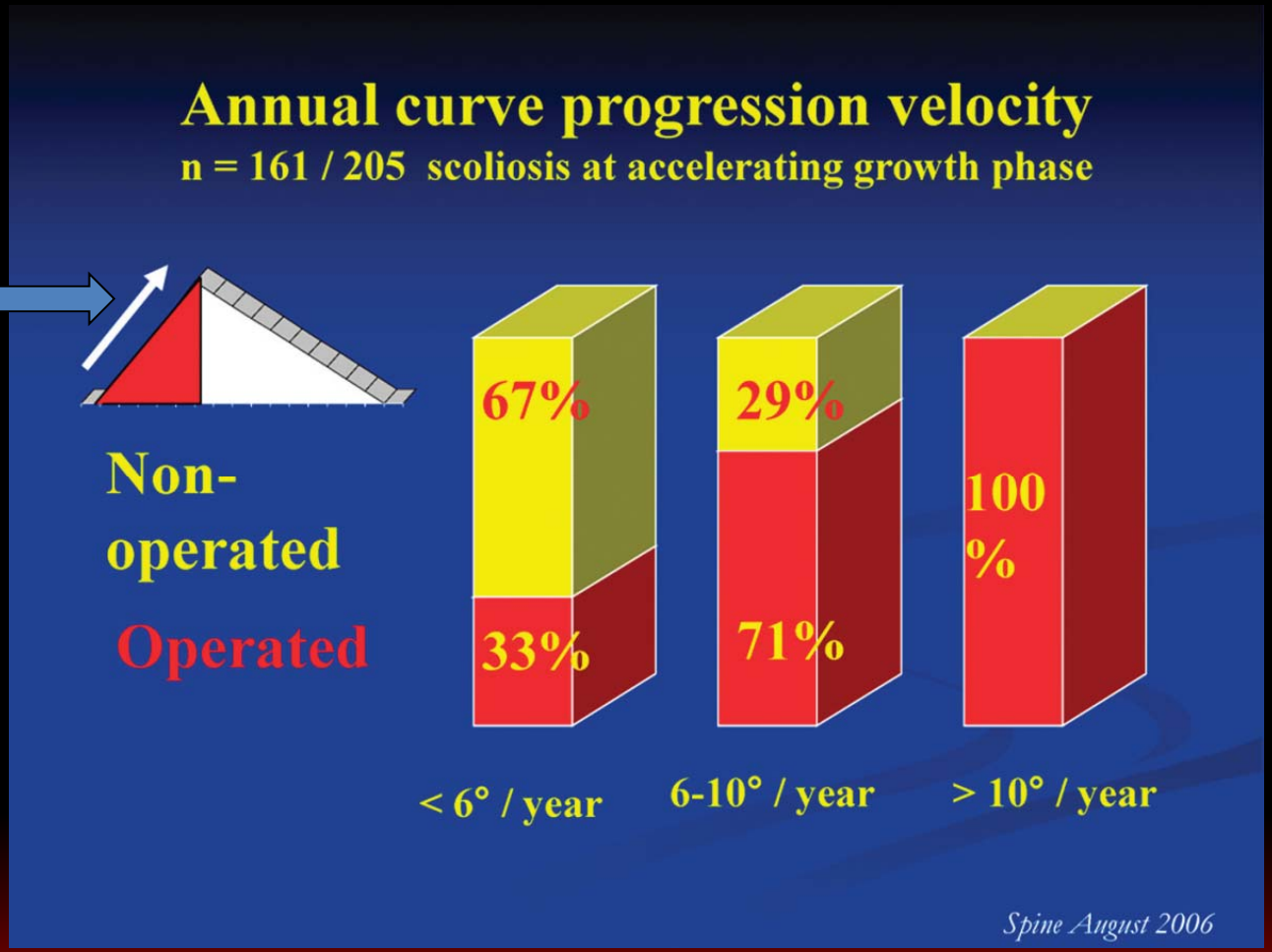


TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Scoliosis and growth

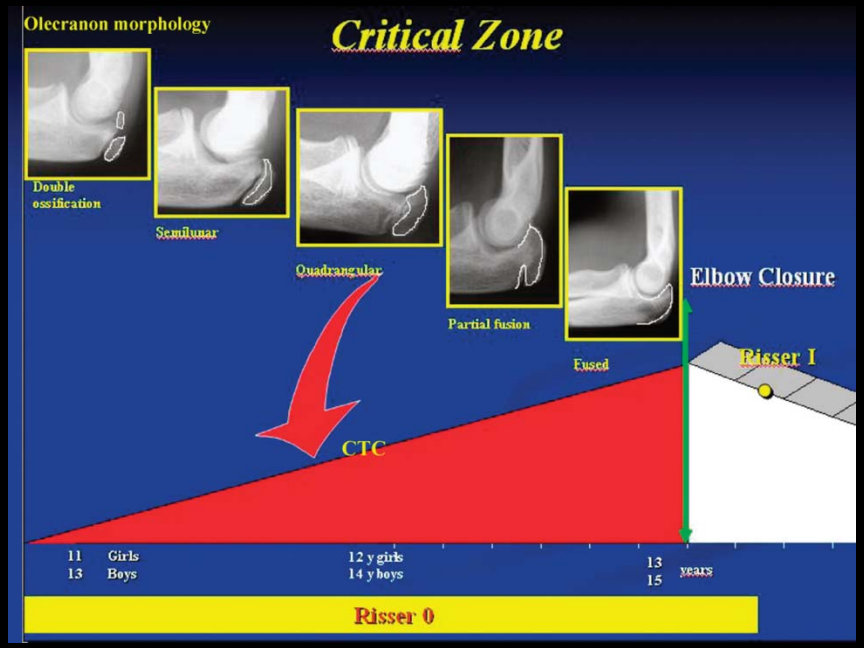
Judgment Phase

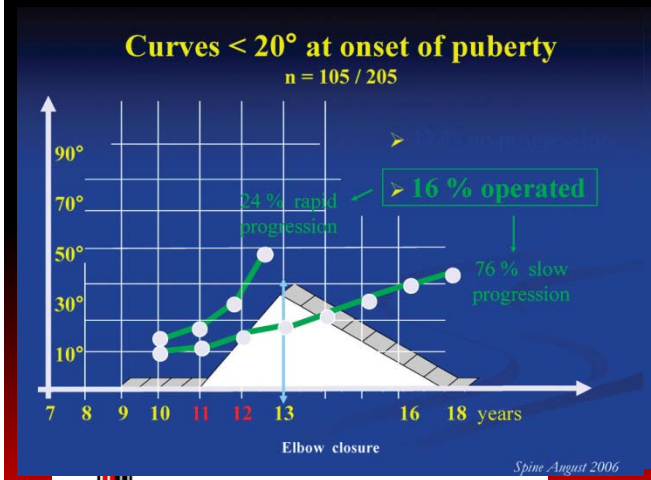


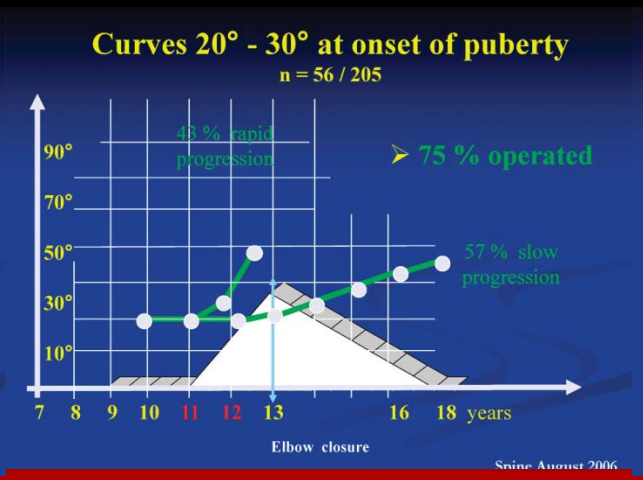
TEXAS TECH UNIVERSITY

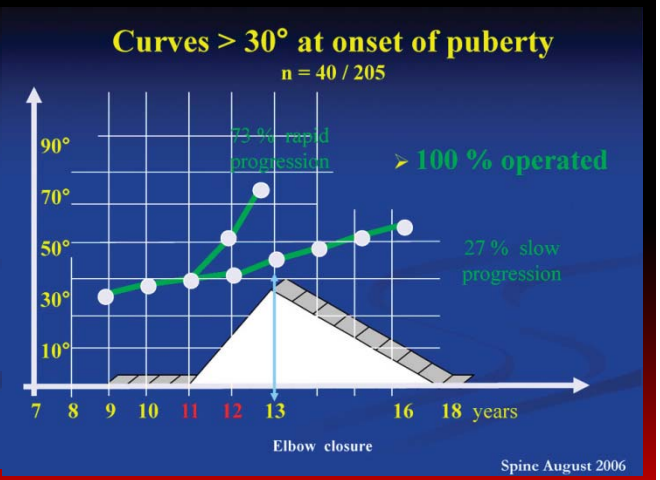
TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER

Scoliosis and growth









UNIVERSITY.

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

Summary

Progression of scoliosis depends on the curve type, the initial curve magnitude, and the growth velocity.

Fast growth velocity and a greater magnitude of scoliosis indicate progression of scoliosis.

Thank you

TEXAS TECH UNIVERSITY

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER®