Treatment of spinal deformities

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The most common spinal deformities

scoliosis

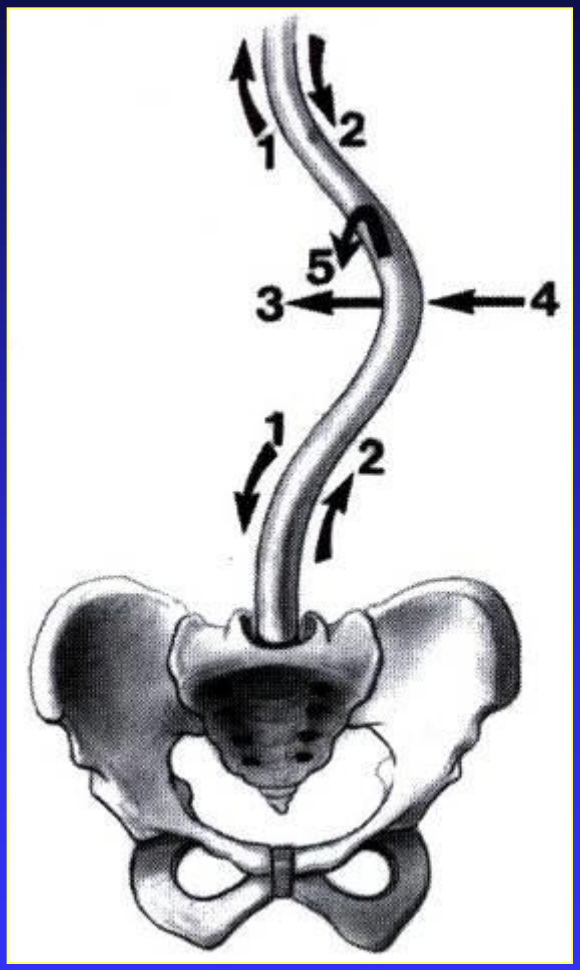
kyphosis

SCOLIOSIS

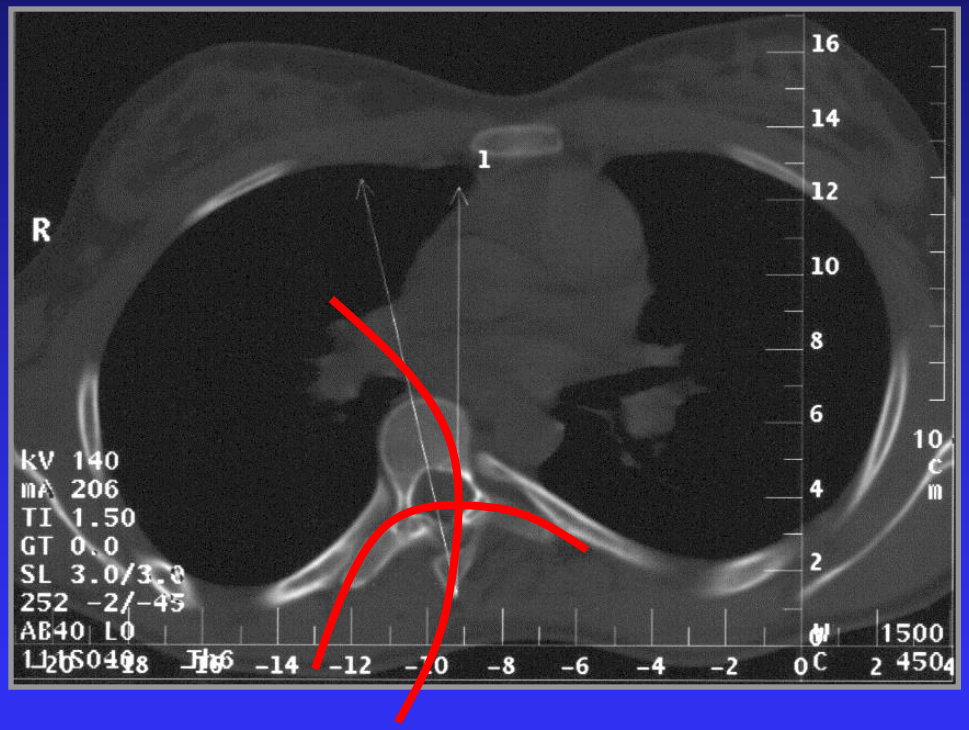
Scoliosis is three-dimensional deformity

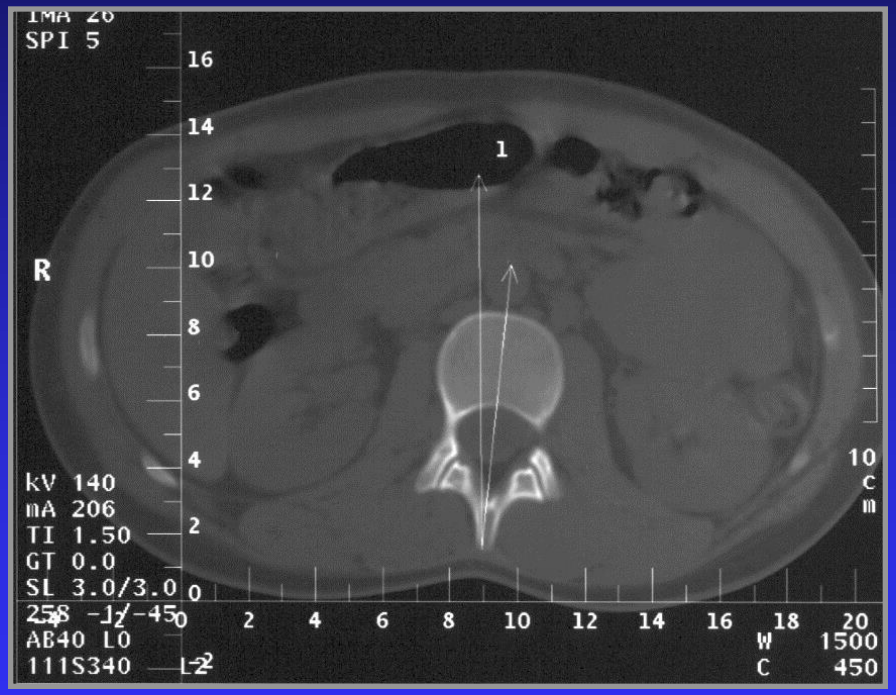
- in frontal plane - scoliosis
- in sagittal plane – hypo, hyperkyphosis
- in transversal plane – rotation, torsion

Scoliosis: 3-D deformity



Torsion


R
1
kV 140
mA 206
TI 1.50
GT 0.0
SL 3.0/3.0
AB40 LO
W 1500
C 450


SPI 5
R
1
kV 140
mA 206
TI 1.50
GT 0.0
SL 3.0/3.0
AB40 LO
W 1500
C 450

Elementary primary evaluation

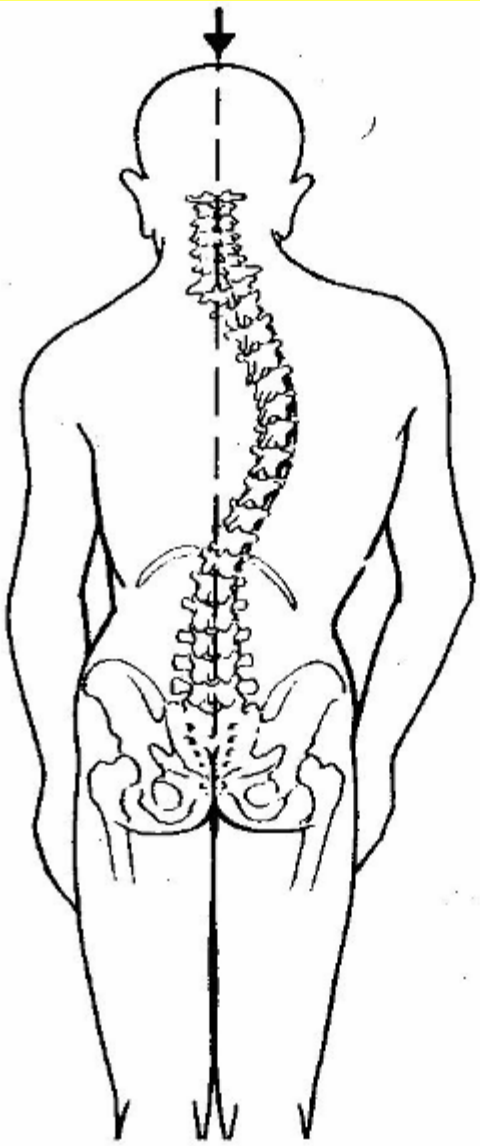
- anamnesis
- clinical examination
- X-ray evaluation
- treatment

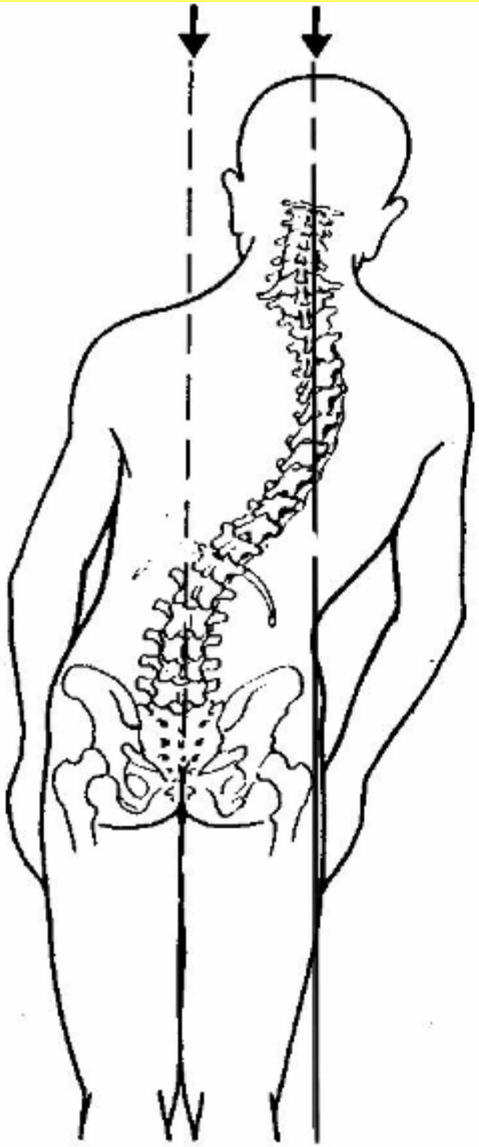
Anamnesis

- familiar anamnesis
- complex health status
- development – sitting, standing, …
- capture and present treatment

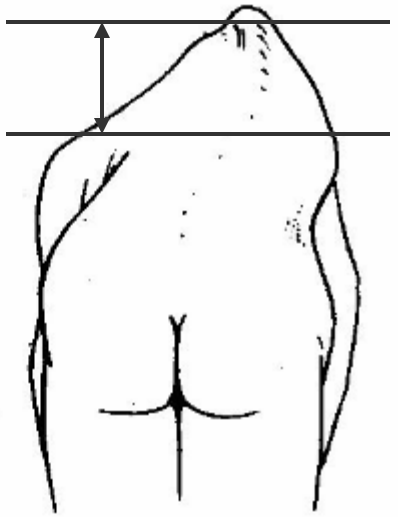
Clinical evaluation

- trunk compensation – plumb line
- shoulder height
- waist asymmetry
- pelvic balance
- curve flexibility in bending position
- prominence in bending forward
- others - laxicity, sexual development, skin pigmentation, lenght of lower extremities



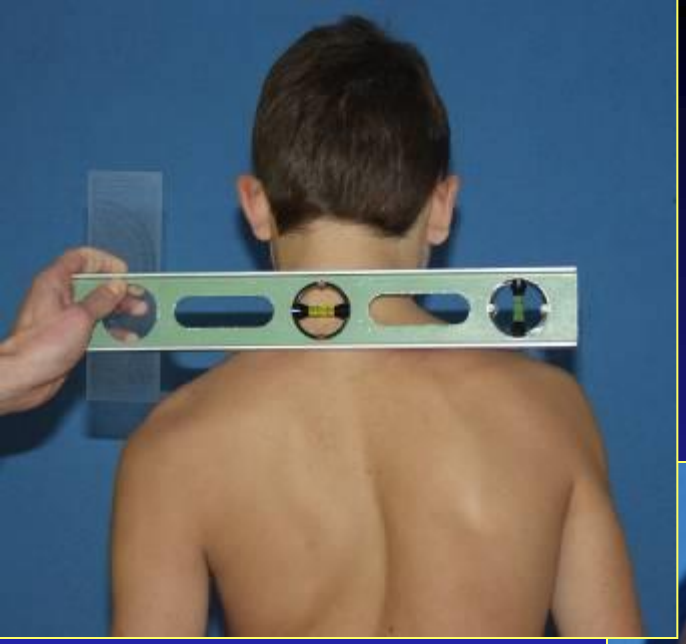


Dekompenzace skoliózy



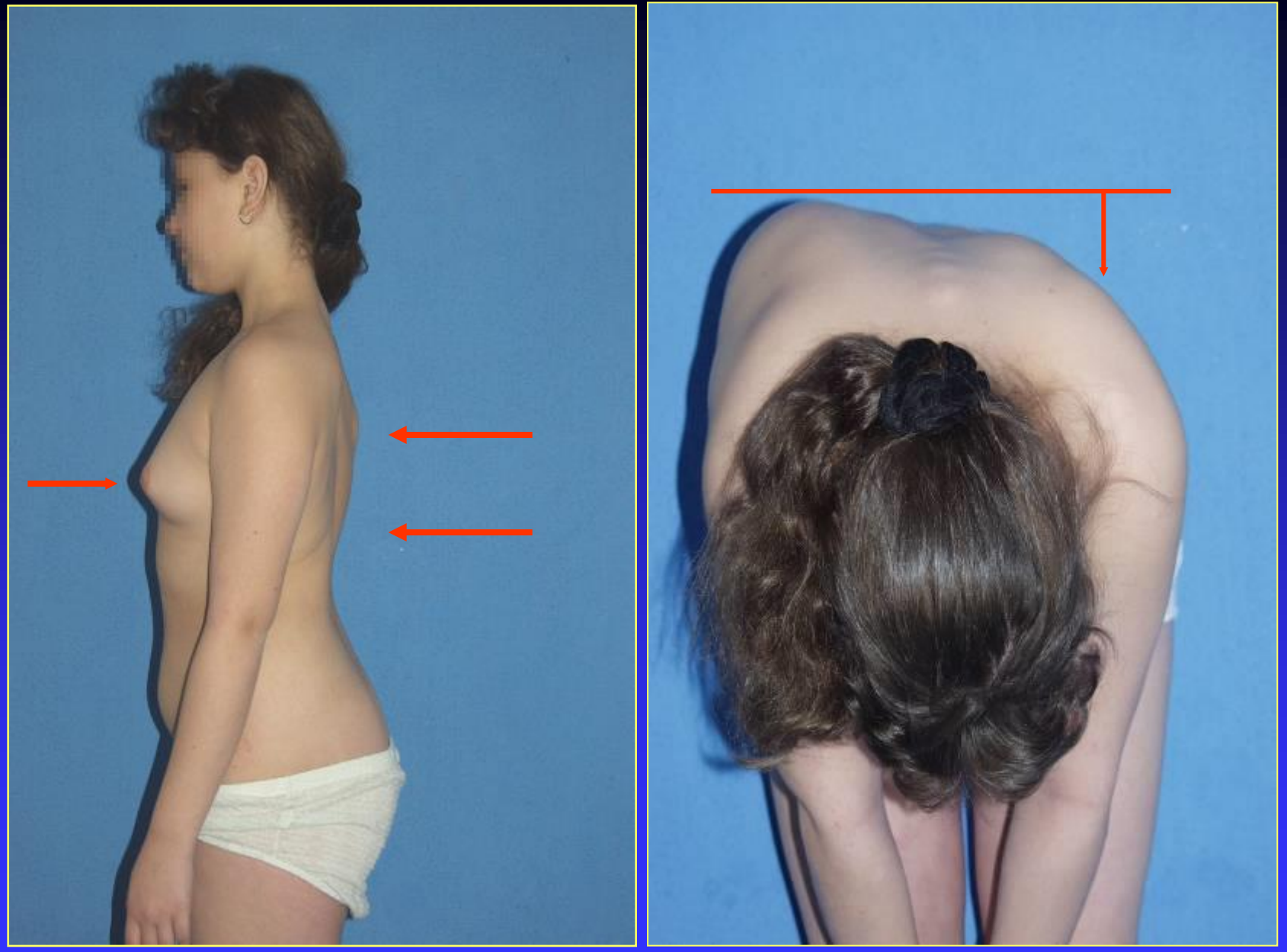
Žeberní prominence (APVZ)

Measurement of trunk decompensation



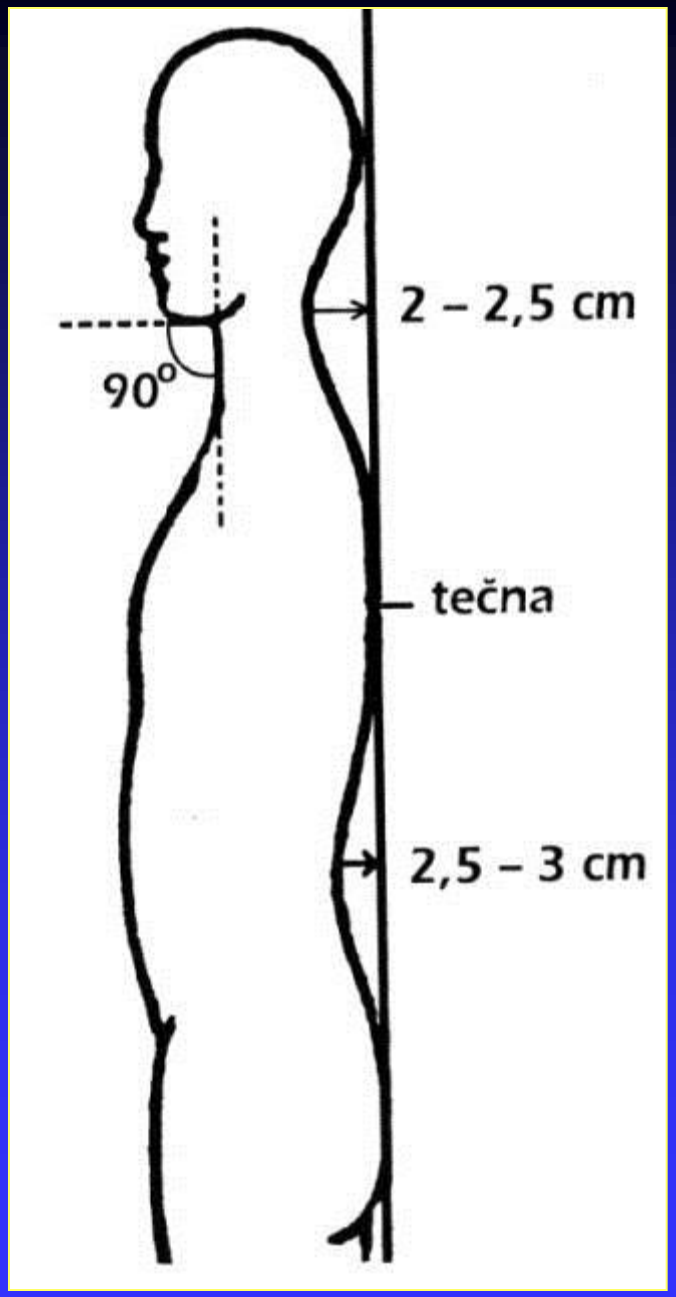
Measurement of shoul der asymmetry

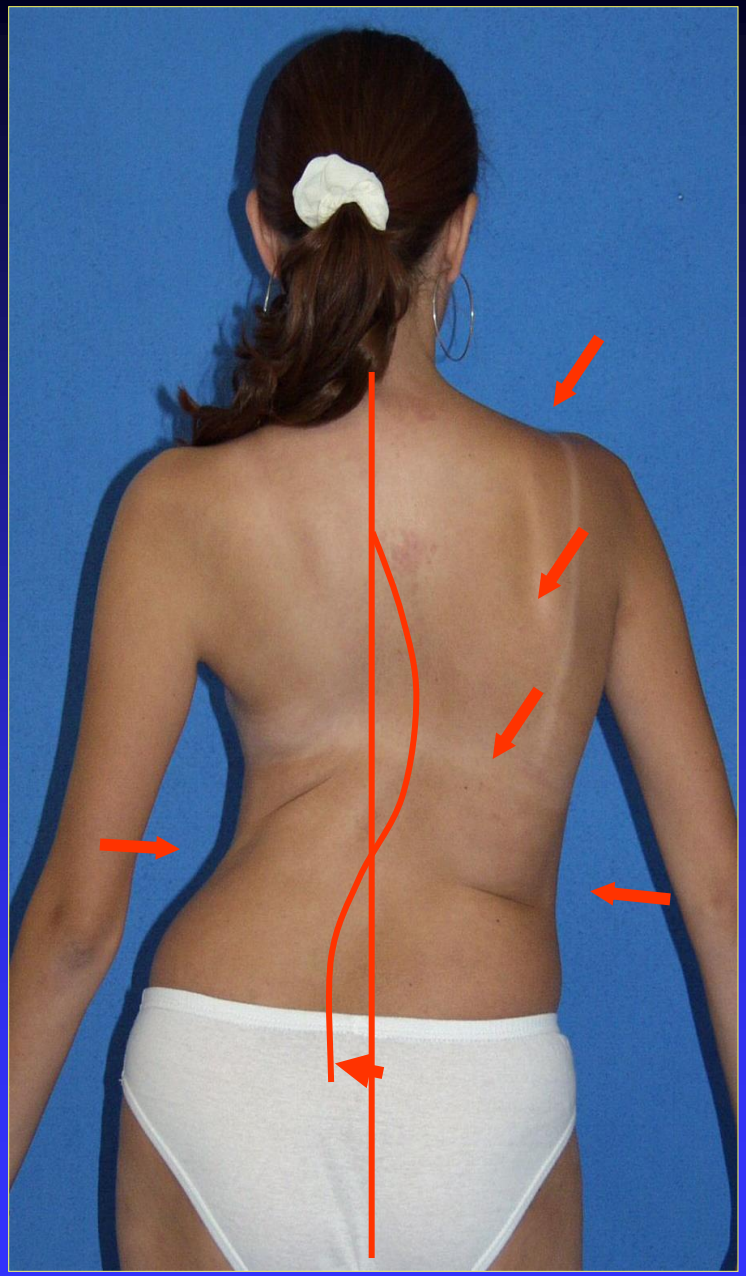
Measurement of paravertebral gibbus



Measurement of paravertebral gibbus

Sagittal balance





Shoulder height

Gibbus

Asymmetry of waist

Trunk decompensation

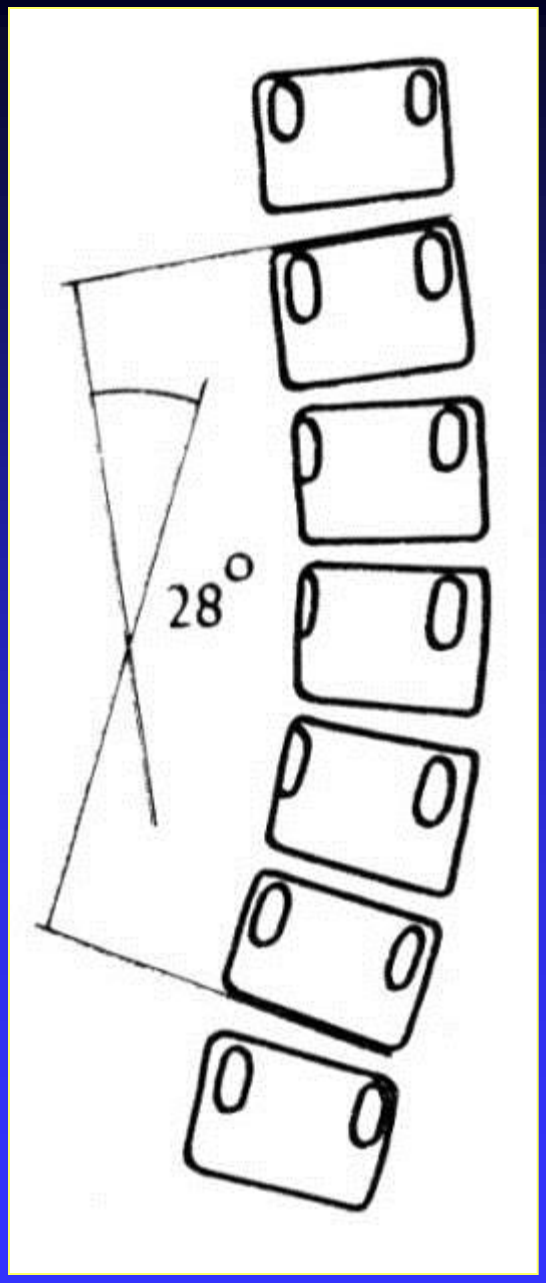
Neurofibromatosis „café au lait“

Radiological evaluation

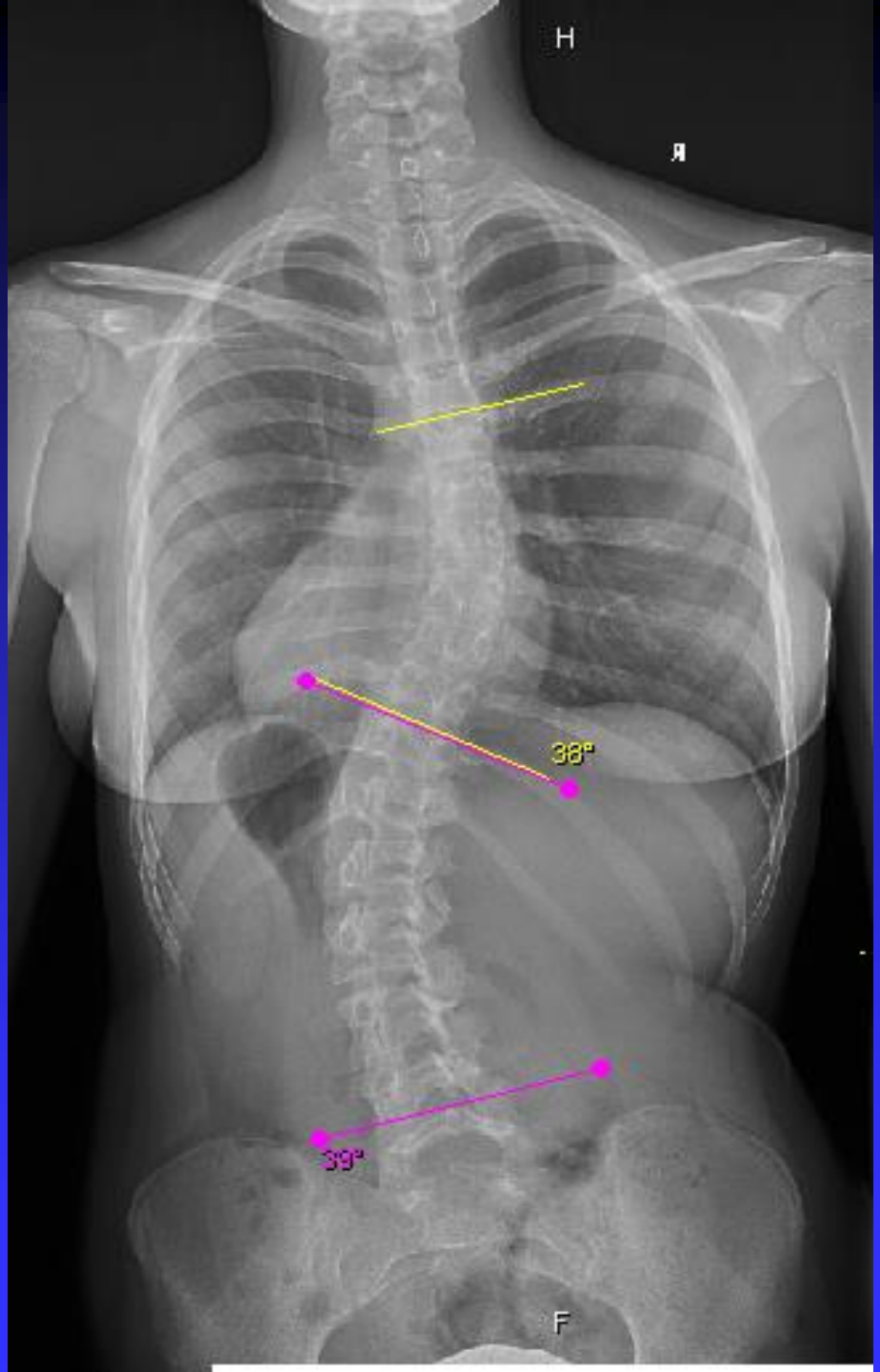
- PA and lateral X-rays in standing position (35x90 cm)
- lateral bending X-rays and traction of 200 N
- Special projections: Fergusson a Stagnara
- wrist X-ray for bone age measurement (Greulich-Pyle 1959)
- CT for measurement of apex vertebra rotation

Radiological scoliotic measurement

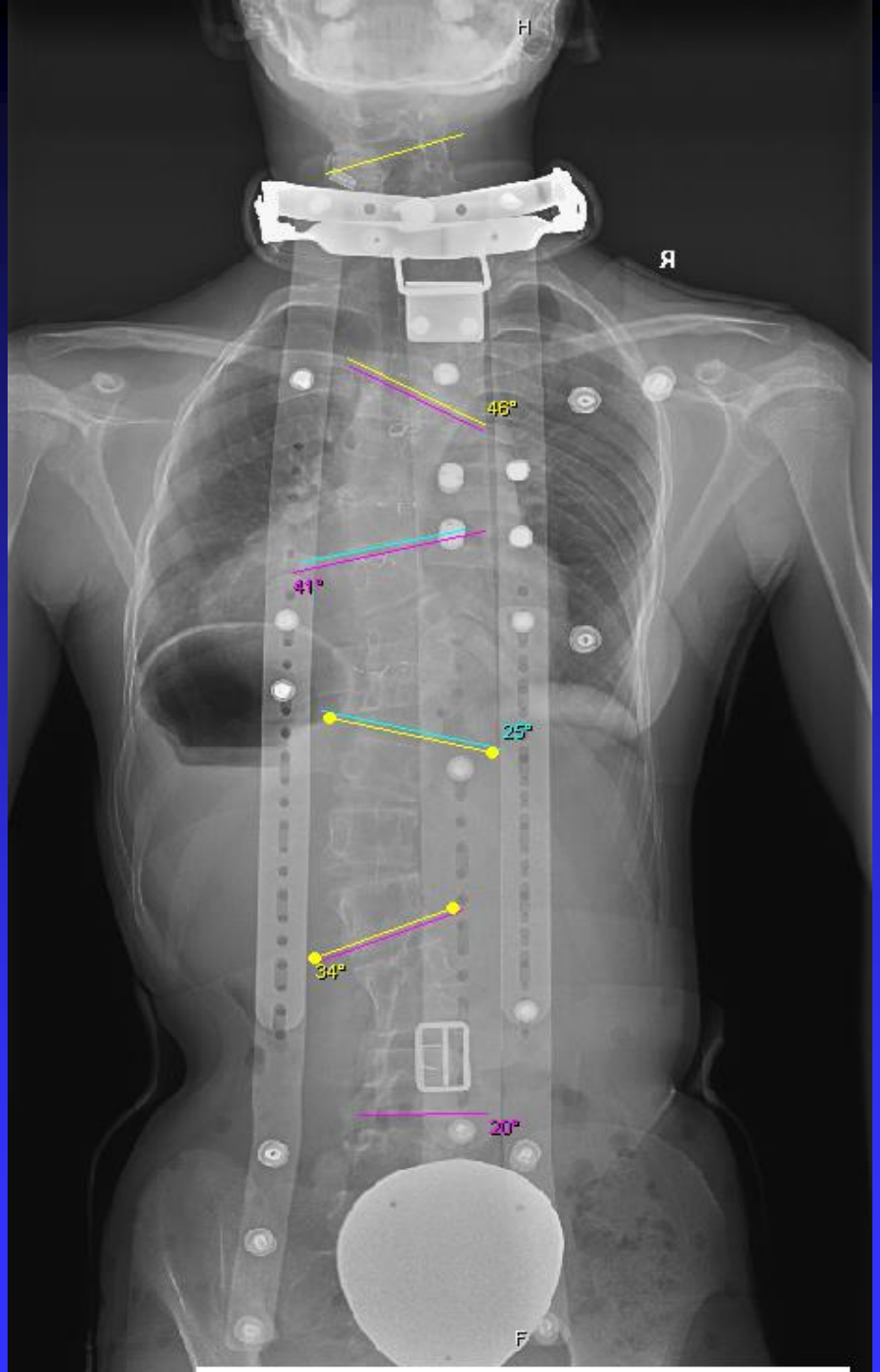
- COBB – angle of scoliosis and sagittal balance
- MOE – evaluation of vertebral rotation
- RISSER sign – evaluation of bone age



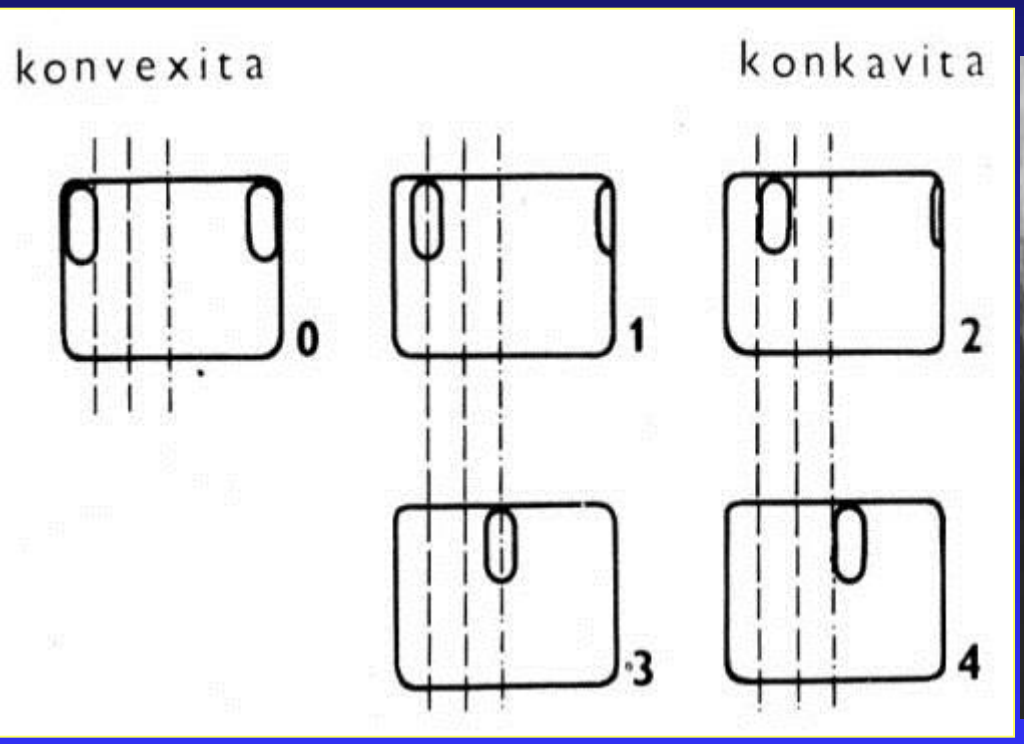
Curve gravity evaluation according to COBB

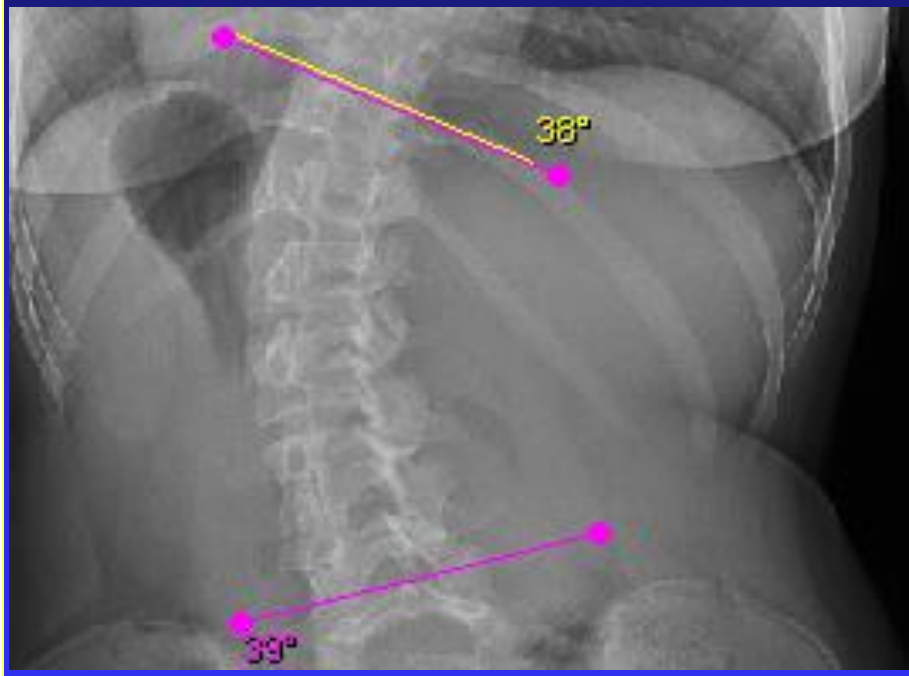

H
Я
38°
39°
F


H
Fakultr
28°
62°
F


H
Я
46°
41°
25°
34°
20°
F

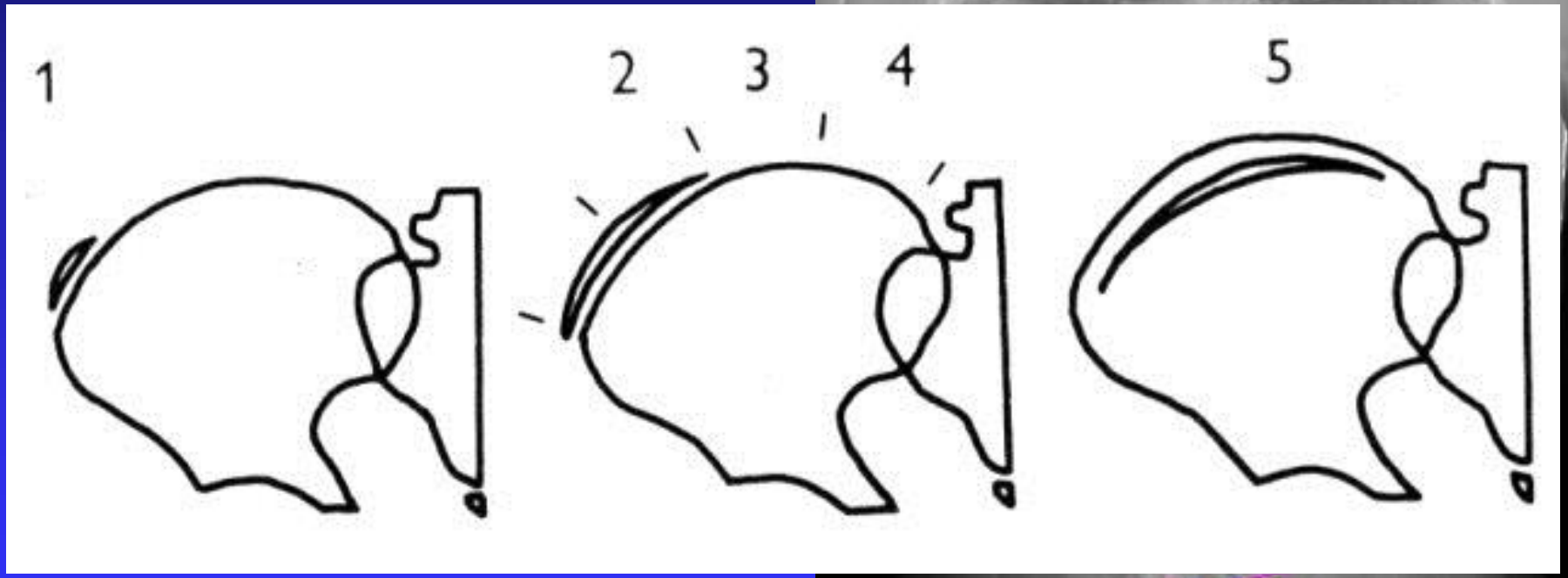
Rotation evaluation according to MOE



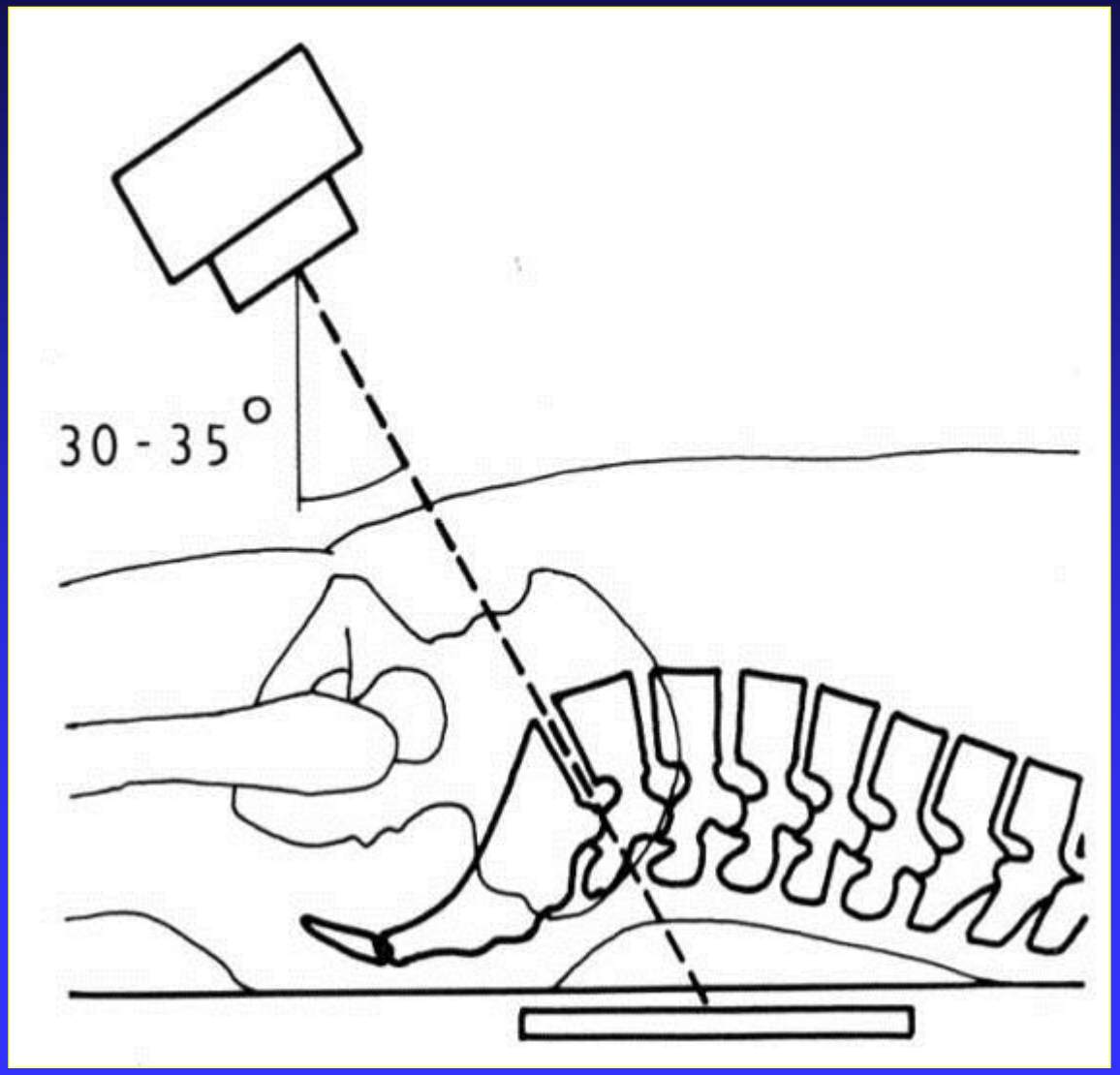


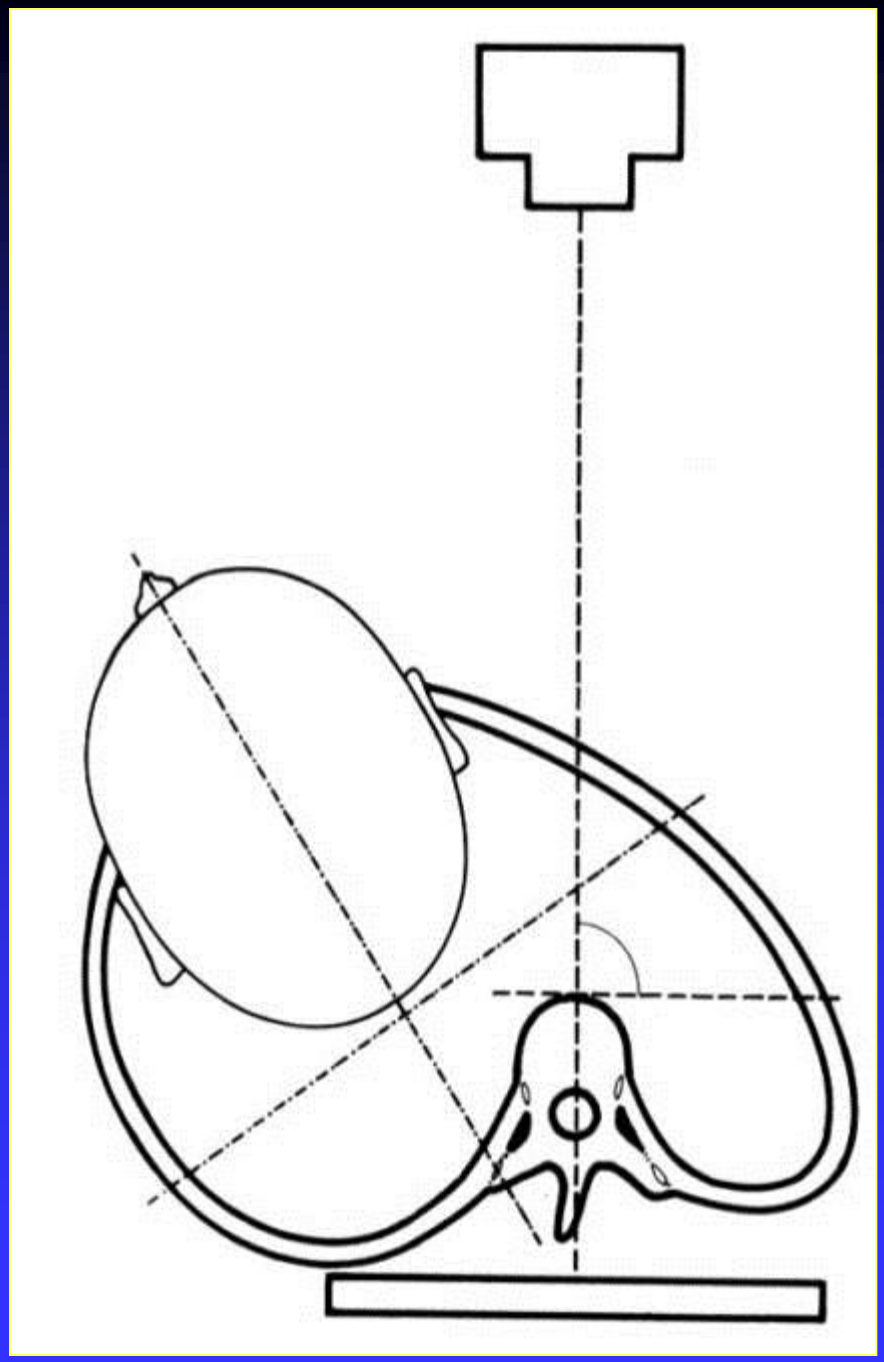
RISSER´s sign

- **STADIUM 1 = 2 years before ending of growing period**
- **STADIUM 3 = peak of growing spurt**



FERGUSON´s projection





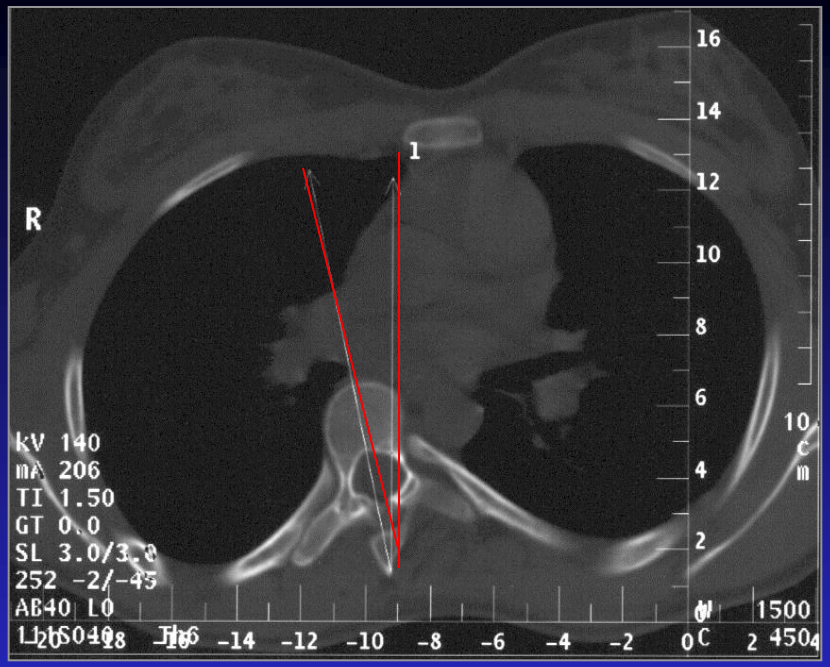
STAGNARA projection

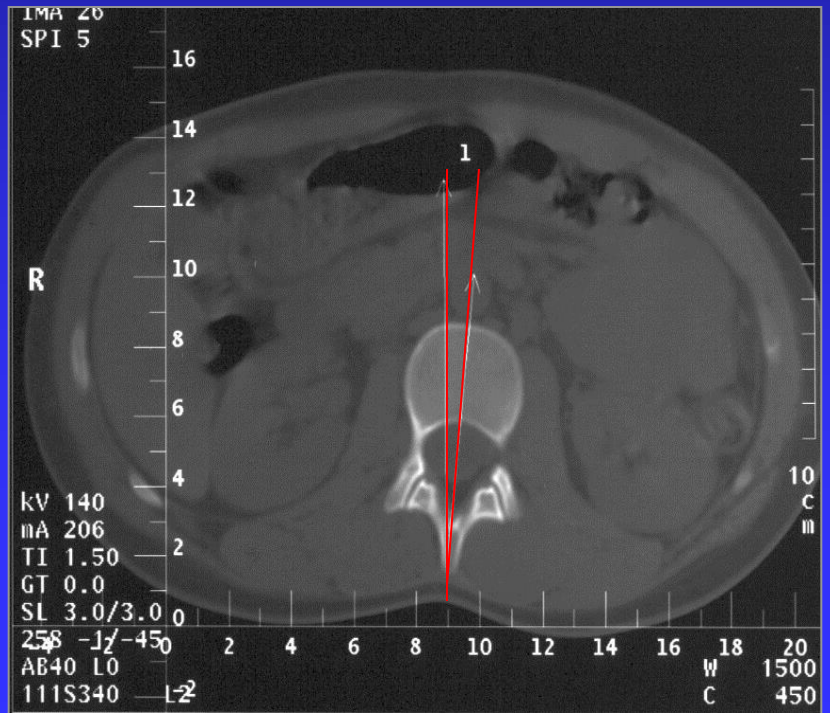
Rotation - vertebra evaluation

Th apical vertebra

double Th-L curves

L apical vertebra





Basic terms

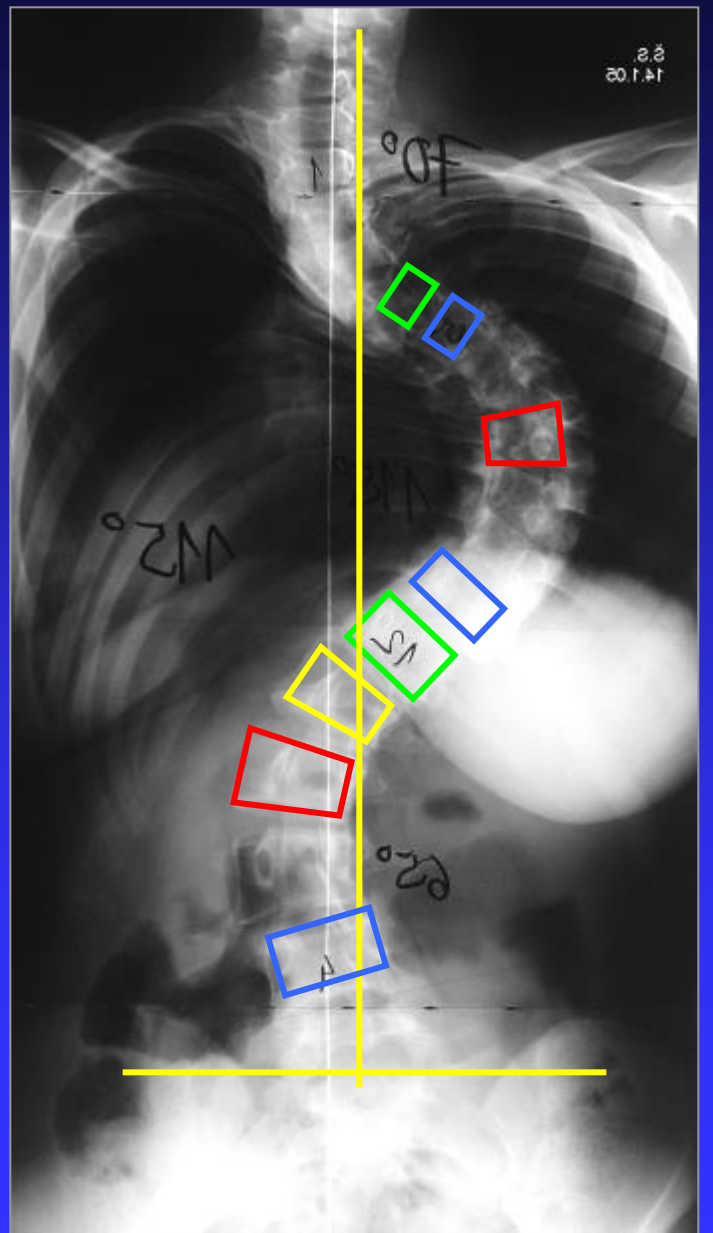
Apical vertebra

Ending vertebra

Neutral vertebra

CSVL

Stable vertebra



Characteristics of the curves

Structural

Non-structural

Curves terminology
(according to Cobb angle)

Main (weighty rotation)

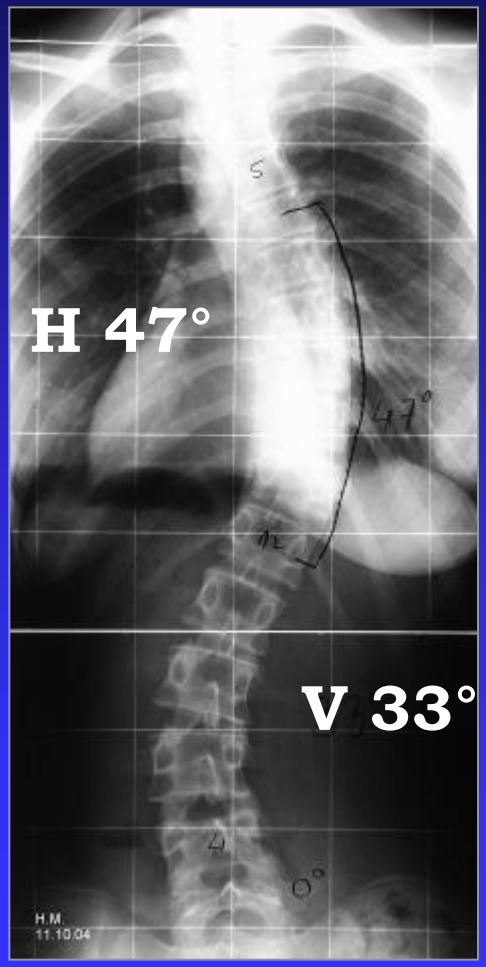
Adjacent (compensatory)

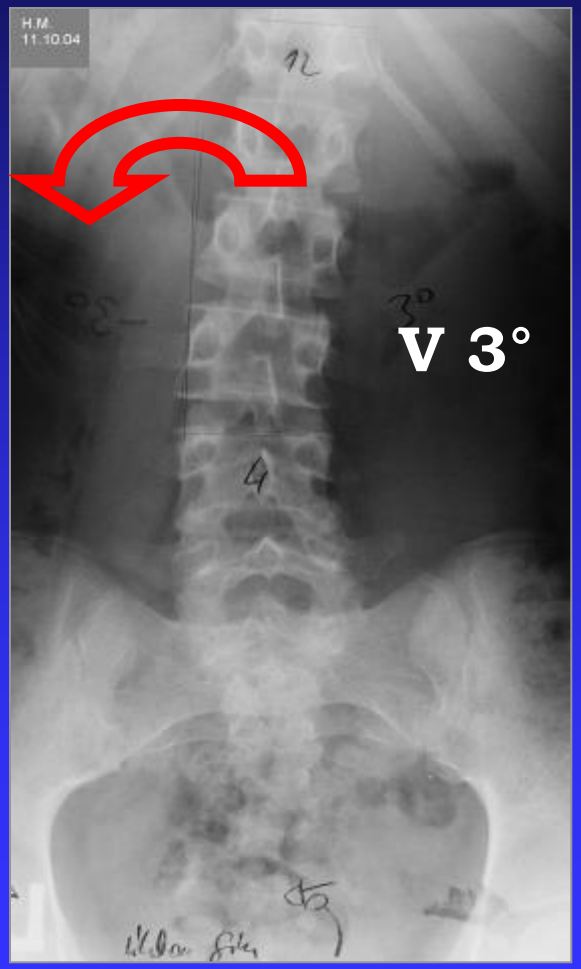
Curve structurality

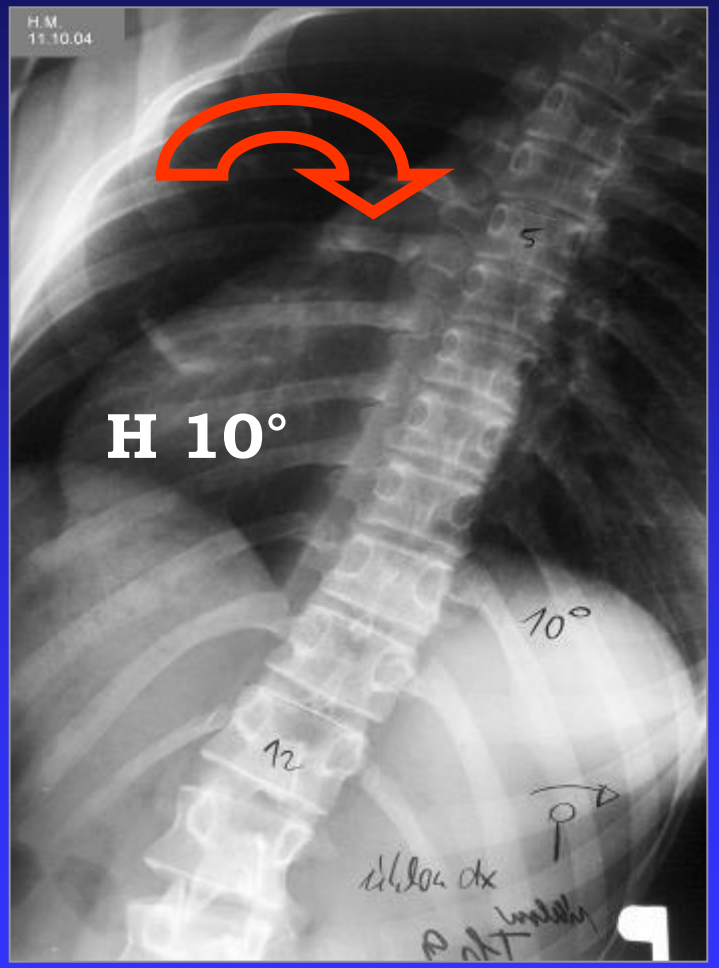
- **Main – structural**
- **Adjacent – structural, non-structural**

Curve structurality of adjacent curve is important to decide the fusion of adjacent curve in surgical treatment of AIS

Non-structural curve





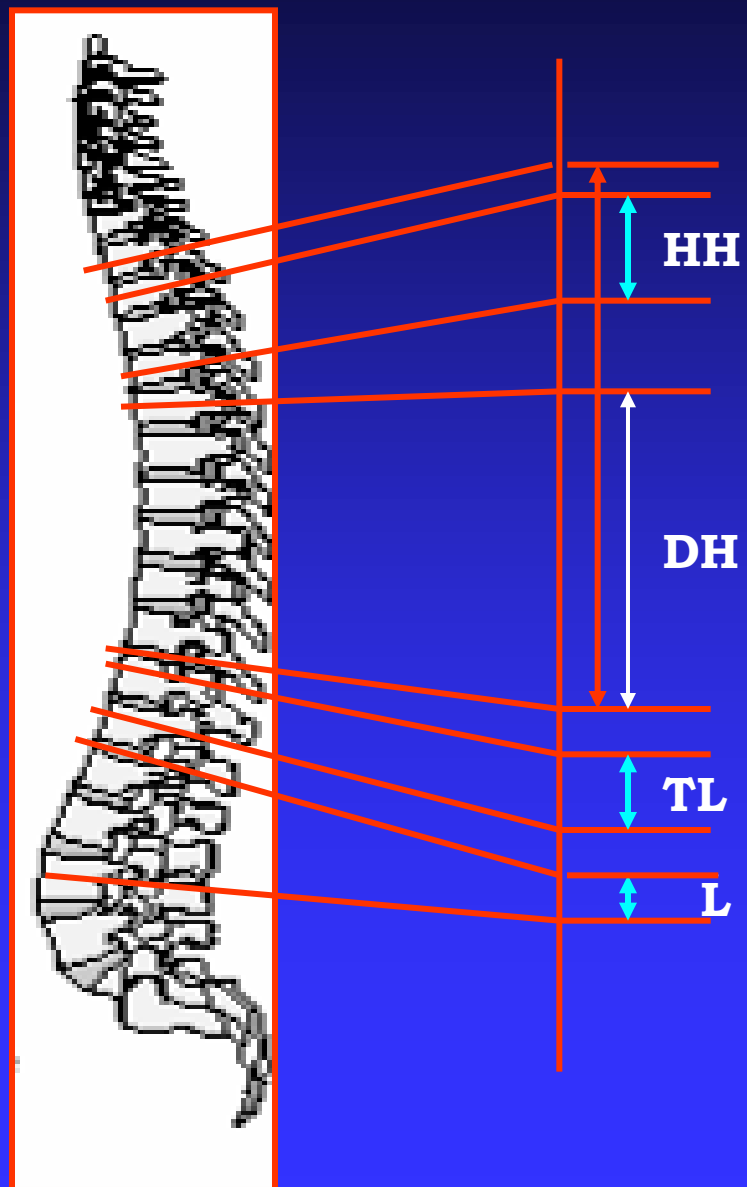


Classification

- Orientation – right or left convexity
- Localisation – C,CT,T,TL,L,LS
- Gravity of curves – according to Cobb angles
- Etiology

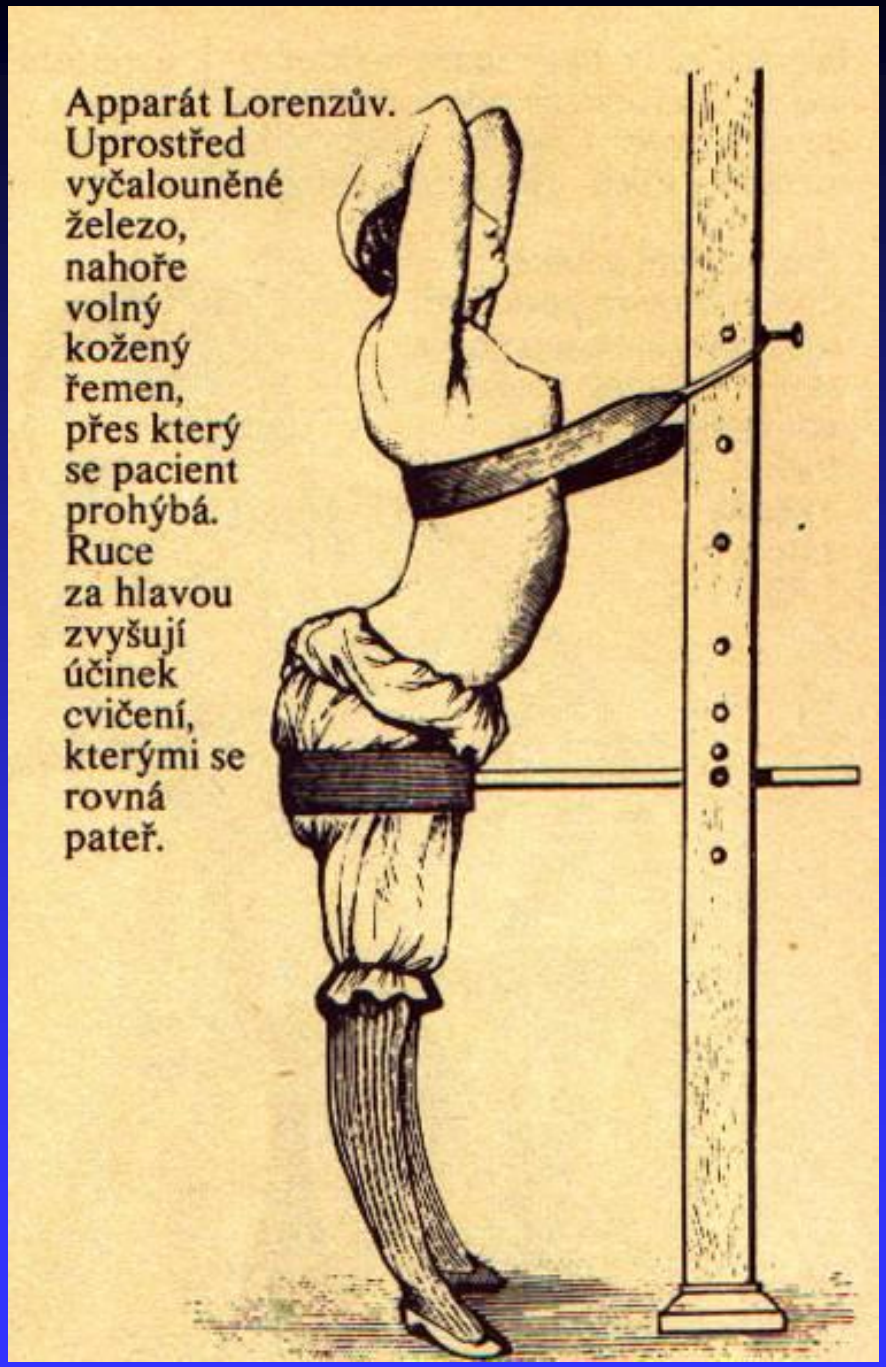
Localisation of the curve according to position of the apical vertebra

- **Thoracic:** T2- disc T11/12
  Upper Th T3 – T5
  Lower Th T6 – disc T11/12
- **Thoracolumbar:** T12-L1
- **Lumbar:** disc L1/2-L4



Scoliosis – ethiopathogenetic classification

- Congenital
- Idiopathic……4/5 80%
  - infantile
  - iuvenile
  - adolescent
- Neuromuscular
  - neuropatic
  - myopatic
- Neurofibromatosis
- Secondary
  - Postural
  - Tumours
  - Other syndromas (Marfan, Ehlers-Danlos……..)
- Hysteric
- Degenerative



IDIOPATHIC SCOLIOSIS

- Unknown etiology, multifactorial
- Genetic predispositions
- 8 times more frequent in girls

Idiopathic scoliosis

- **Infantile**
  - < 3 years, neonatorum, mostly spontaneous regression, but some times with serious progression
- **Iuvenile**
  - Age of 3 y. – puberty start (10 y.)
- **Adolescent**
  - From puberty start (10 -12 y.) – up to puberty end

Classification according to the curve gravity

Up to 10 ° -observation

11-20 ° -physiotherapy, observation

20-40° -physiotherapy, bracing

More than 40 ° -surgical treatment

Conservative therapy

Physiotherapy

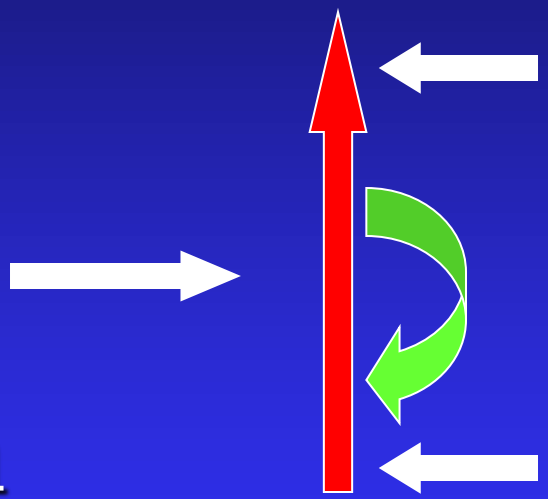
Brace

Brace characteristics:

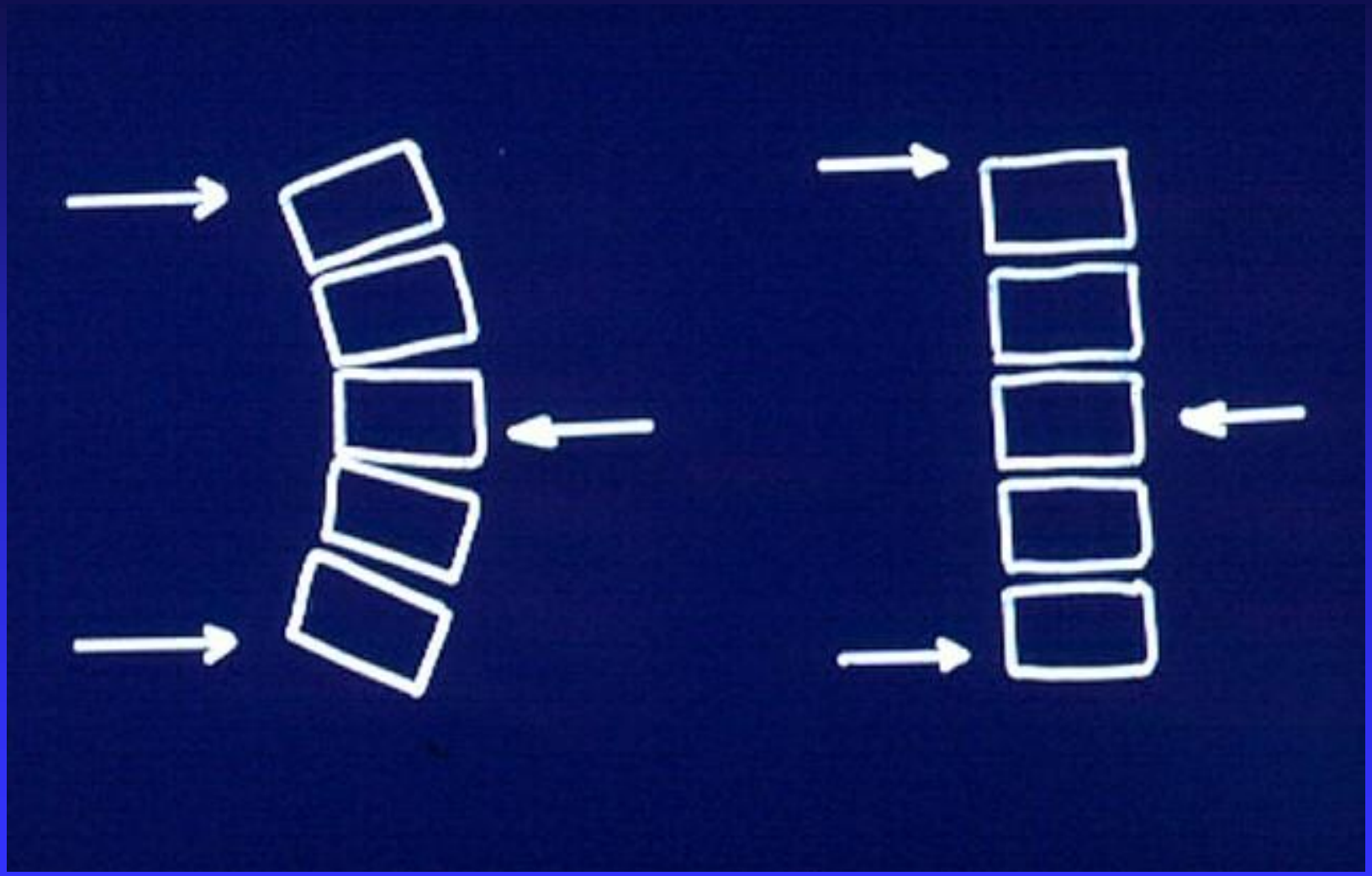
- maximally effective
- active and pasive curve correction
- lite
- easily slip-over
- without chest compression

Effective forces:

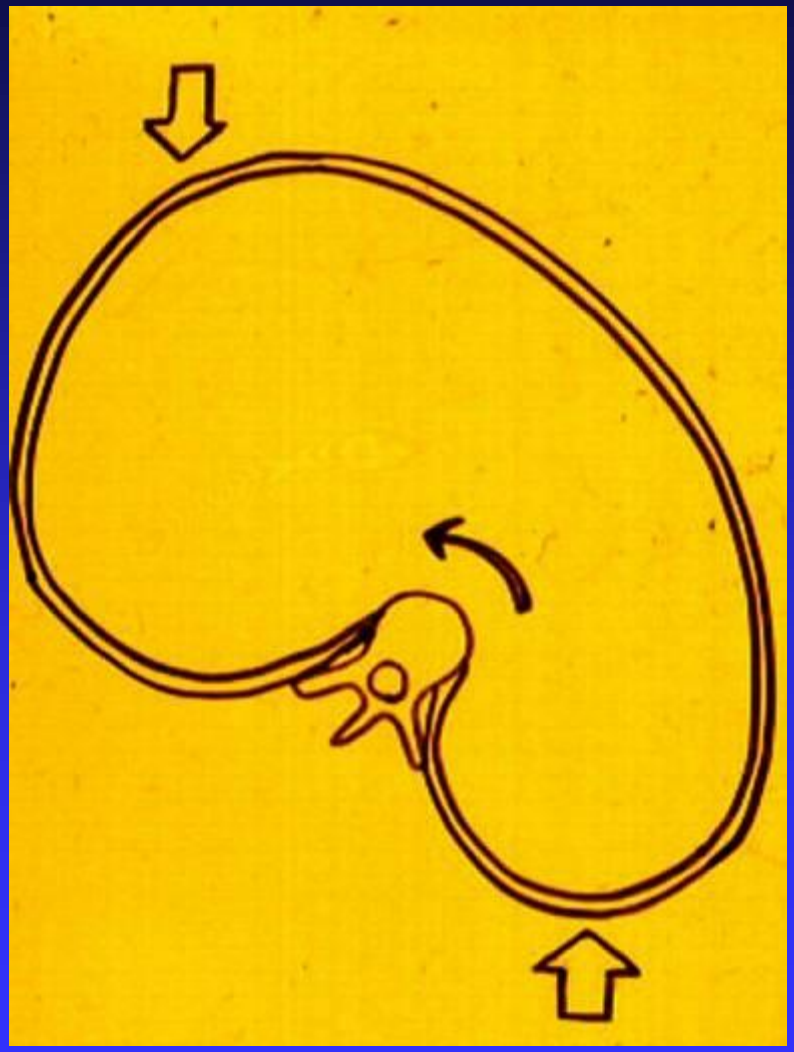
- distraction
- derotation
- three-point system



Three-point principle



Derotation



Physiotherapy in brace

- body posture
- muscle

strenghtening

Body posture

wrong

good

strengthening

- without brace

  - swimming

  - hippotherapy

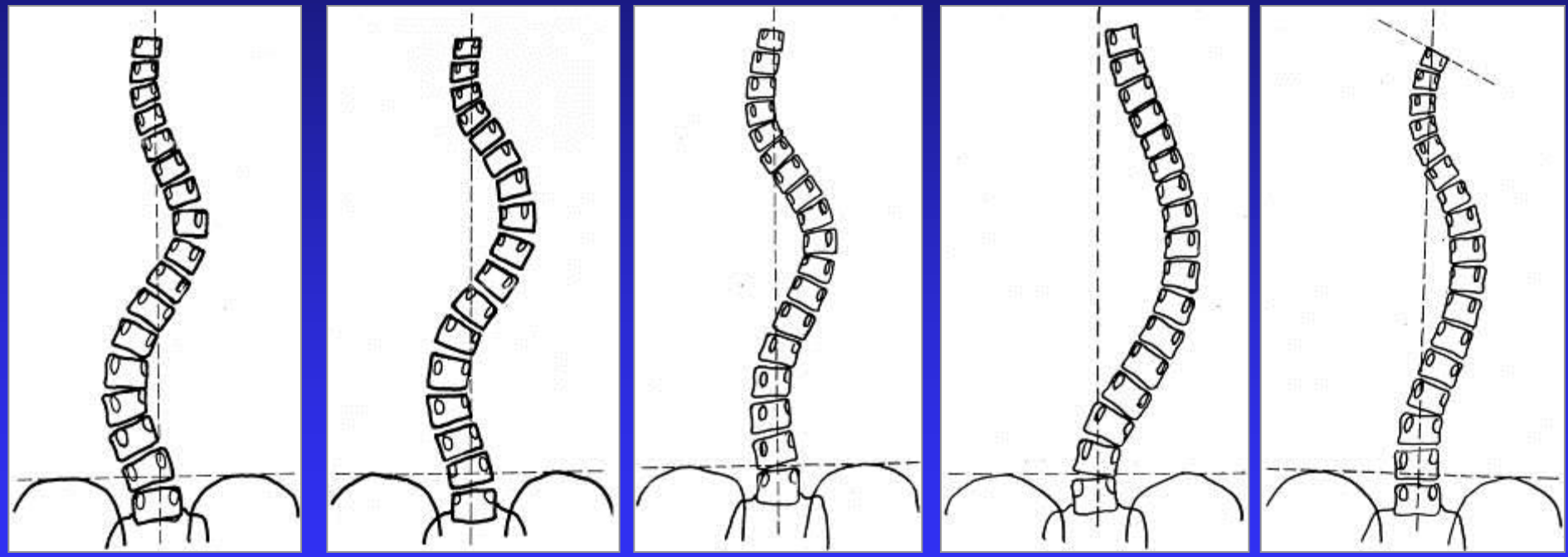
  - excercises according to Vojta

  (limited effect) and Schrott

- Breathing – *deep breathing*
  - *special bottles*
  - *derotation breathing*

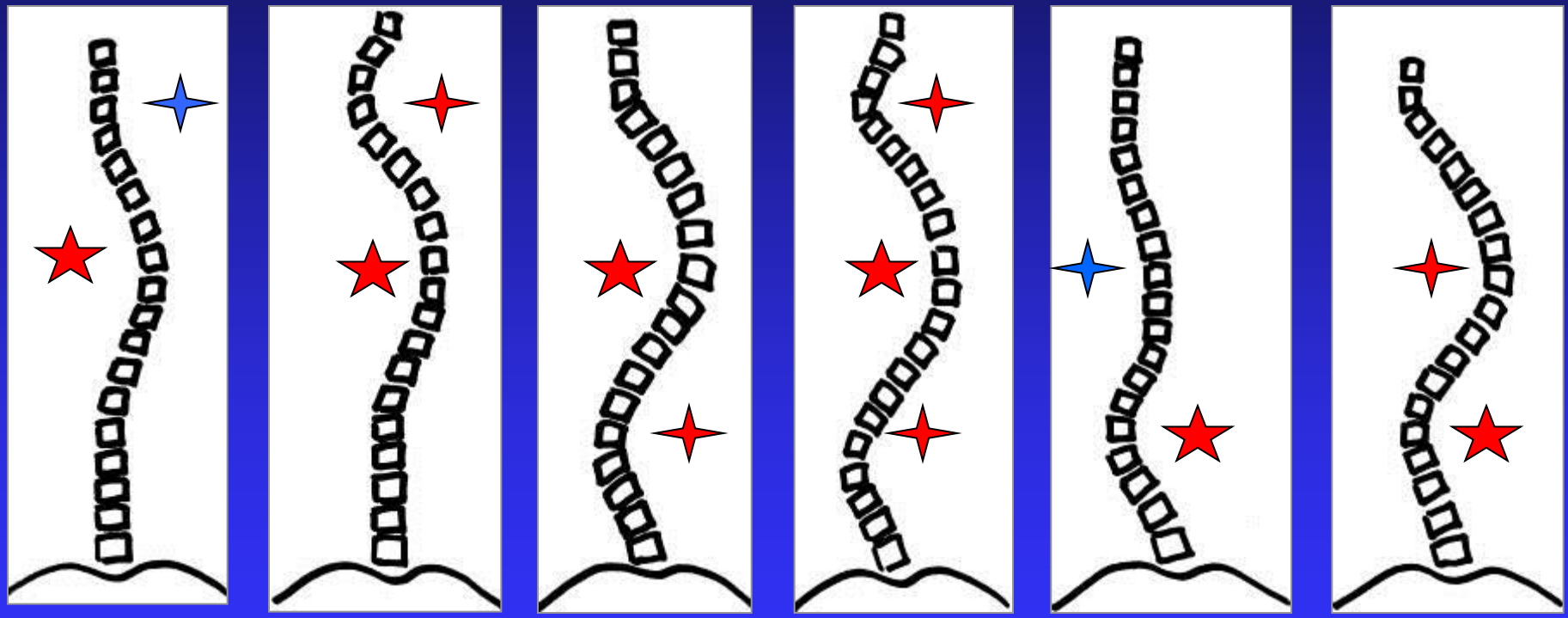
Surgical therapy

King classification



I II III IV V

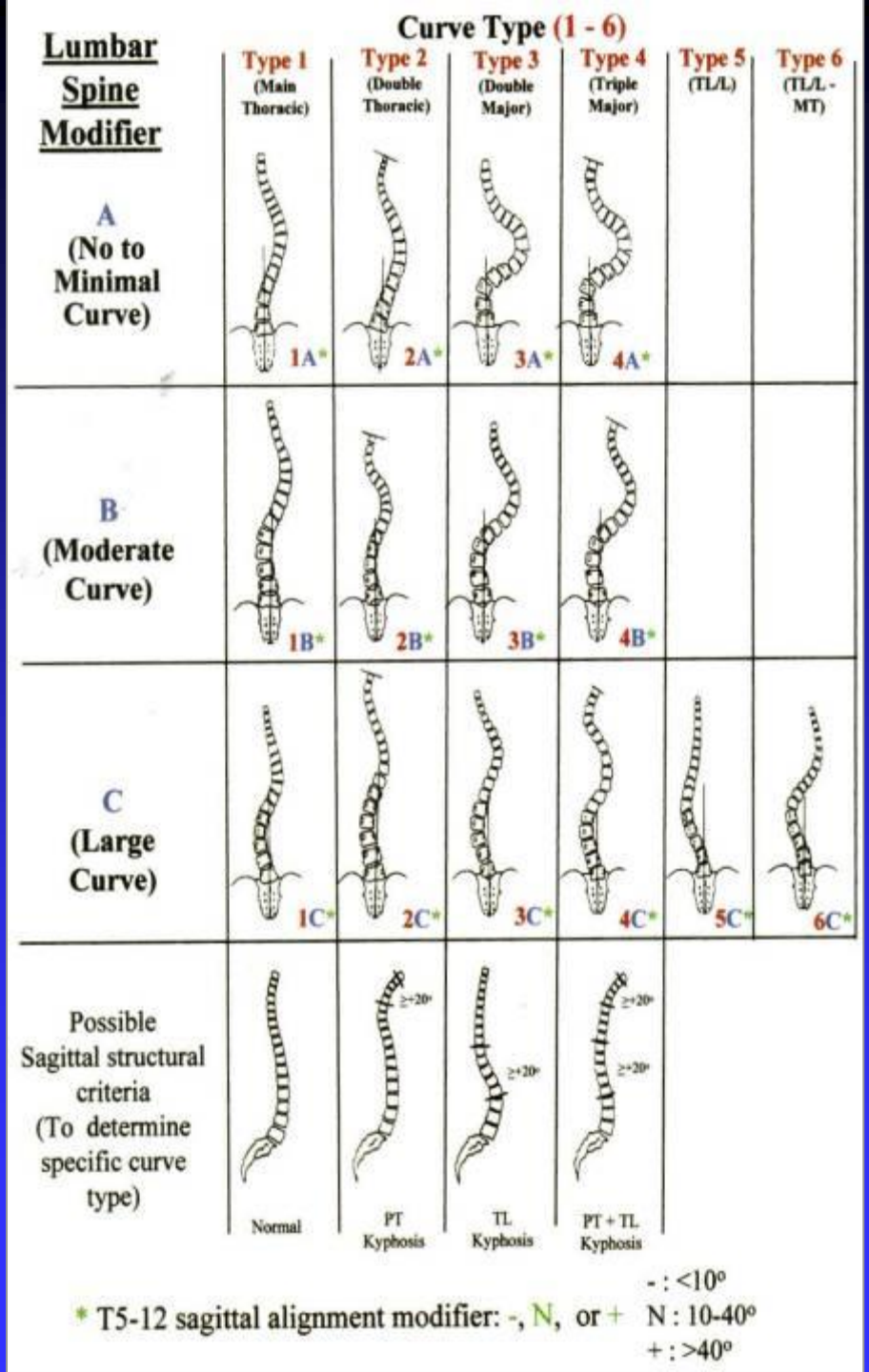
Lenke classification basic types



1 2 3 4 5 6

Main V struct. V non-struct.

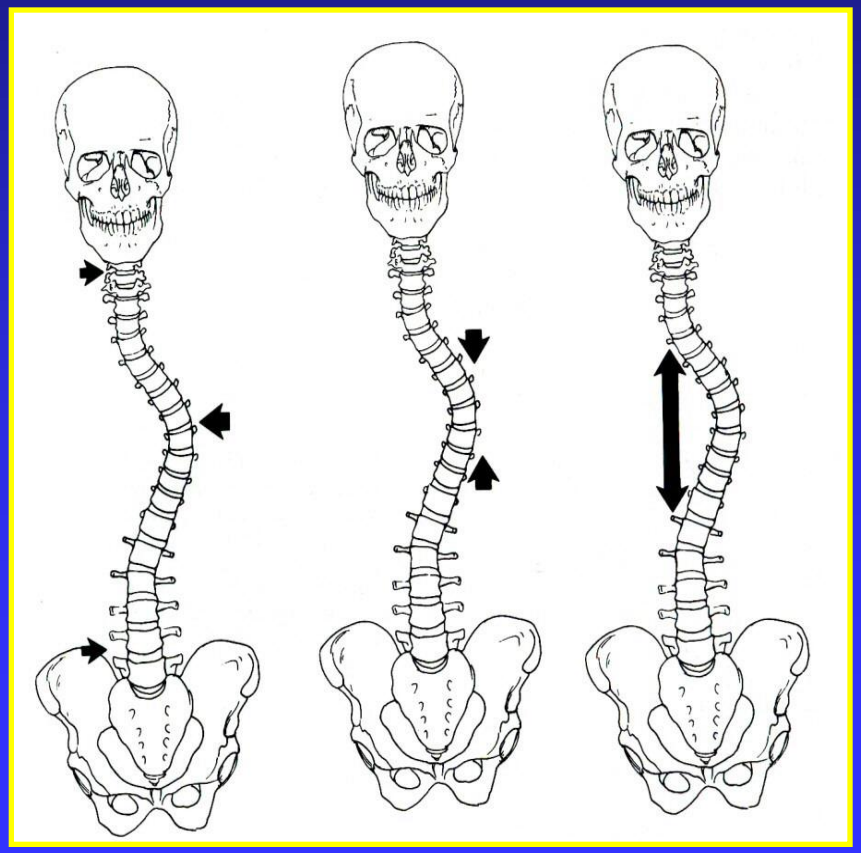
Lenke classification

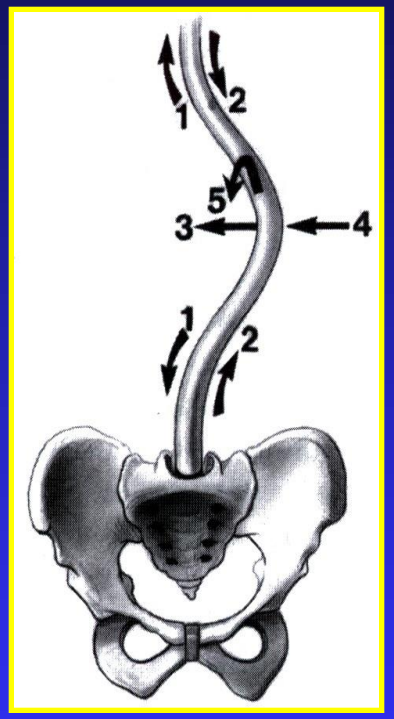


Therapeutic planning

1.Observation	up to 20°
2.Conservative treatment	20-40°
3.Surgical treatment	over 40°

Methods of correction

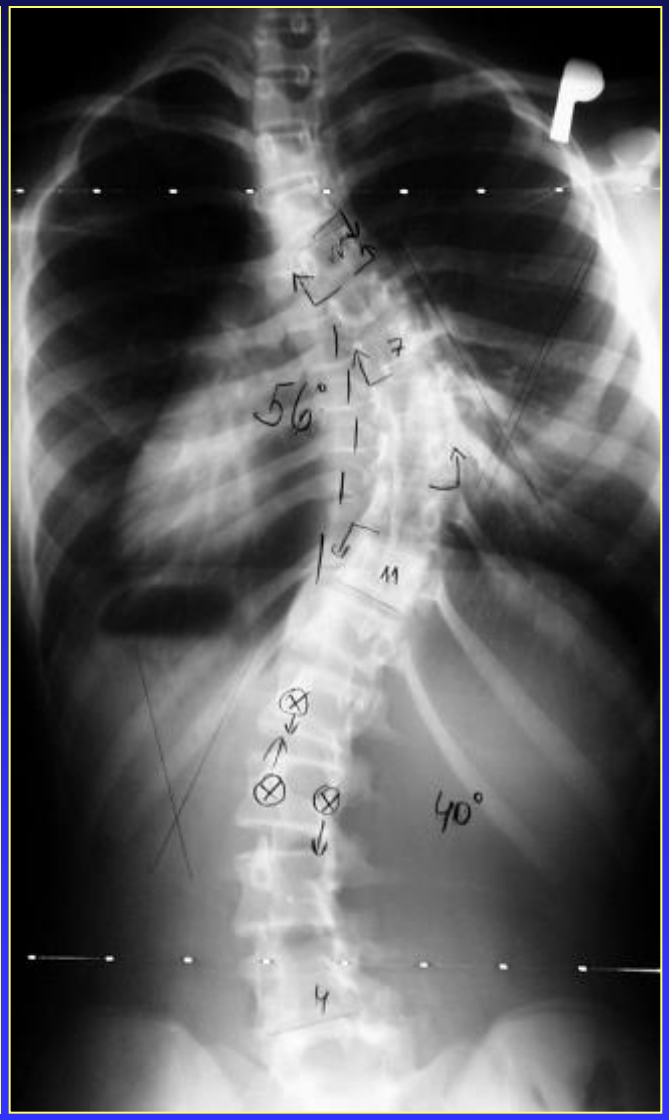


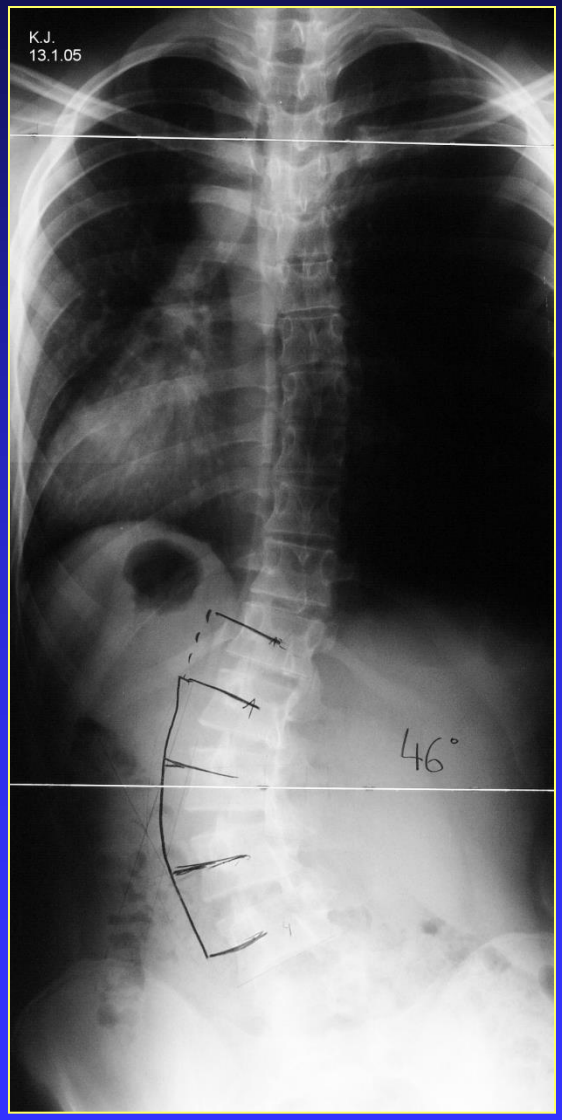


Adolescent scoliosis
Definitive treatment

- Segmental deliberation (posterior, anterior)
- Deformity correction
- Curve instrumentation
- Stabilisation
- Fusion

Preoperative planning





Preoperative planning

- Posterior approach
- Anterior approach
- Combined approach
  - One-session
  - Two-sessions

Posterior approach

- One or two curves stabilisation
- Hyperkyphosis
- Neuromuscular curves

Anterior approach

- Stabilisation of one curve only

Extent of instrumentation

- Posterior approach
  - Neutral – neutral vertebra
- Anterior approach – saving 1-3 segments
  - Ending - ending vertebra

Types of surgery

- Posterior approach
  - -spine only
  - -spine and pelvis instrumentation
- Anterior approach
  - -transthoracic
  - -transthoracoretroperitoneal
  - -retroperitoneal
  - -thoracoscopic
- Combine approach
  - -anterior release + posterior instrumentation
  - -anterior + posterior instrumentation

Indication for posterior approach

According to Lenke Classification

Posterior approach

- Rigid curves
- Double curves
- Long curves
- Severe curves
- Curves with hyperkyphosis

Anterior approach

- Simple thoracic curves
- Thoracolumbar curves
- Flexible curves
- Curves with hypokyphosis

POSTERIOR APPROACH

Types of instrumentation

- **distractive**
  -Harrington

- **segmental**
  -SSE Evolution
  -USS
  -Miami-Moss
  -ISOLA

HRI

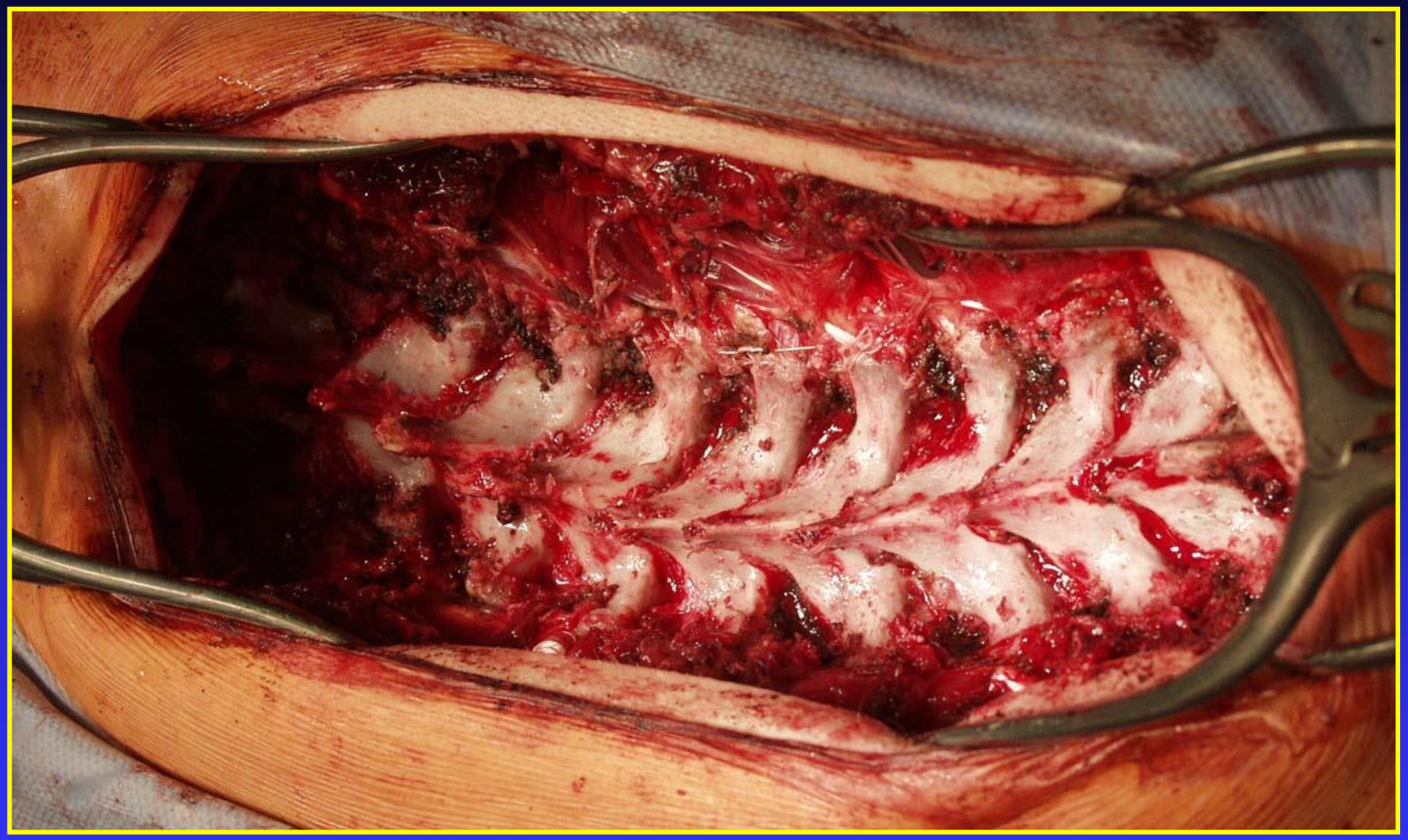
- distraction correction method
- ideal posterior fusion
- postoperative plaster neccessity

HRI – 2 paralel rods

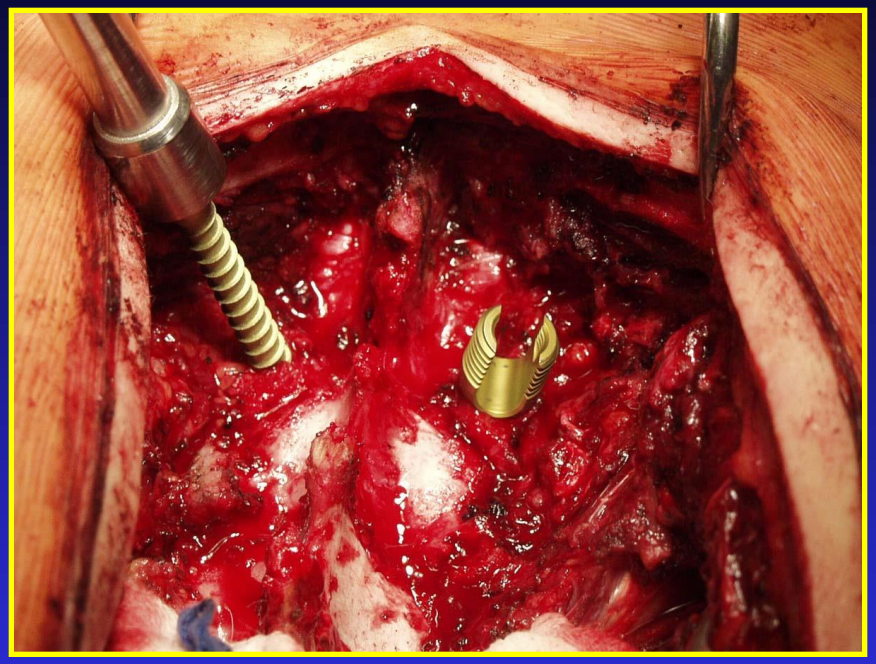
HRI + DTT

Segmental instrumentation

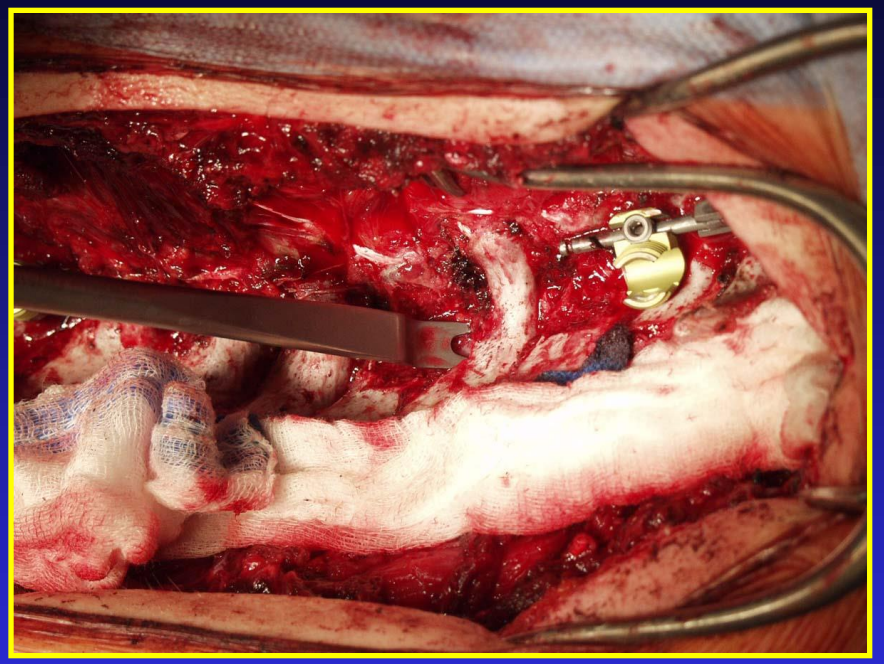
- contemporary method – transpedicular fixation, without postoperative fixation (orthosis)



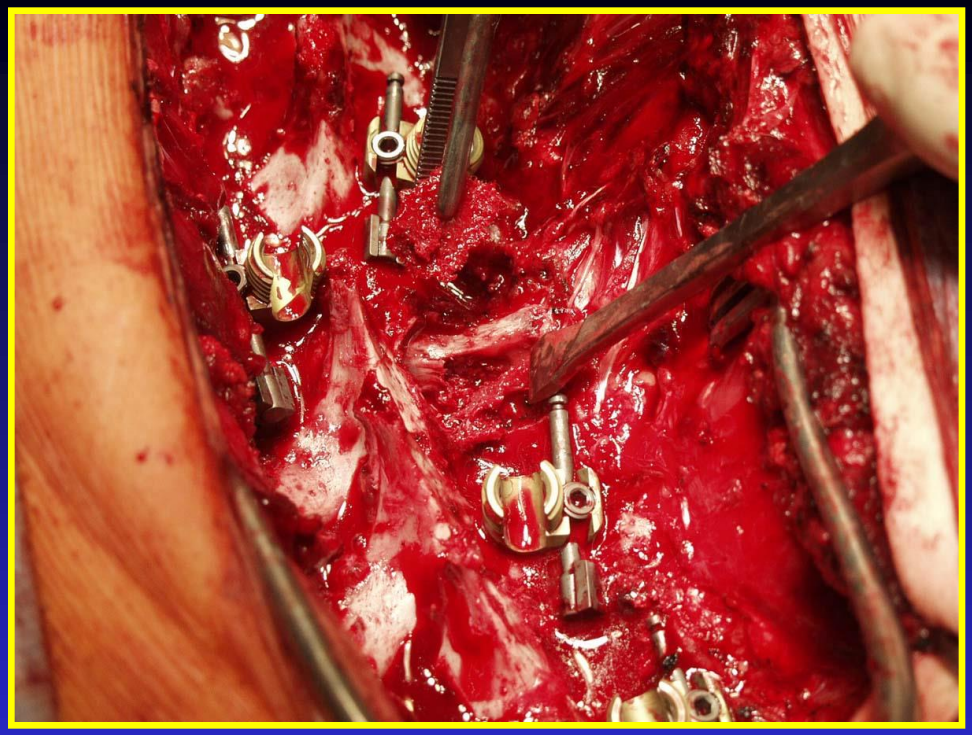
skeletisation

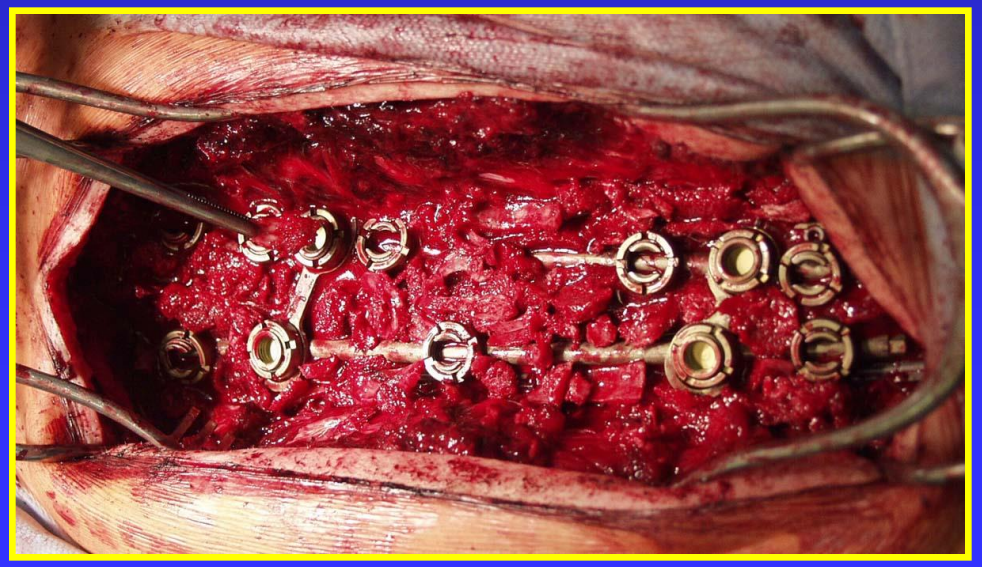


transpedicular screws



pedicular hooks



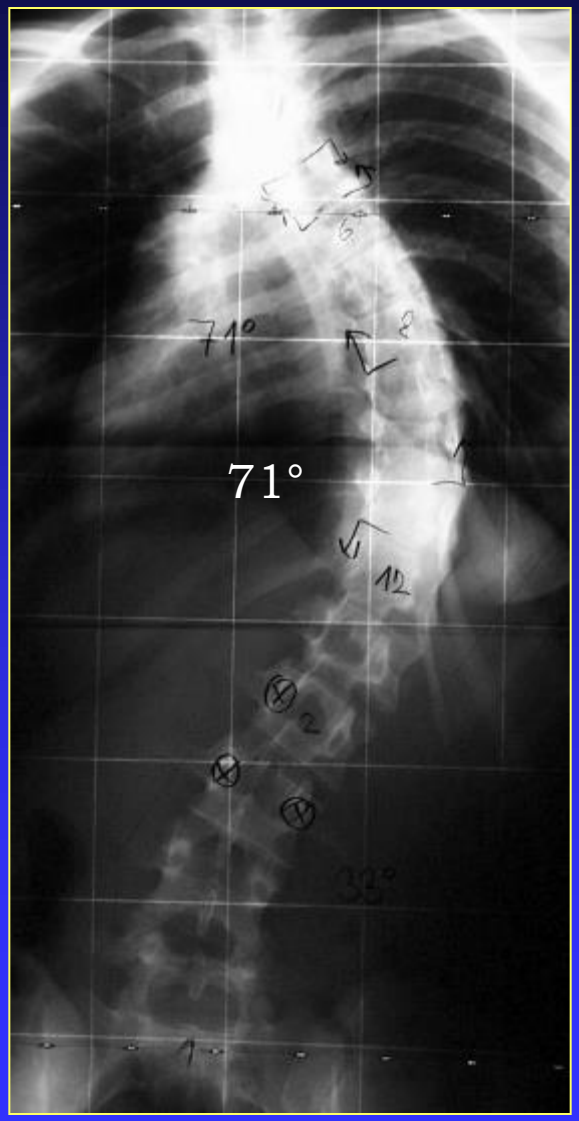


Joint resection

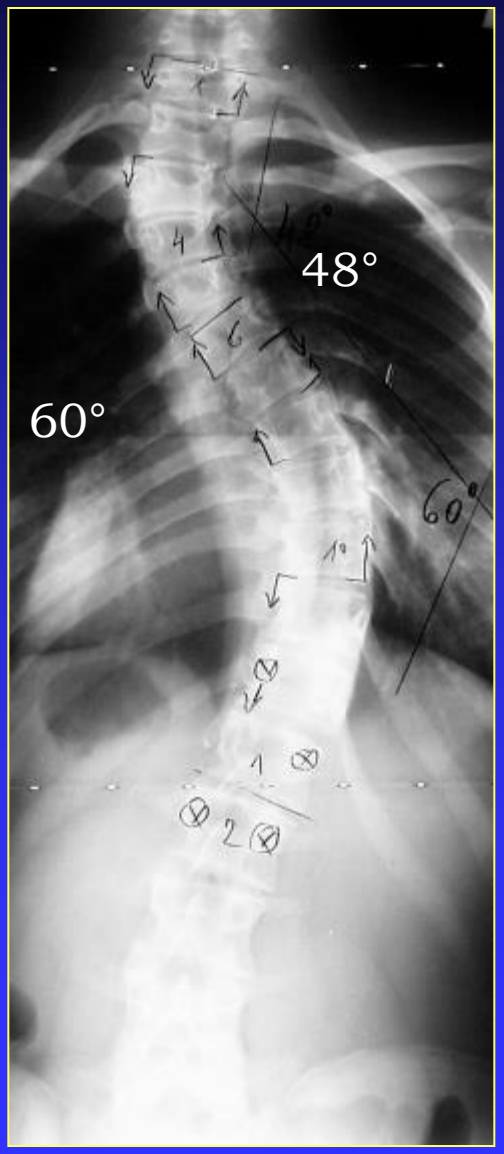
Posterior elements decortication

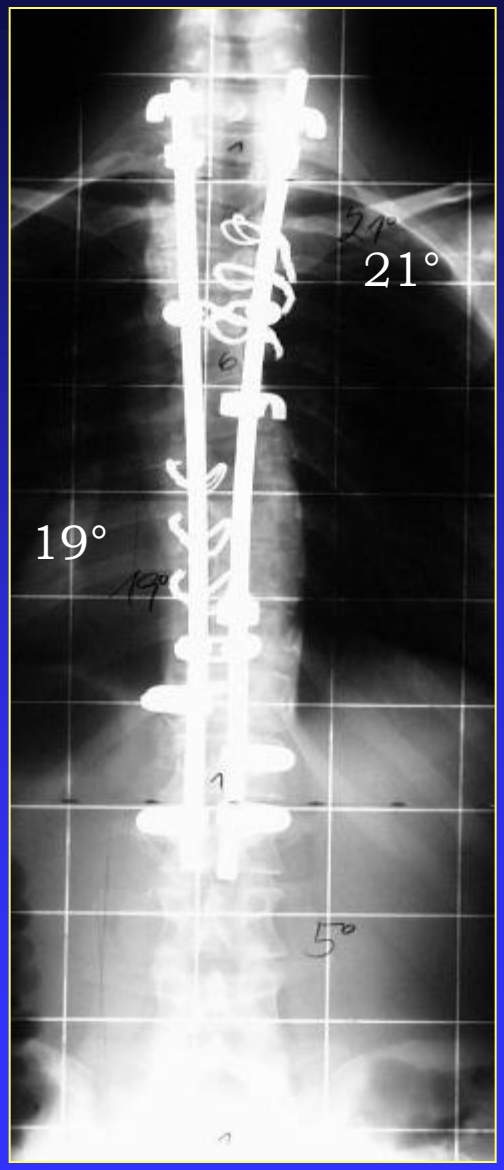
Posterolateral fusion

Lenke 1 – lower thoracic



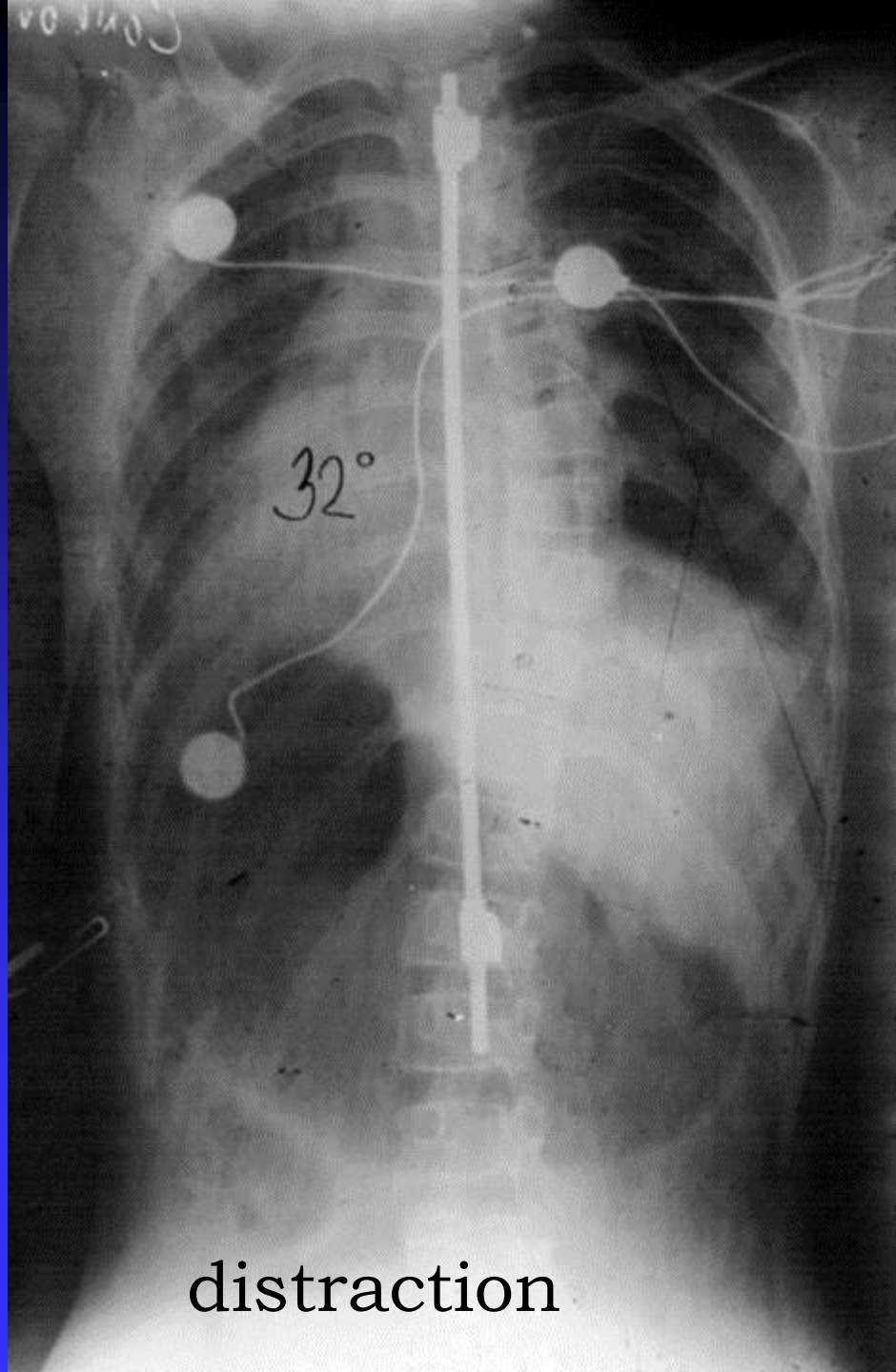
Lenke 2 – double thoracic





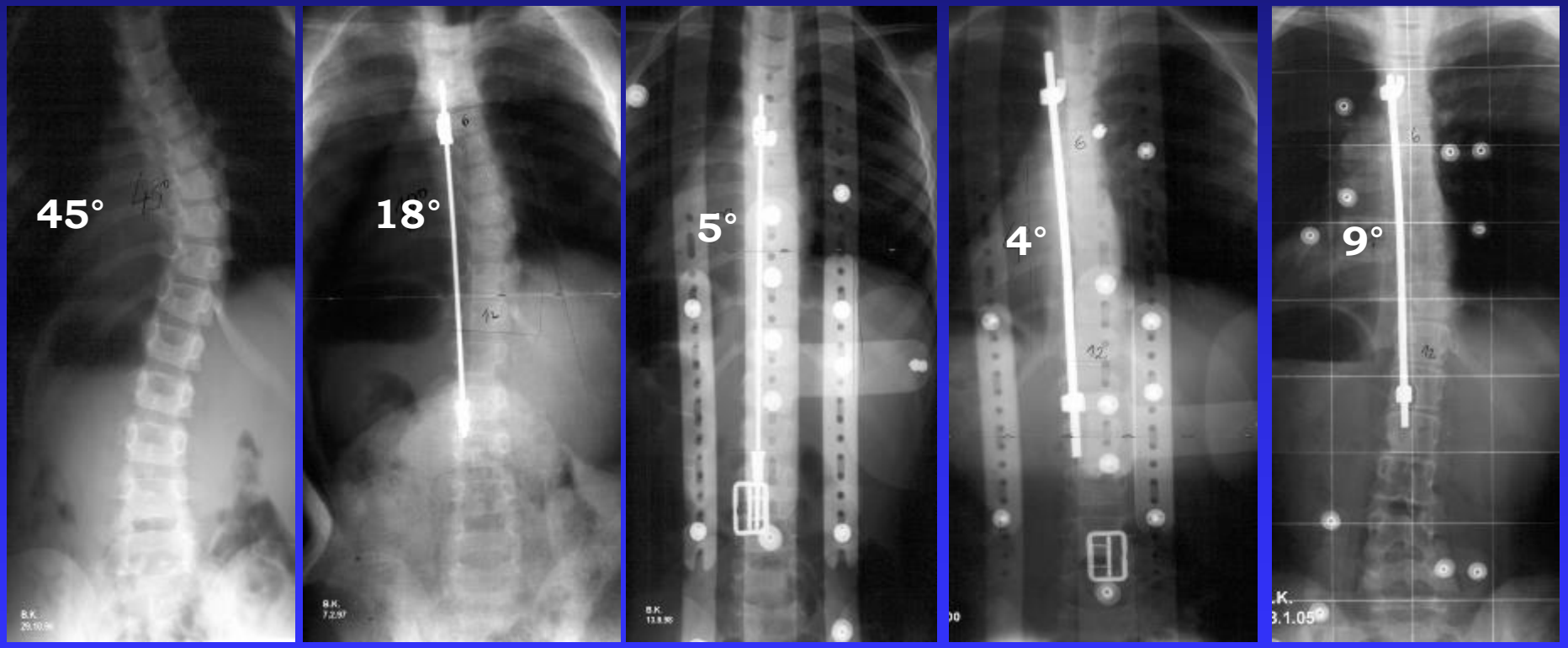
Juvenile scoliosis

- Distraction method - one rod
- Posterior approach
- Repetitive re-distractions up to growth end
- Growing rods system – (2 rods) 3 apex vertebrae fixation, 2 upper and 2 lower curve vertebrae – free rod fixation

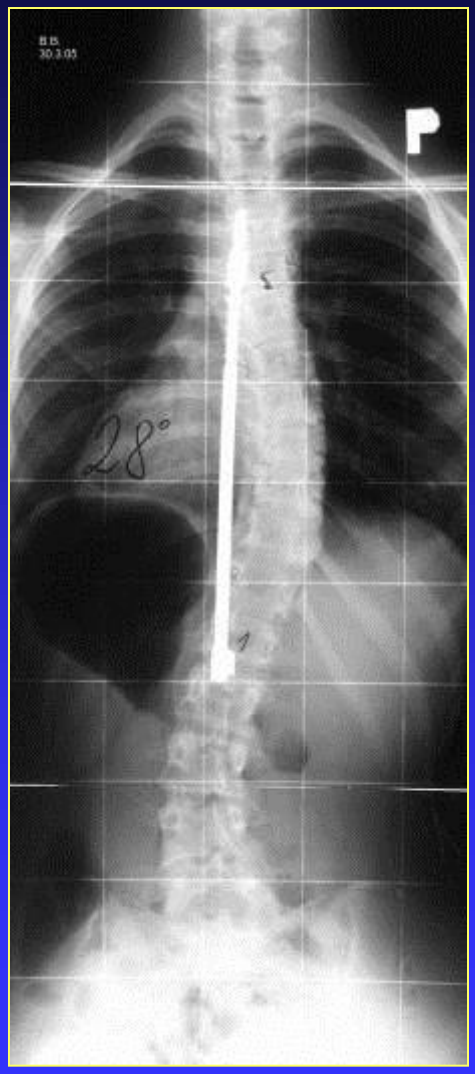


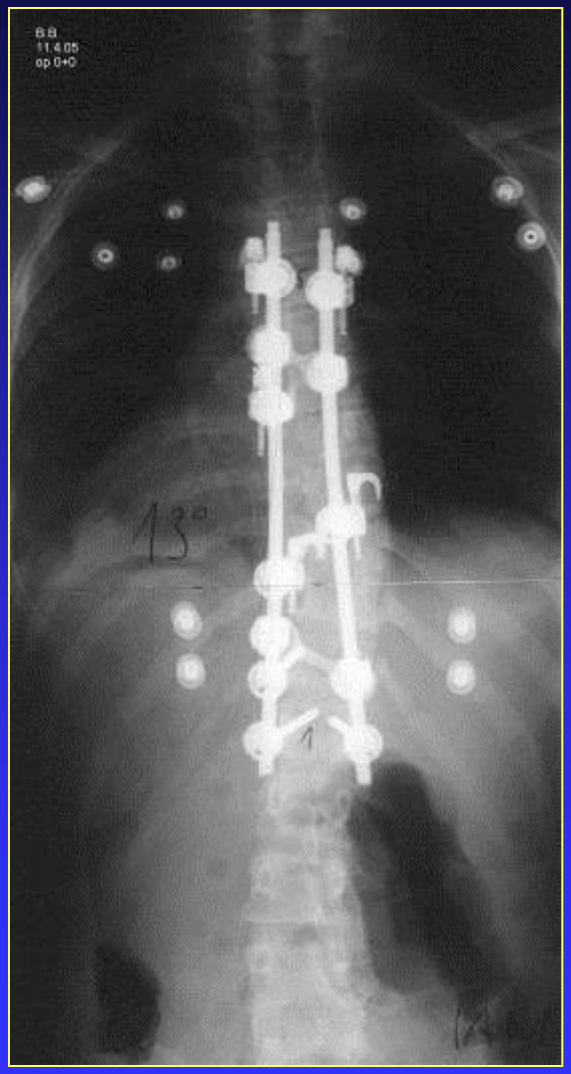
distraction

Repetitive distractions



HRI – distraction + definitive surgery



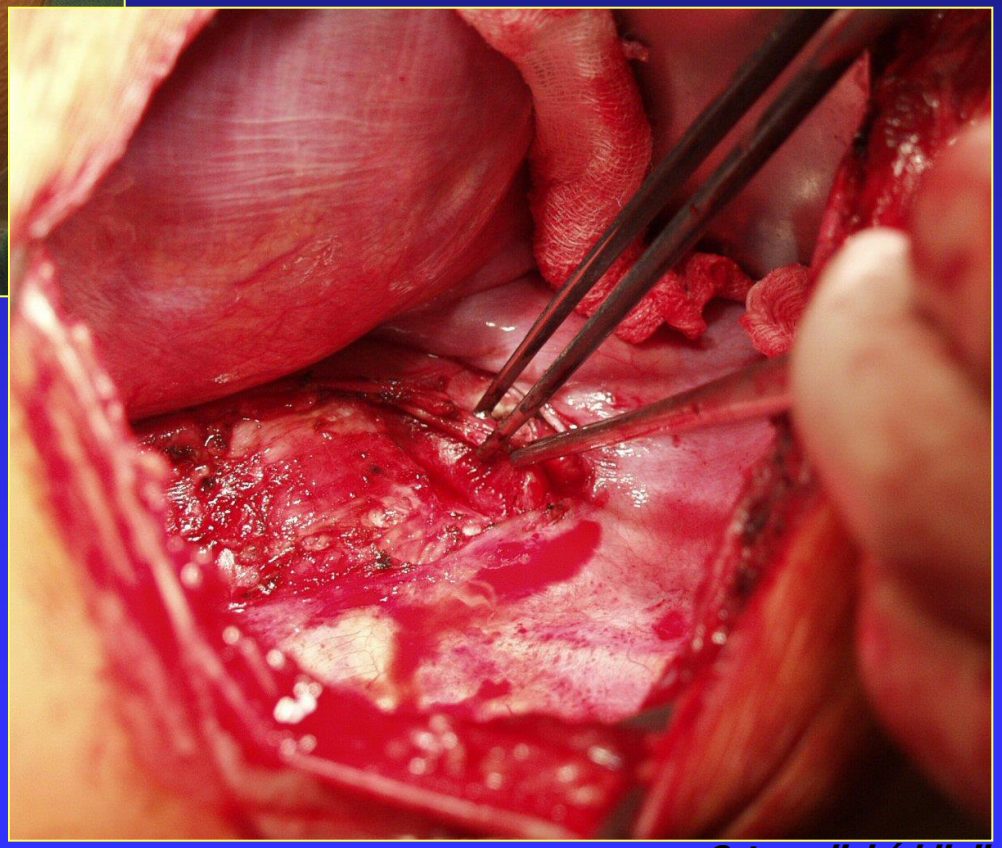


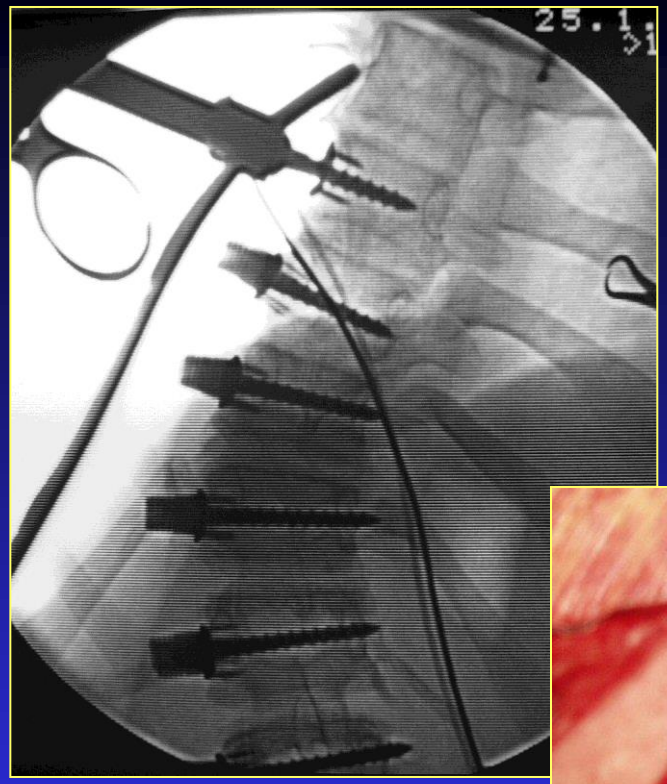
ANTERIOR APPROACH

ADVANTAGES OF ANTERIOR INSTRUMENTATION

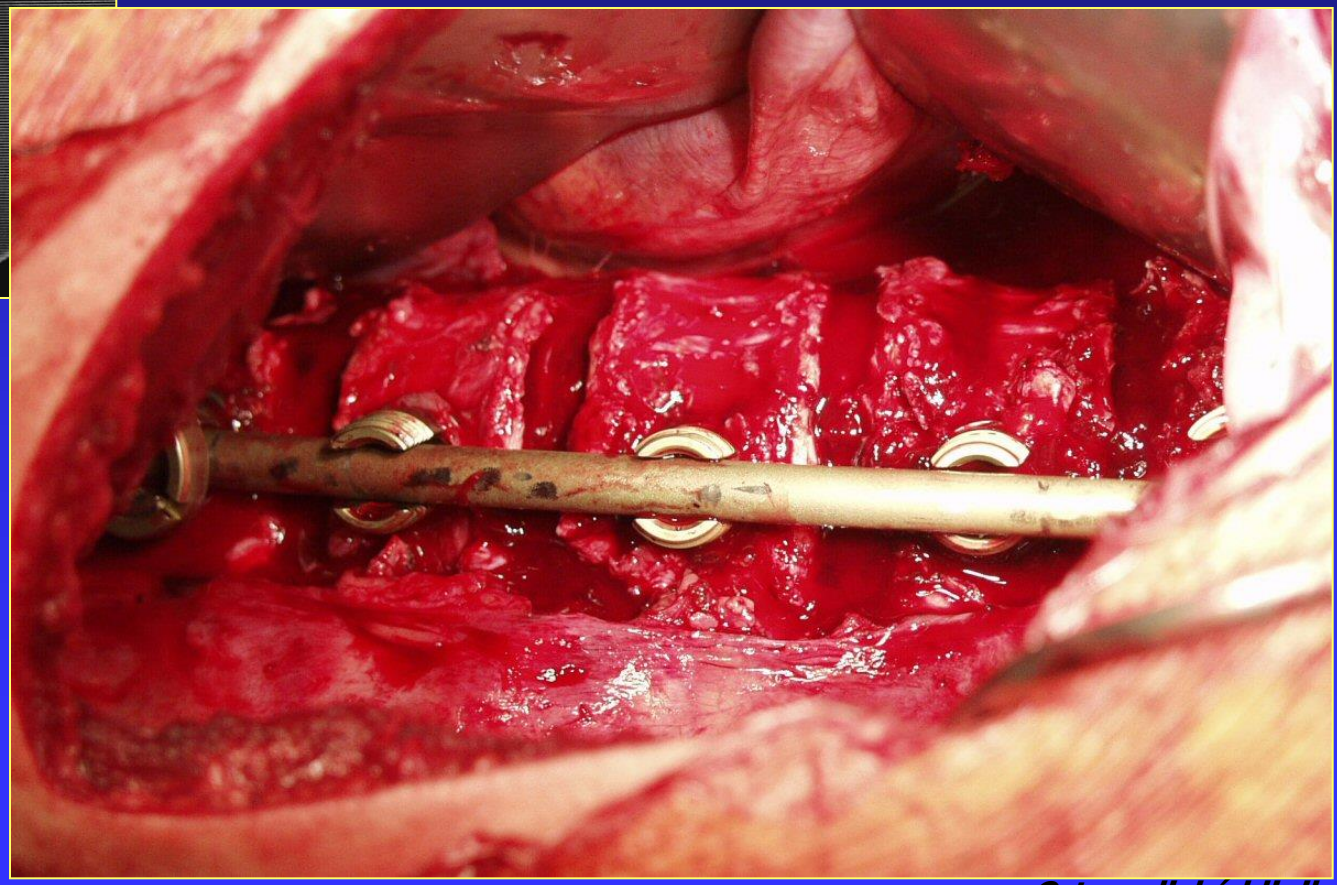
- Significant derotation
- Shorter fusion
- Lordotisation
- Kyphotisation
- Minor blood loss
- Minor surgical complications

TTRP approach

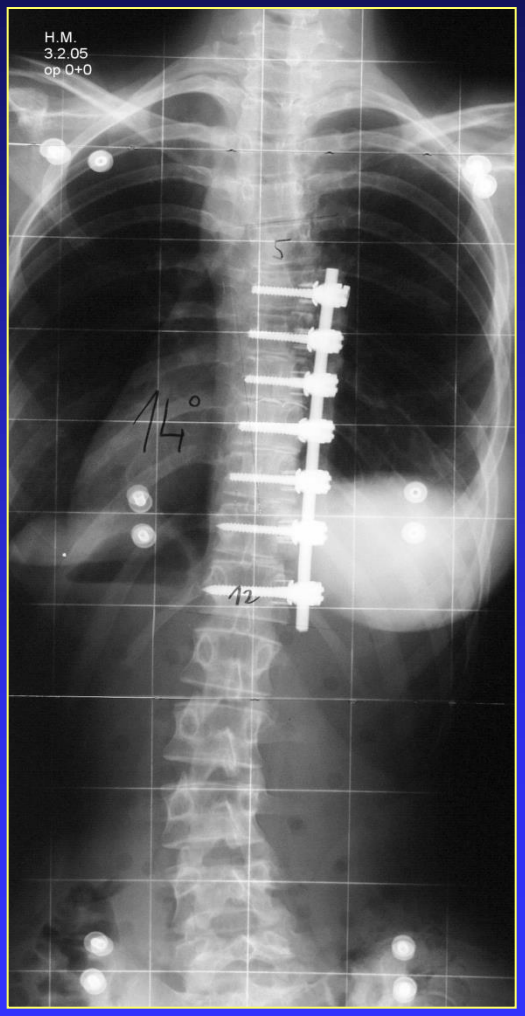




Implantation of screws and rod



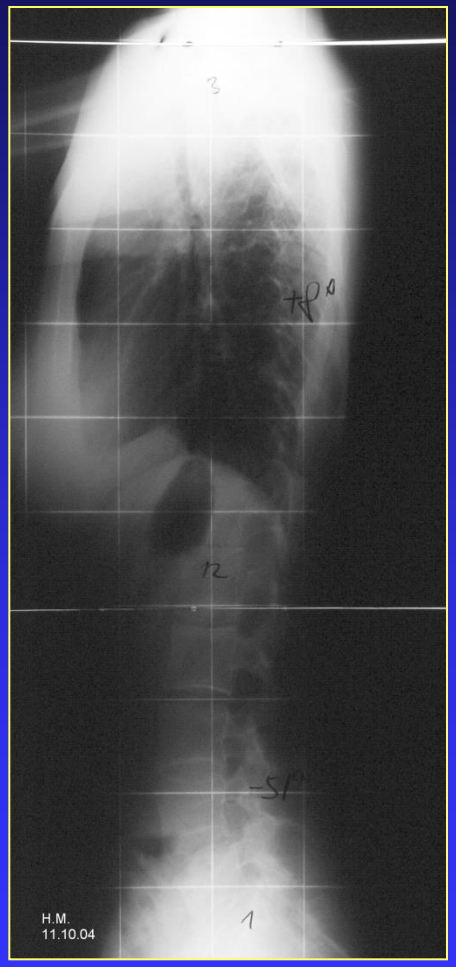
Lenke 1



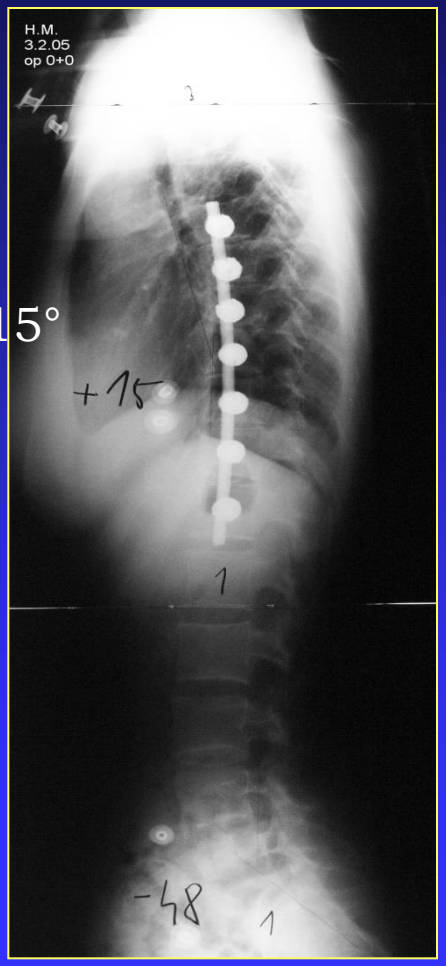
+8°

Lenke 1

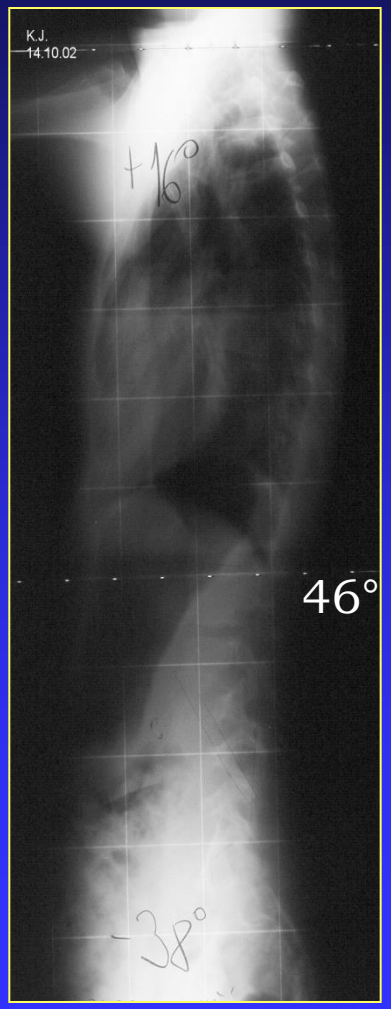
14°



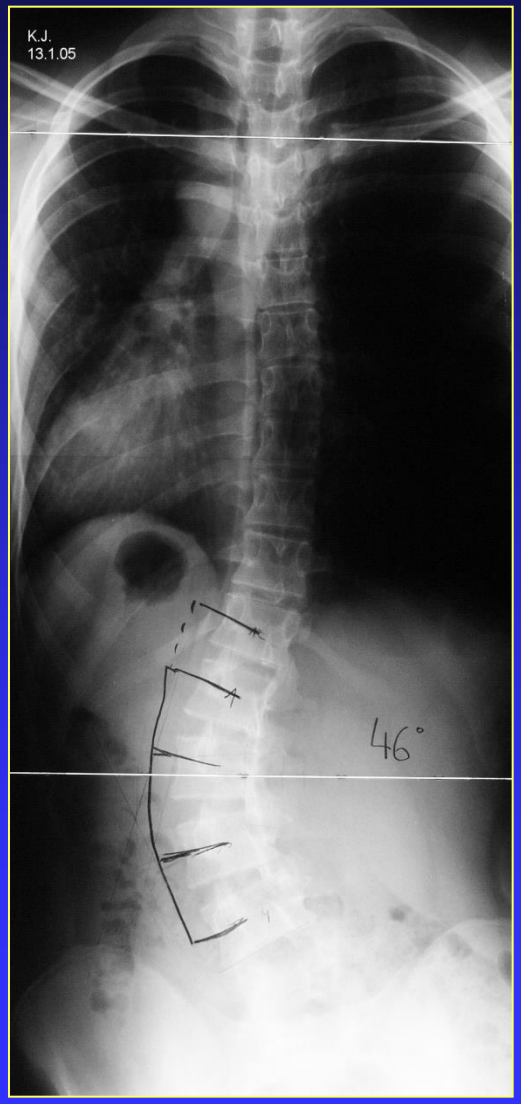
15°

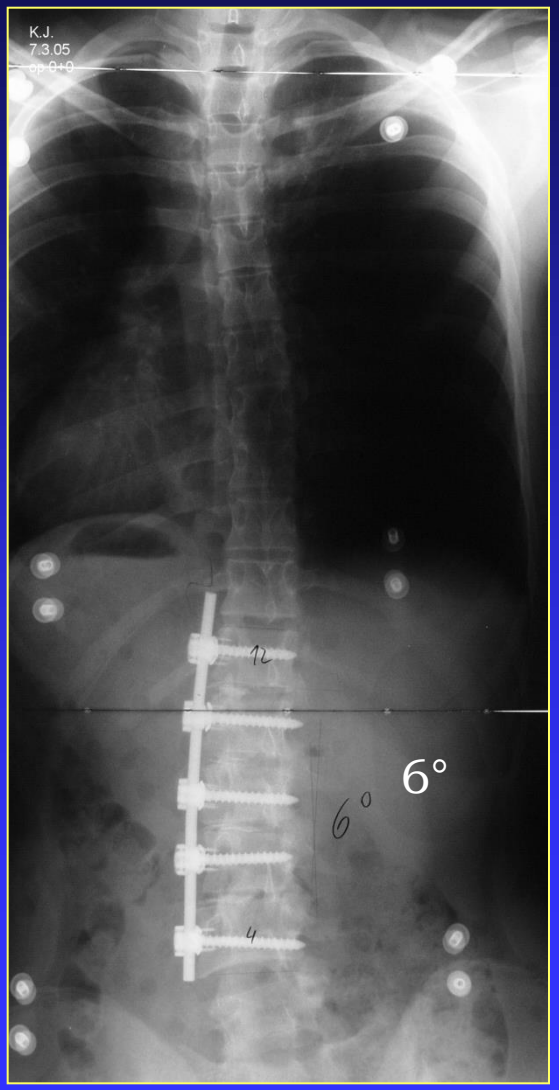


Lenke 5



Lenke 5

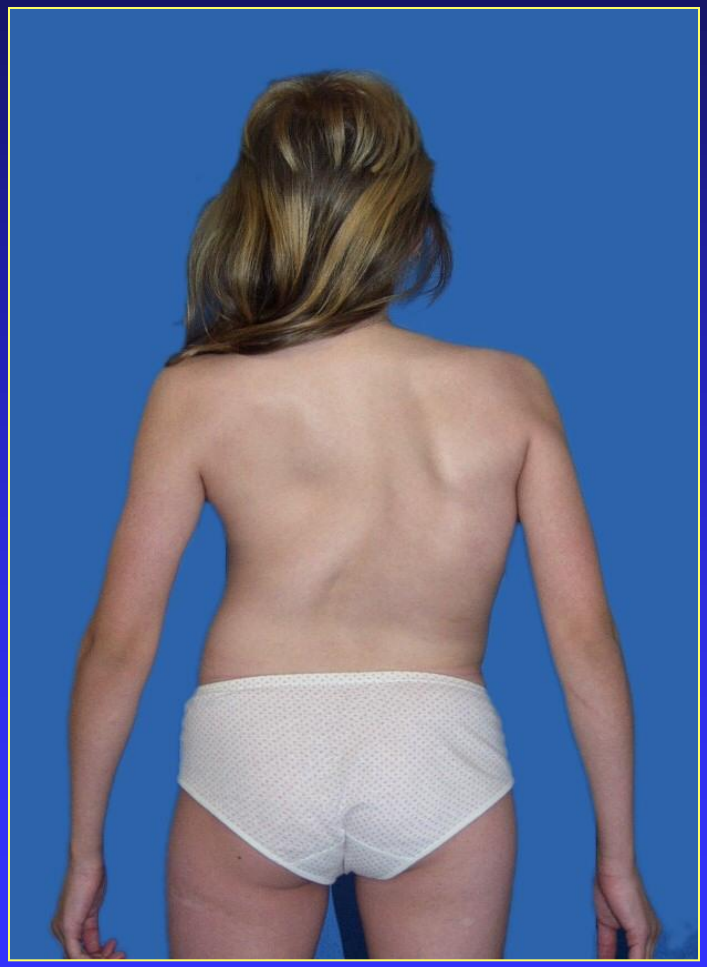


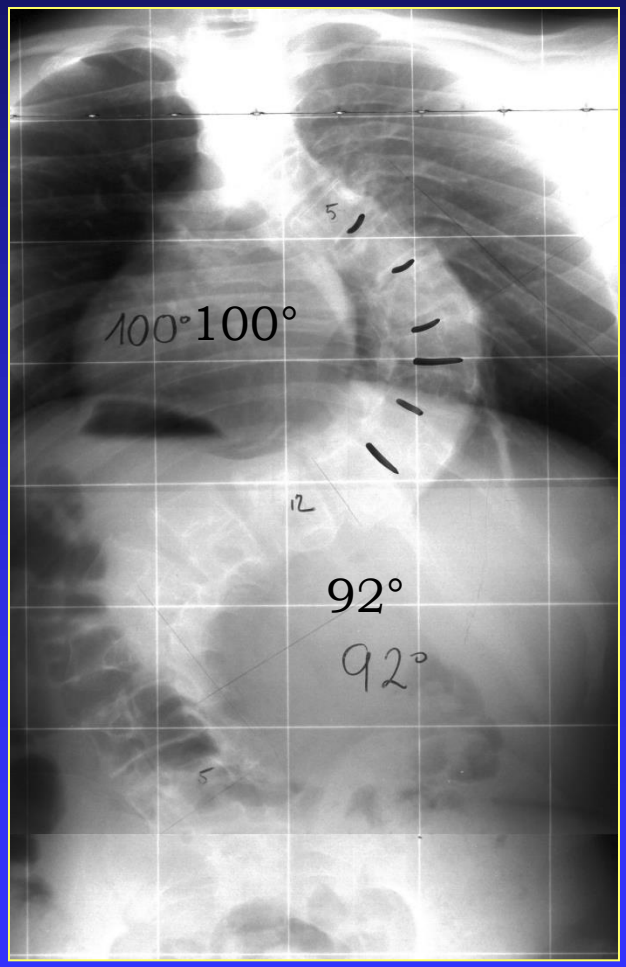


Combined approach in rigid curves

1. Anterior release from minithoracotomy
2. Facultative traction
3. Posterior stabilisation and fusion

Rigid curve Lenke 3



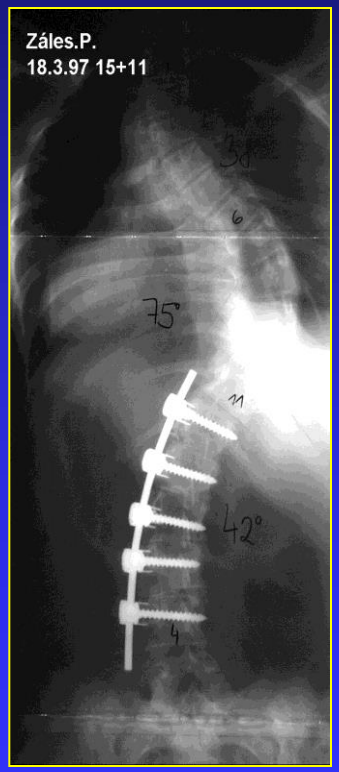


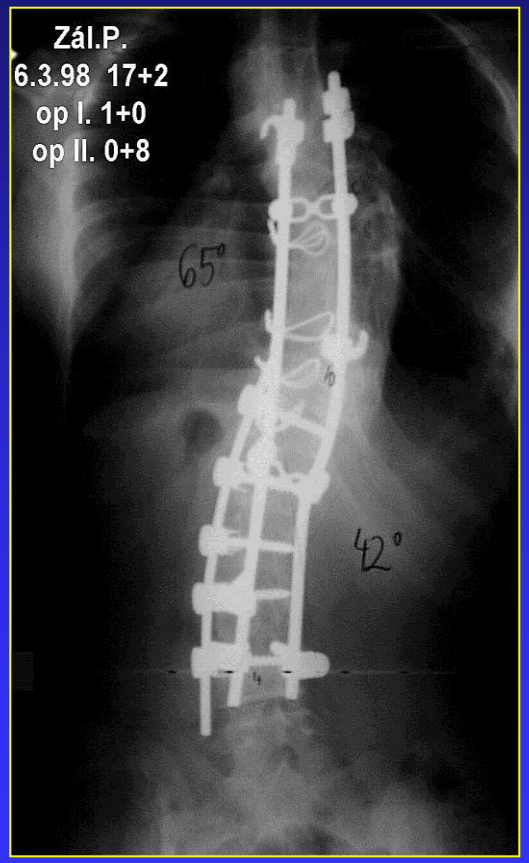
Halo traction

Physiotherapy and wheelchair


Zál.P.
10.12.96 15+11

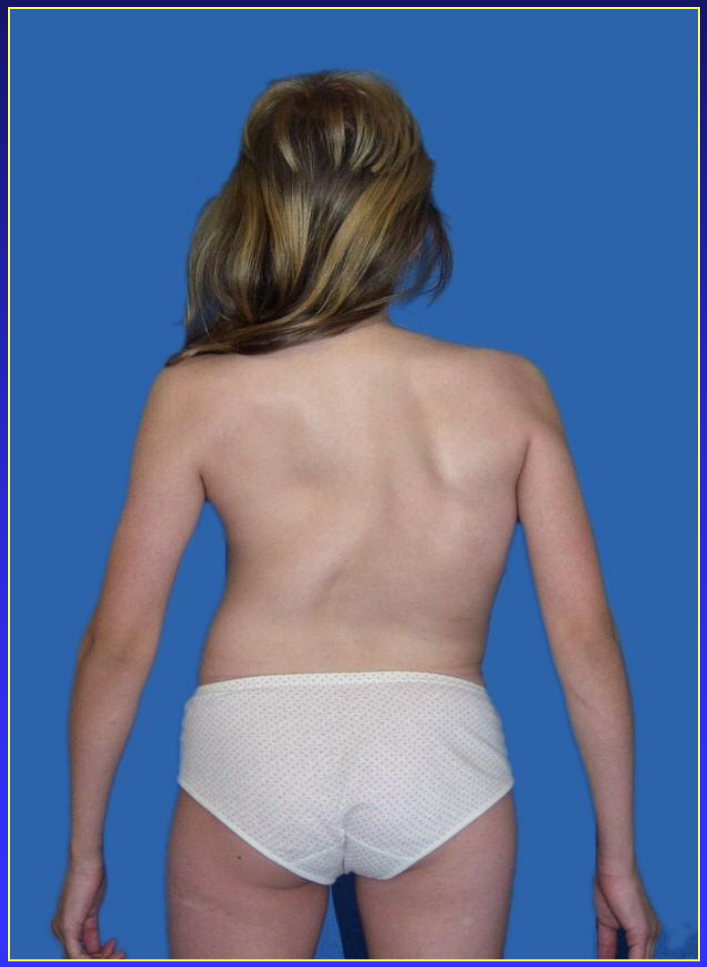

Zál.P.
9.12.96 15+11


Záles.P.
18.3.97 15+11


Zál.P.
6.3.98 17+2
op I. 1+0
op II. 0+8


Zál.P.
5.11.97

6 months postoperatively



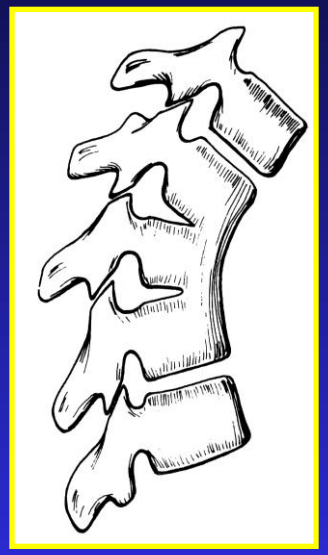
Congenital scoliosis

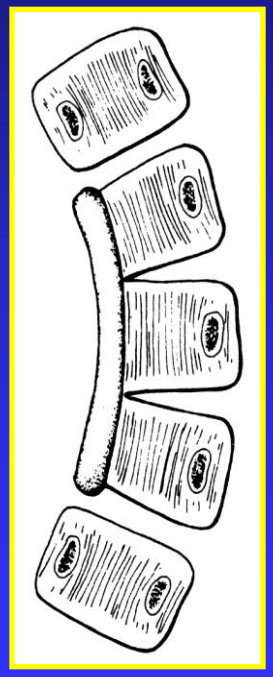
Etiologic classification of congenital scoliosis

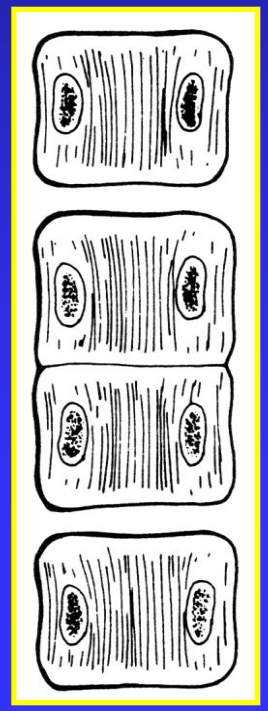
1. defects of formation
   - -wedge vertebra
   - -hemivertebra
2. defects of segmentation
   - -unilateral failure (unsegmented bar)
   - -bilateral failure
3. combined defects

Defects of segmentation

- anterior ➡ kyphosis
- posterior ➡ lordosis
- lateral ➡ scoliosis
- posterolateral ➡ lordoscoliosis
- anterolateral ➡ kyphoscoliosis
- complete

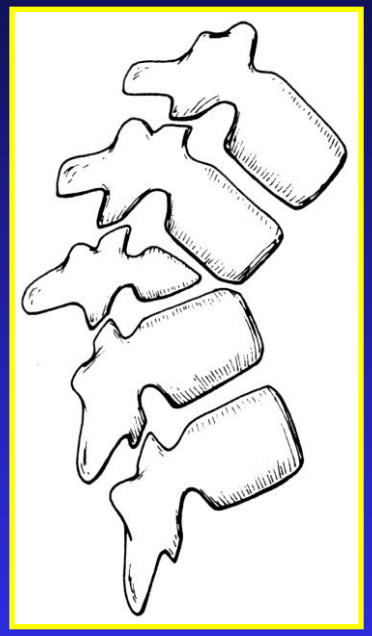


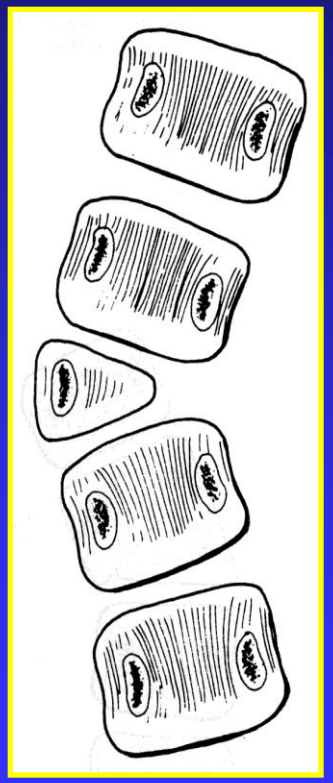


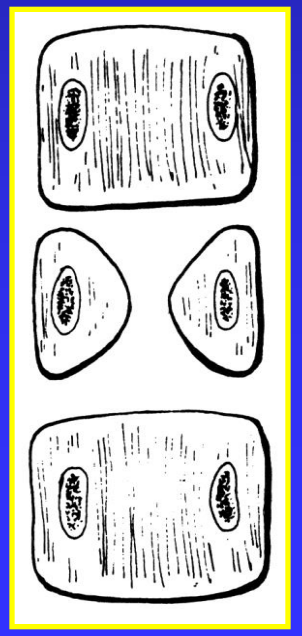


Defects of formation

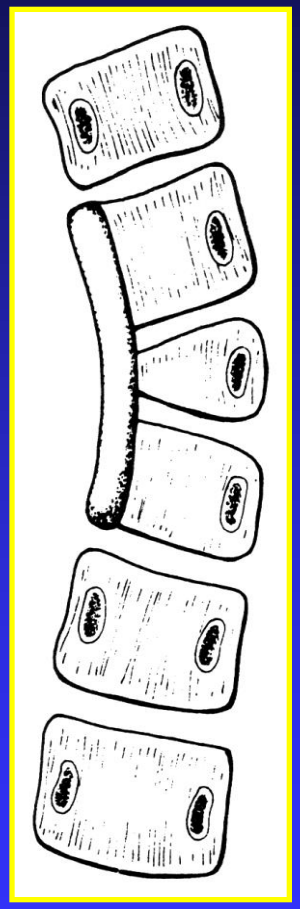
- anterior ➡ kyphosis
- posterior ➡ lordosis
- lateral ➡ scoliosis
- anterolateral ➡ kyphoscoliosis
- anterior central defect



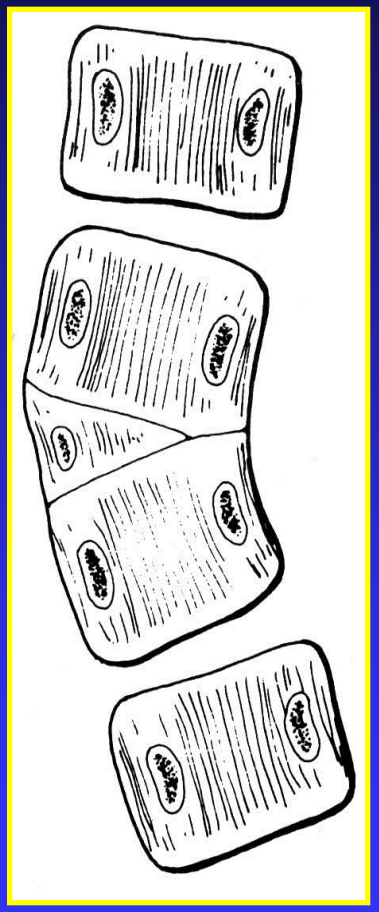




Combined failure



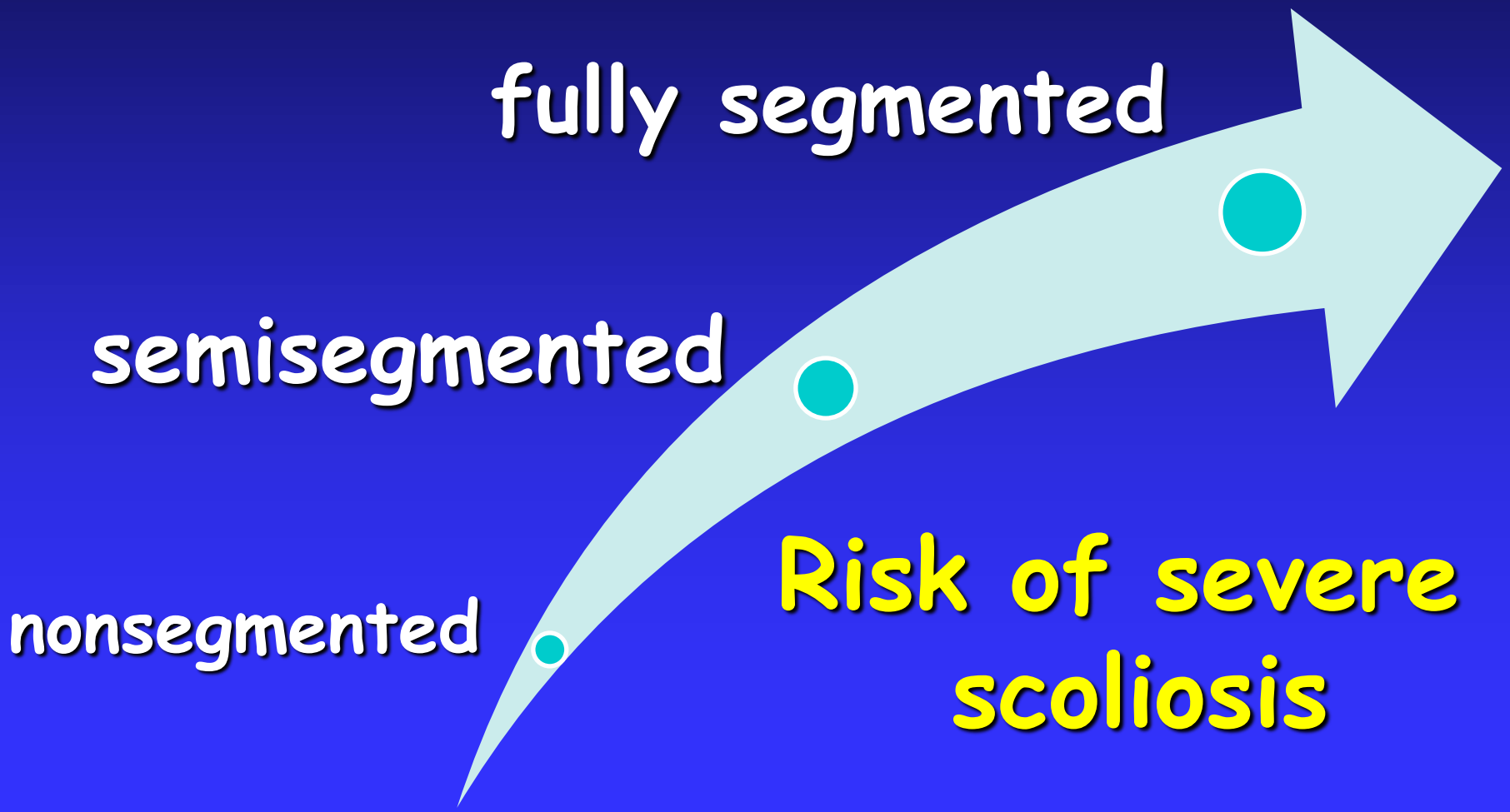
Hemivertebra + unilateral bar



Nonsegmented hemivertebra

Hemivertebra

=the most common failure

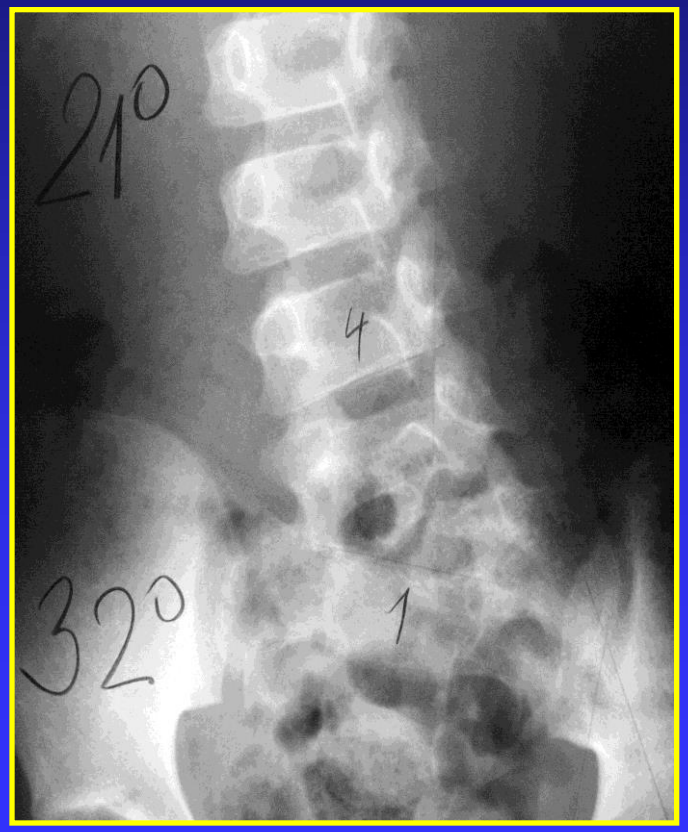


Evaluation of congenital scoliosis

- anamnesis (personal and familly)
- physical evaluation
- neurological evaluation
- spinal imaging methods (X-ray,CT,MRI)
- echocardiogram
- renal ultrasound

Imaging methods

X-ray



CT with 3D reconstr.

Magnetic resonance imaging (MRI)

Treatment possibilities

- conservative treatment
  - observation
  - casting and bracing
- surgical treatment
  - simple bony fusion
    - hemiepiphyseodesis
    - complete posterior
    - combined a/p
  - posterior instrumentation
  - hemivertebrectomy
    - combined a/p surgery
    - posterior only surgery

Observation

Indication:
- small curves <20°
- curves at low risk of progression
  - -nonsegmented hemivertebra
  - -bilateral defects of segmentation
- curves <40° at the end of an adolescent age

Follow up:
- clinical examination every half year
- follow-up X-ray once per year up to growth completition
- FU X-ray every five years in adults

Progression over 25° → bracing or surgery

Bracing

Indication:

- curves 20°-40°
- curves at low risk of progression
  - -semisegmented hemivertebra
- controling of secondary curves in growth period

Progression over 40° → surgery

2 main surgical techniques used today

Simple bony fusion

Arrest of curve progression (without direct correction)

-in small curves
-in early detection

Hemivertebrectomy with instrumentation

Correction of scoliotic curve

-in greater curves
-in supposed curve progression

Simple bony fusion

Indication:

- hemivertebra without kyphosis
- short curvature < 5 vertebrae
- curvature < 50°

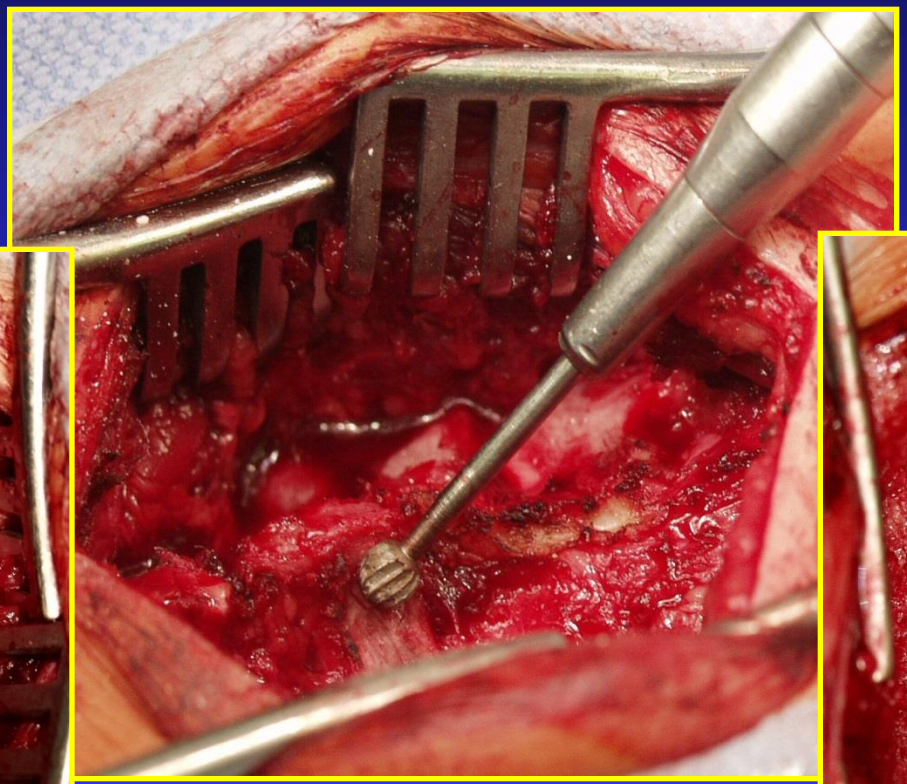
Technique:

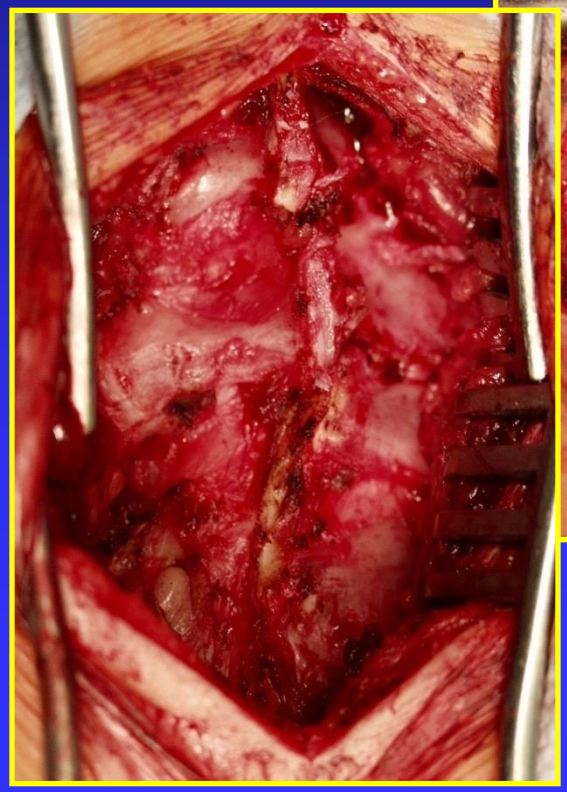
- bilateral bone desis
- unilateral bone desis – hemiepiphyseodesis (convex side)
- posterior, anterior or combined

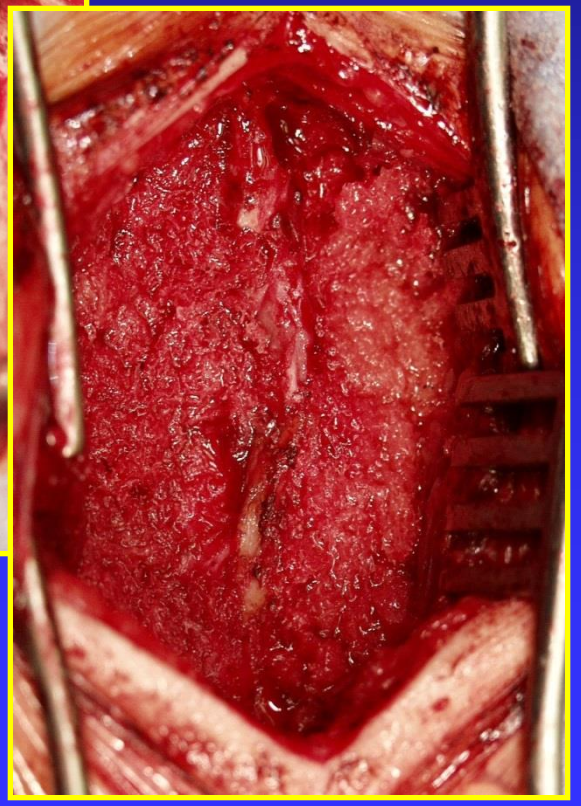
Unilateral fusion ⟺ growth arrest on convex side

allow growth on concave side

Simple bony fusion







Postoperative care

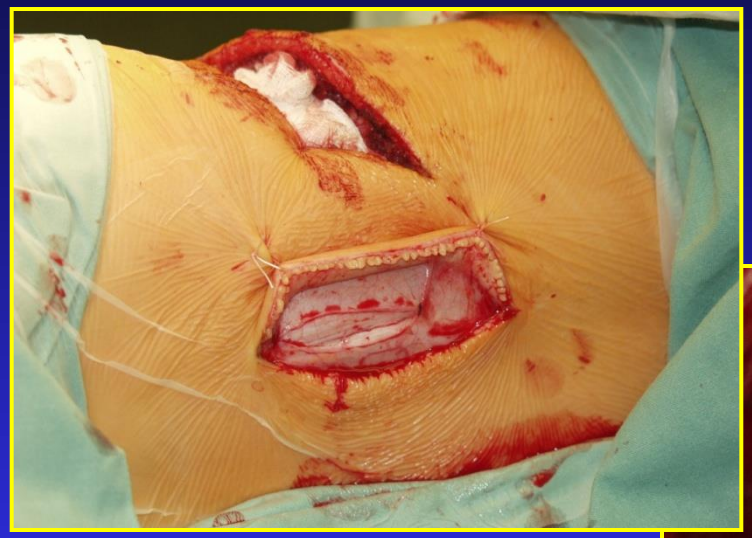
Plaster cast:
first 6-12 months

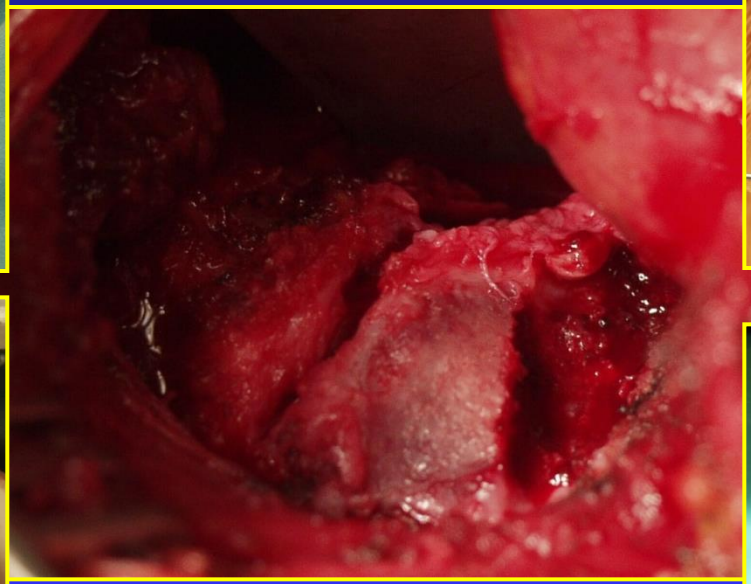
Bracing:
till the growth ending

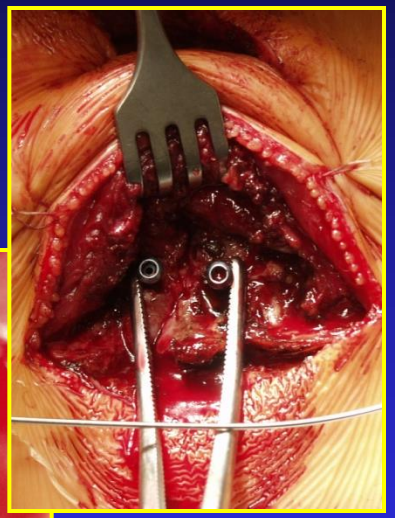
- clinical examination every half year
- follow-up X-ray once per year
  up to growth completition

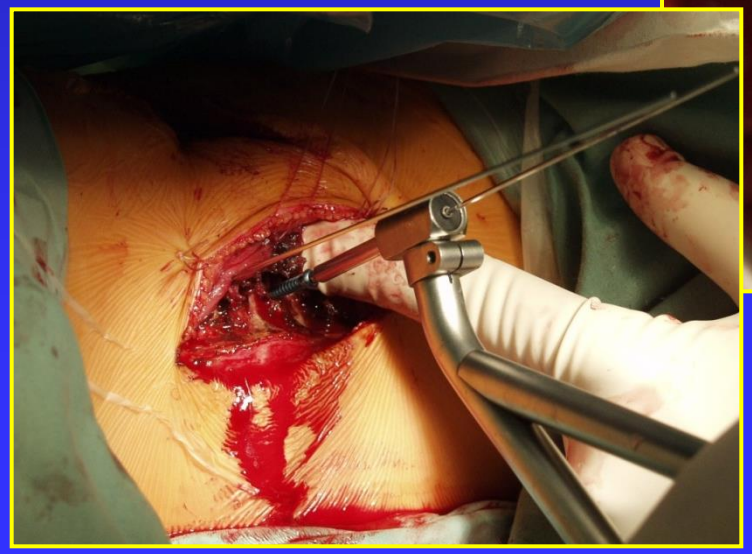
Hemivertebrectomy

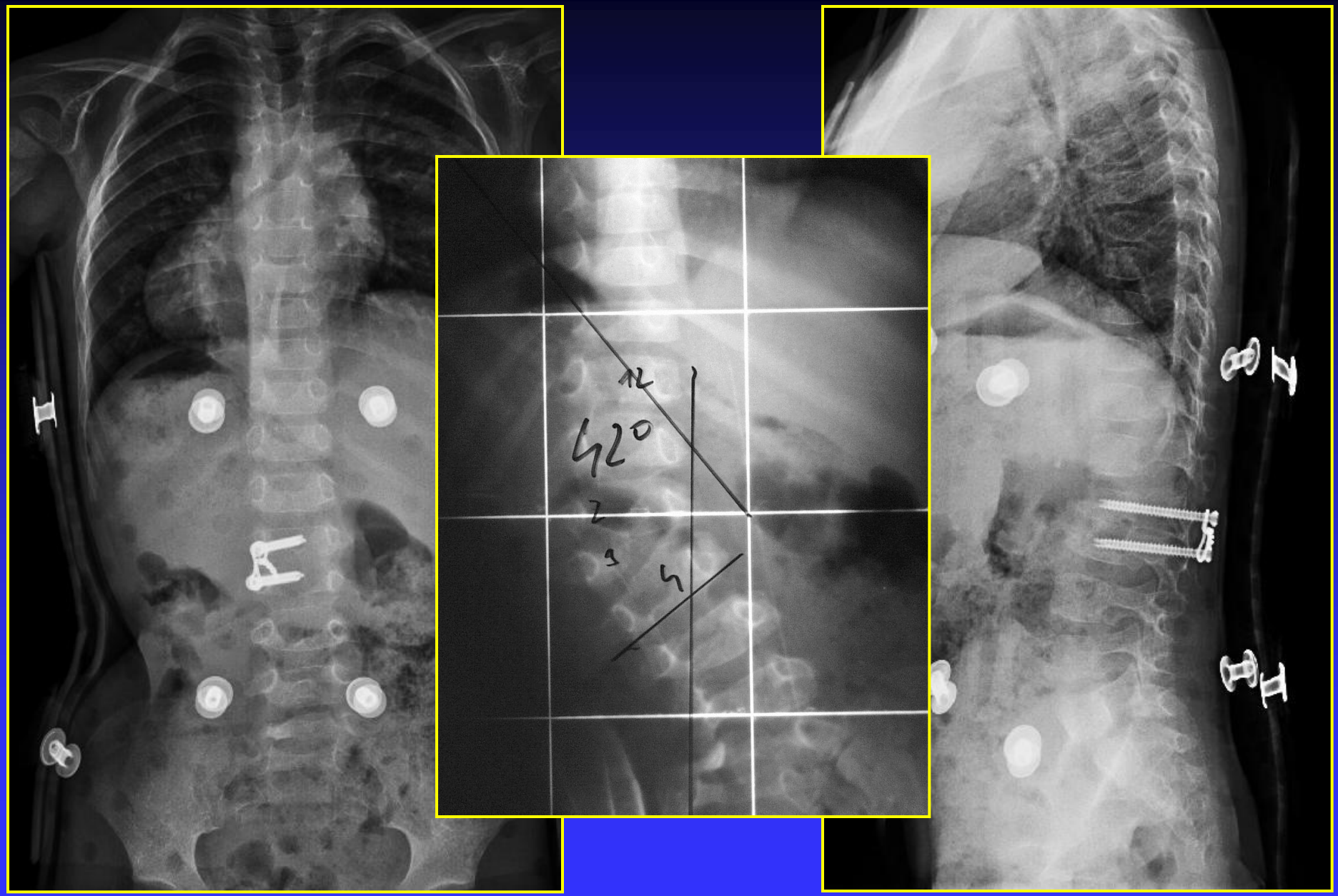
using combined a/p surgical approach with instrumentation stabilization





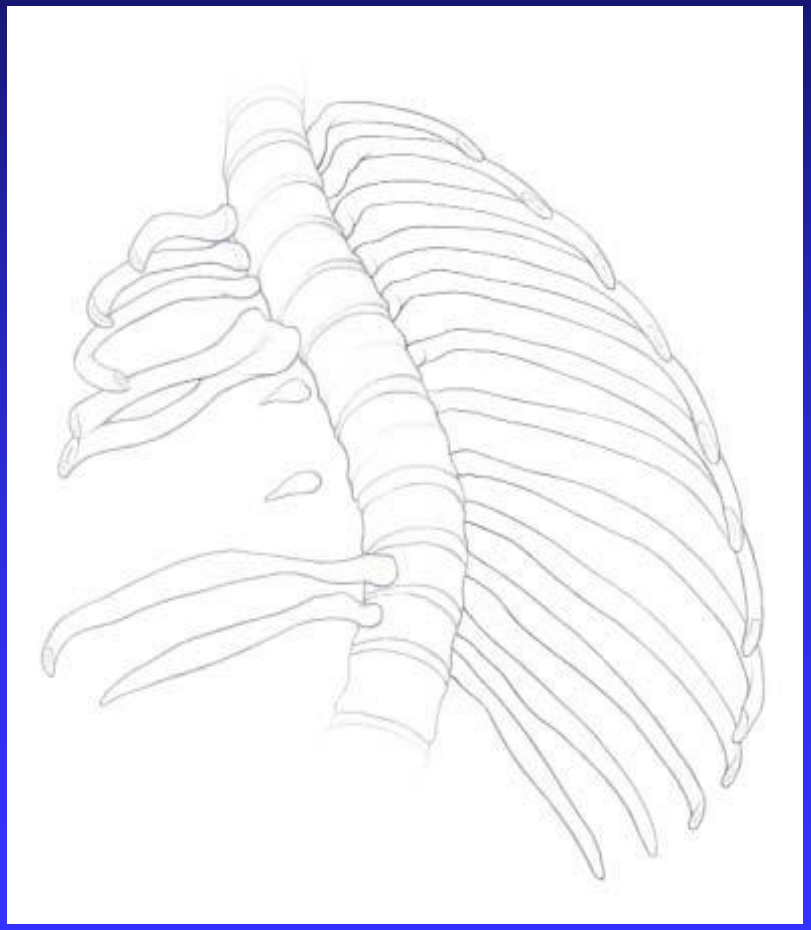




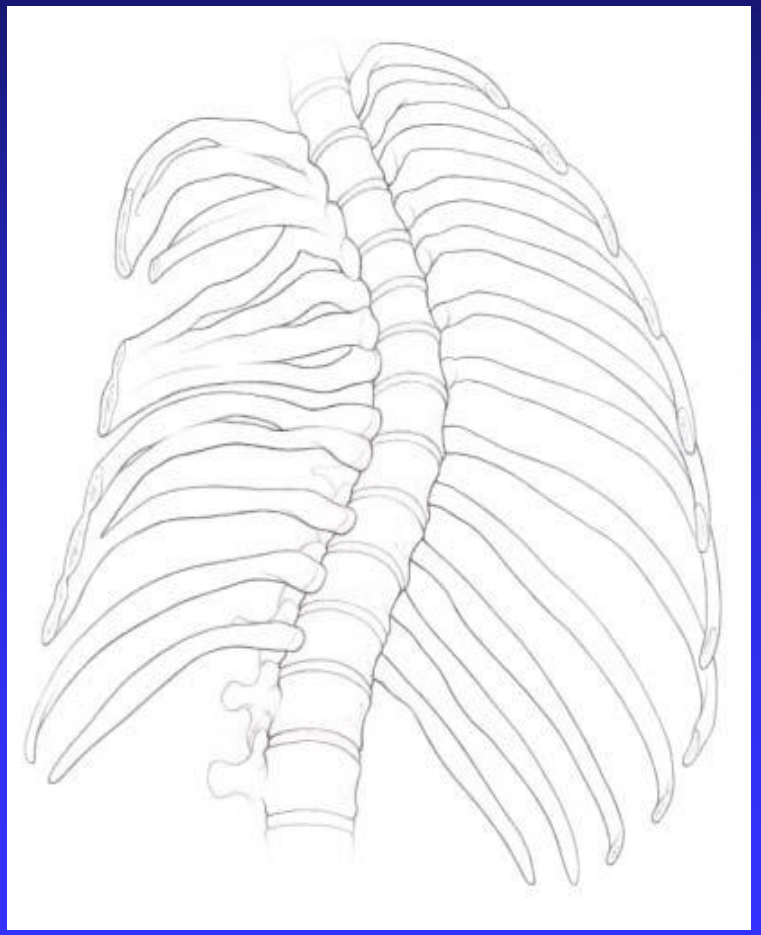

12
42°
2
3
4

Associated rib cage deformities

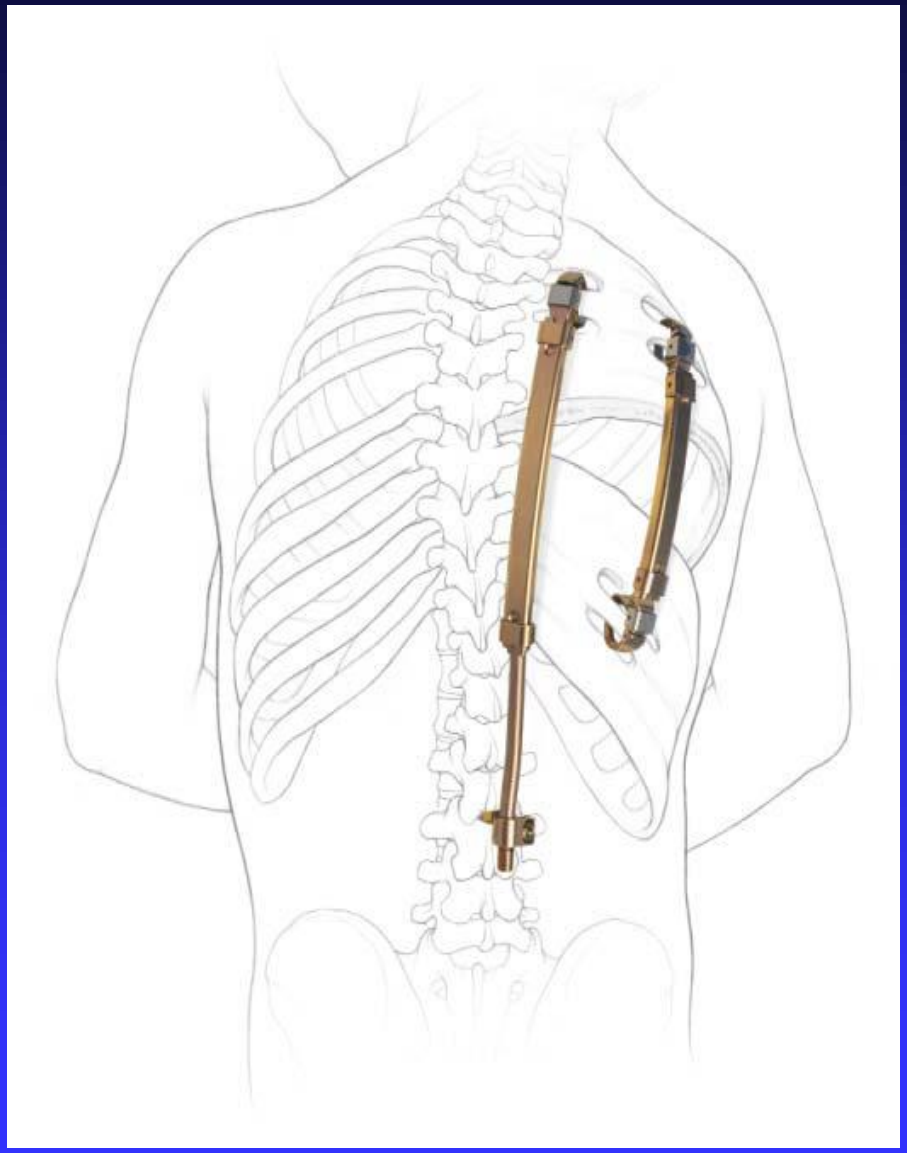
Absented ribs



Fused ribs



Vertical Expandable Prosthetic Titanium Rib (VEPTR)



The main factors of quality treatment results:

-early detection
-good timing
-choosing of adequate
surgical treatment type

Neuromuscular scoliosis

Neuromuscular scoliosis
the 3rd main scoliotic deformity

- extensive progression (even after mature)
- weighty deformities
- associated with pelvic and hip deformities
- high rate of associated dysfunctions
  - cardiopulmonal
  - urinary
  - pressure sores
  - osteopenia

Neuromuscular scoliosis

Sitting instability

Standing instability

Etiologic classification of the spinal neuromuscular deformities

1.neuropathic

-affection of the upper motoric neuron

- **-cerebral palsy**
- -spinocerebelar degeneration (Friedreich, Charcot-Marie-Tooth, Roussy-Lévy)
- -syringomyelia
- -spinal tumours
- **-spinal trauma**

-affection of the lower motor neuron

- -poliomyelitis
- **-spinal muscular atrophy** (Werdnig-Hoffmann)
- **-paralytic myelomeningocele**

2.myopathic

- **-artrogryphosis**
- **-muscular dystrophy (Duchenne)**

Neuromuscular scoliosis

- long unilateral curve
- kyphoscoliosis
- lumbar hyperlordosis
- pelvic and hip deformities

1. Spastic forms → rigid kyphoscoliosis
2. Hypotonic forms → paralytic curves

Pelvic deformities

1.structural

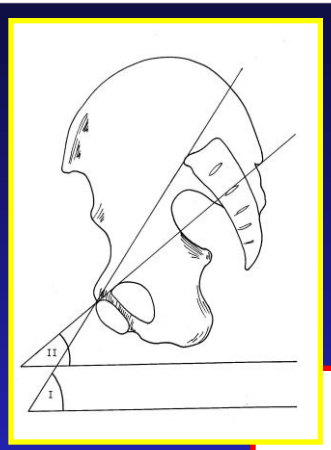
- in spinal deformities

2.functional

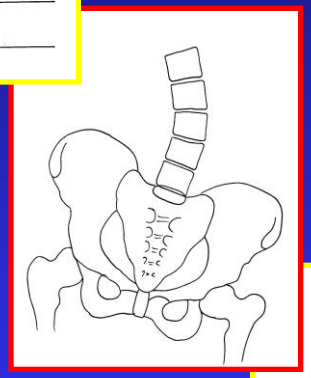
- in muscle imbalances

Pelvic deformities

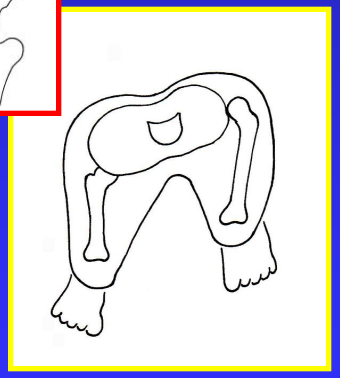
- Posterior tilt
- Anterior tilt



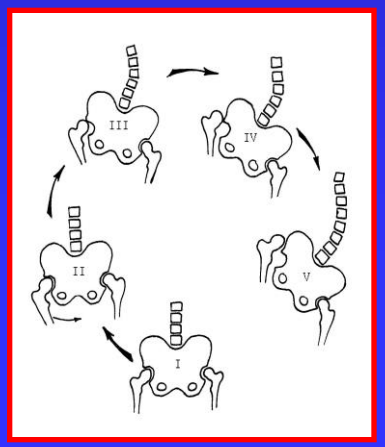
- Pelvic obliquity



- Pelvic rotation

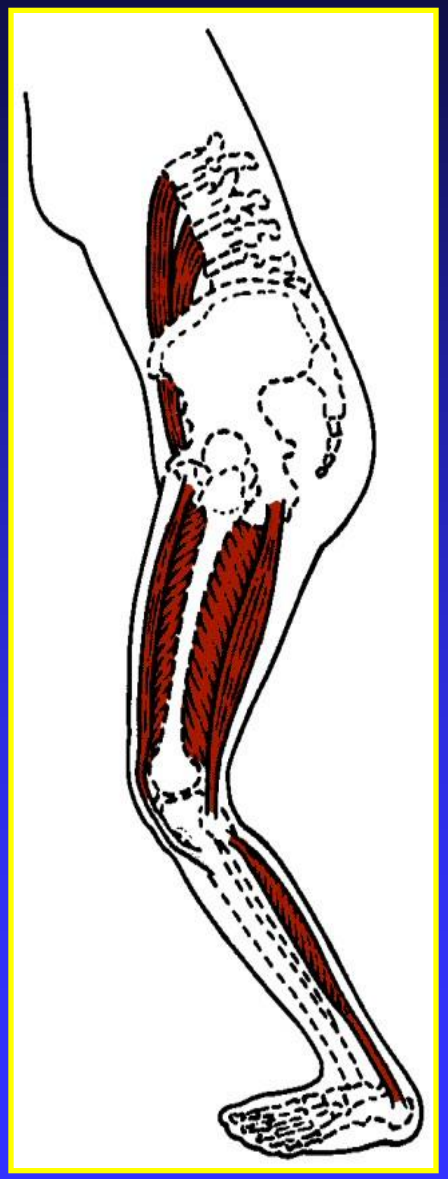


- Windswept hip phenomenon



POSTERIOR TILT

POSTERIOR TILT



- Hyperactivity of hip extensors
- Hamstrings shortening
- Weakeness of lower back extensors

↓

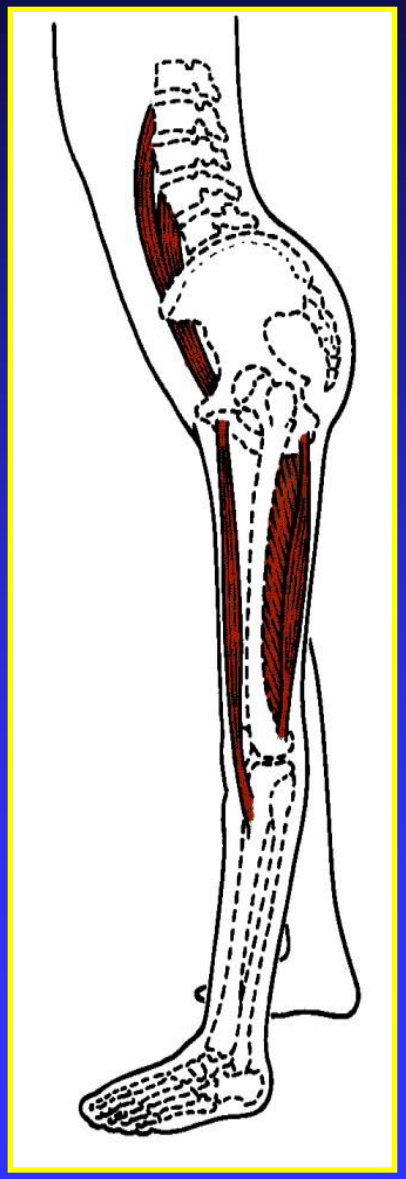
- Decreasing of lumbar lordosis
- Lumbar spine flexion

↓

Extensive pelvic posterior tilt

ANTERIOR TILT

ANTERIOR TILT



- Shortening of lower back extensors
- Weakness of trunk muscles
- Shortening of iliotibial tractus
- Shortening of hip extensors

↓

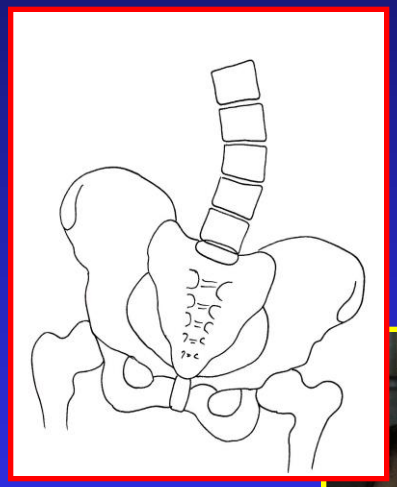
- Increasing of lumbar lordosis

↓

Extensive pelvic anterior tilt

PELVIC OBLIQUITY

PELVIC OBLIQUITY

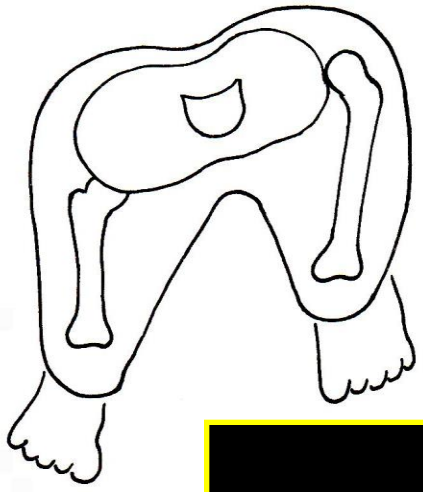


- Unbalanced trunk
- Lumbar scoliosis
- Hip dislocation
- Muscle imbalance:
  - Hip adductors imbalance
  - Hip abductors weakness

Pelvic obliquity

PELVIC ROTATION

PELVIC ROTATION

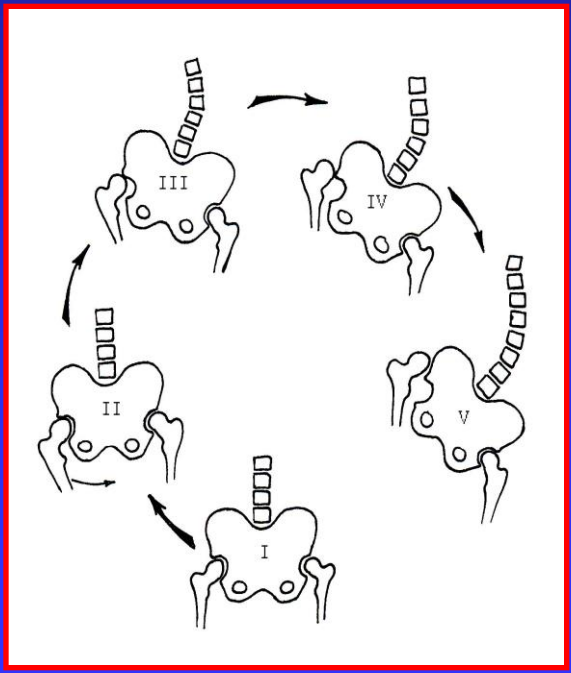


- Often associated with scoliosis
- Dislocated hip located in posterior side of rotation

Pelvic rotation

WINDBLOW HIP DEFORMITY

- 1st hip:
  Flexion+abduction+external rotation
- 2nd hip
  Adduction+internal rotation



- Hip dislocation
- Pelvic obliquity and rotation
- Scoliosis
- Different leg lenght

Wind hip deformity

Therapy of the neuromuscular spinal deformities

1. conservative

disadvantages:
- -low efect
- -poor tolerance of the orthosis
- -worsening of the cardiopulmonal functions
- -pressure sores

2. surgical

indications:
- -collapse and instability of the spine
- -progressivity in cardiopulmonal dysfunctions
- -back pain
- -tendence to pressure sores

Surgical therapy

- doesn´t solve the primary affection
- improving the secondary dysfunctions

Main aims of the surgical therapy:

- prevention of the deformity progression
- correction of the deformity
- improving of the sitting and standing stability
- compensation of the pelvic obliquity
- improving of the cardiopulmonal functions

Combination of the surgical techniques

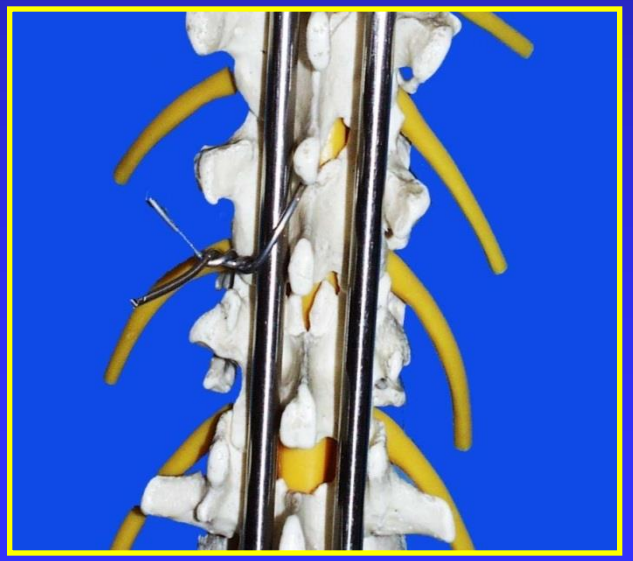
LUQUE = segmental spinal sublaminar instrumentation with translation forces

GALVESTON = pelvic stabilisation

Luque

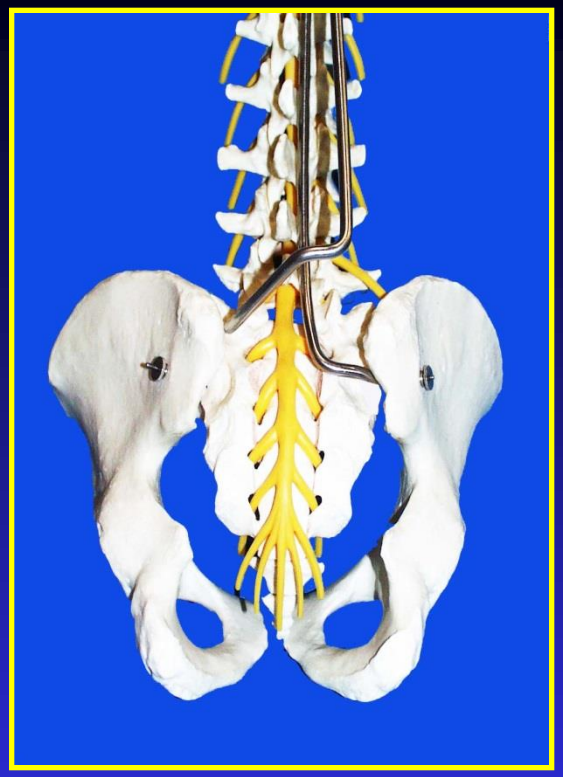
spinal segmental instrumentation

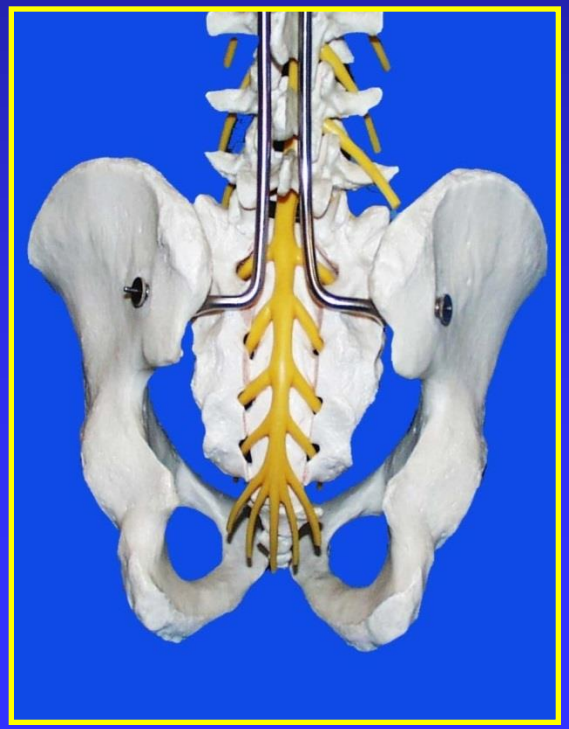
- good and safe correction
- stable instrumentation
- allows the release of the orthosis
- possibility of the extending to the pelvis



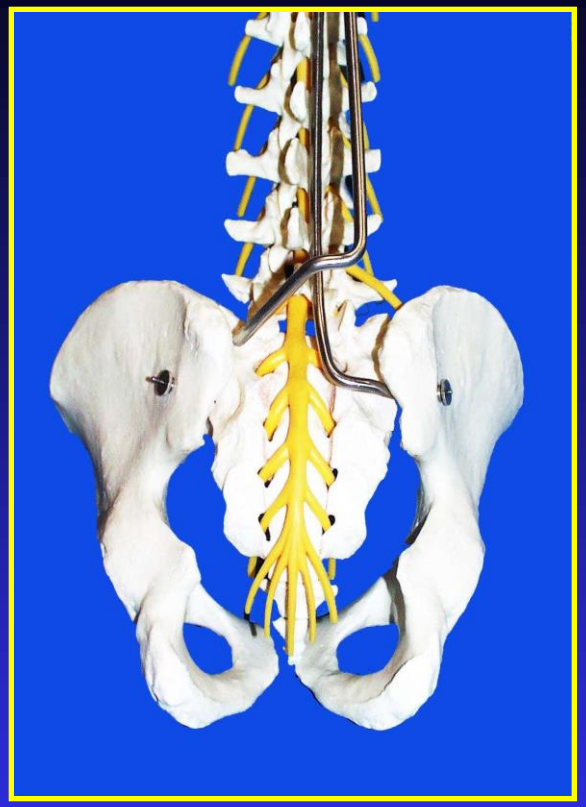
Galveston

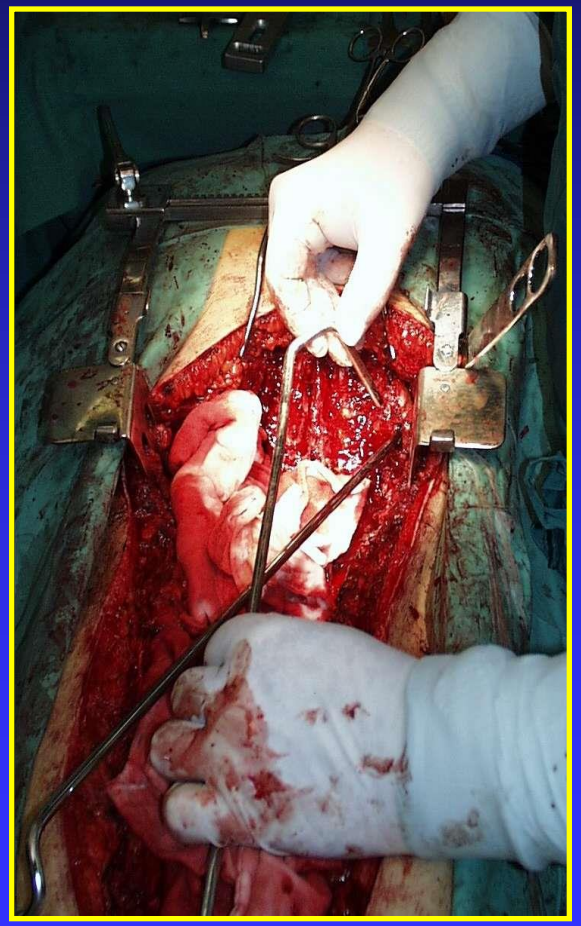
pelvic stabilization

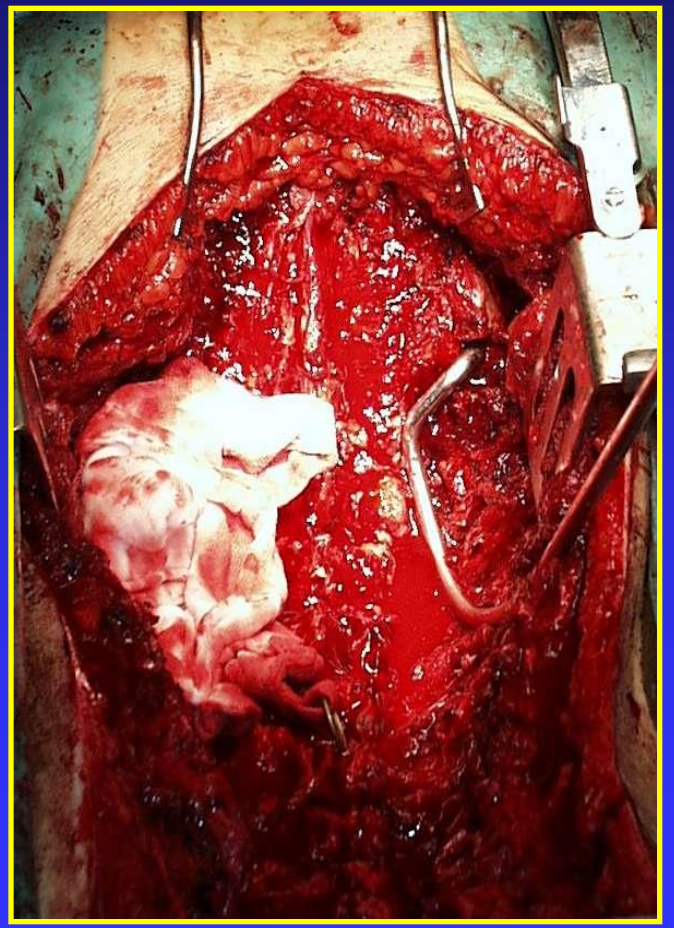




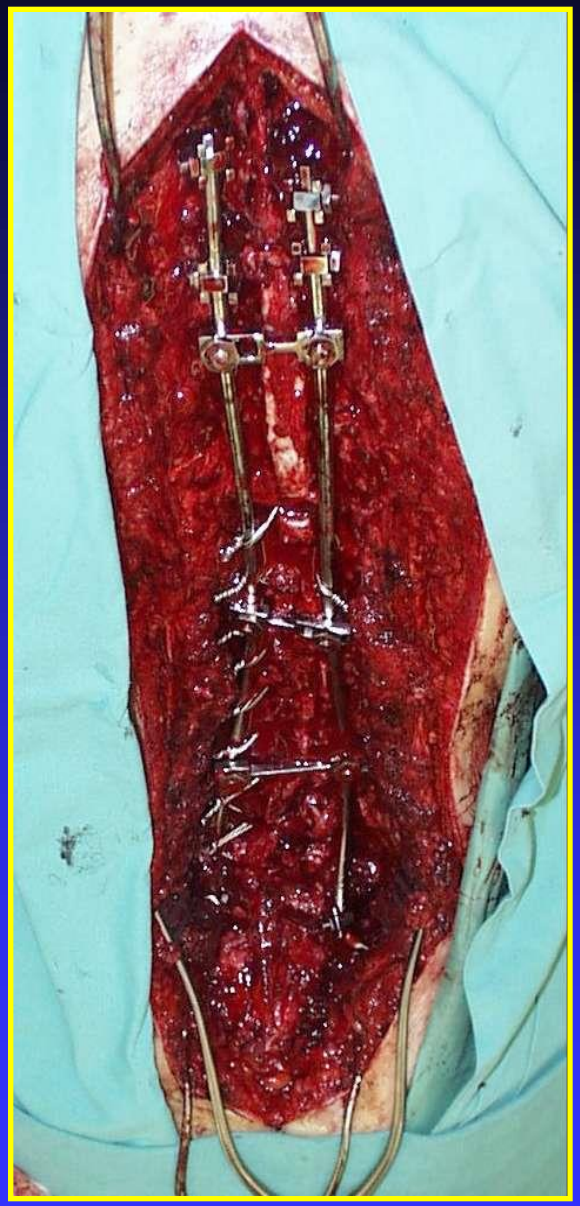
GALVESTON





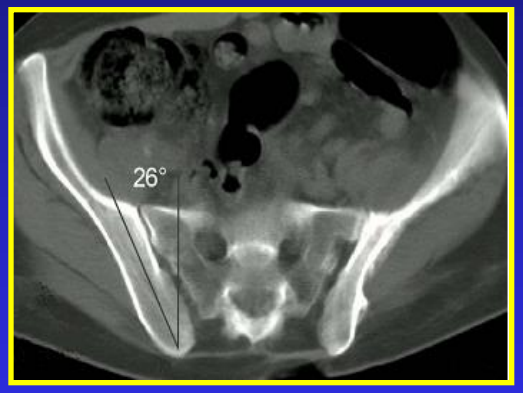


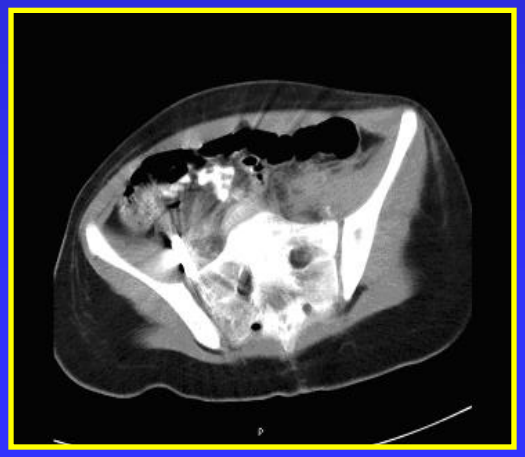
LUQUE + GALVESTON



Main complications in instrumentation

Incorrect implantation of the rod to the pelvis





Dislocation of the upper instrumentation part

Contemporary treatment

- transpedicular fixation

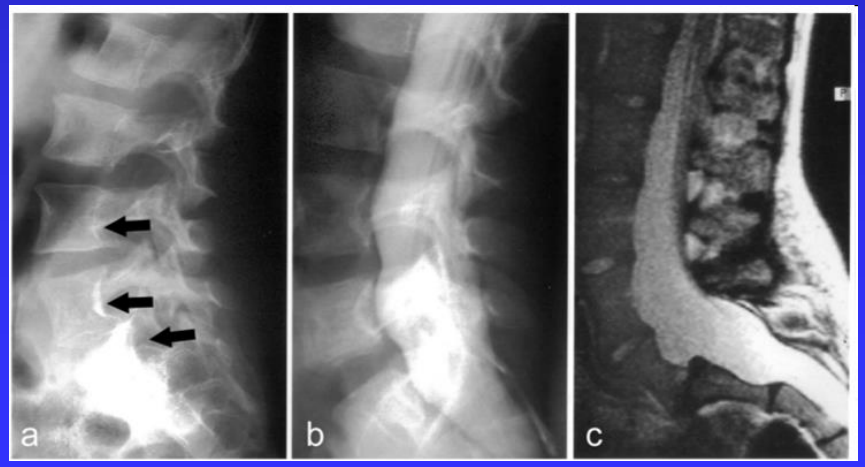
Other scoliosis

Neurofibromatosis

Neurofibromatosis „café au lait“

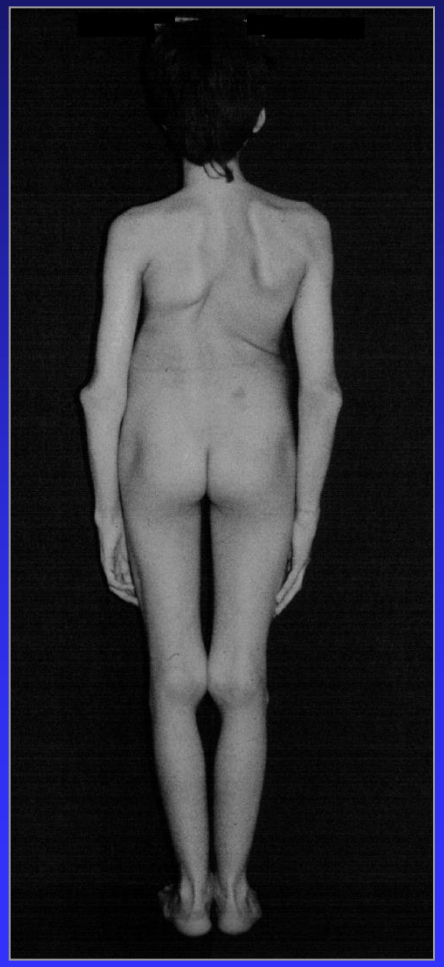
Neurofibromatosis

- Sharp curves
- High rate of pseudoarthrosis
- Reexploration of fusion



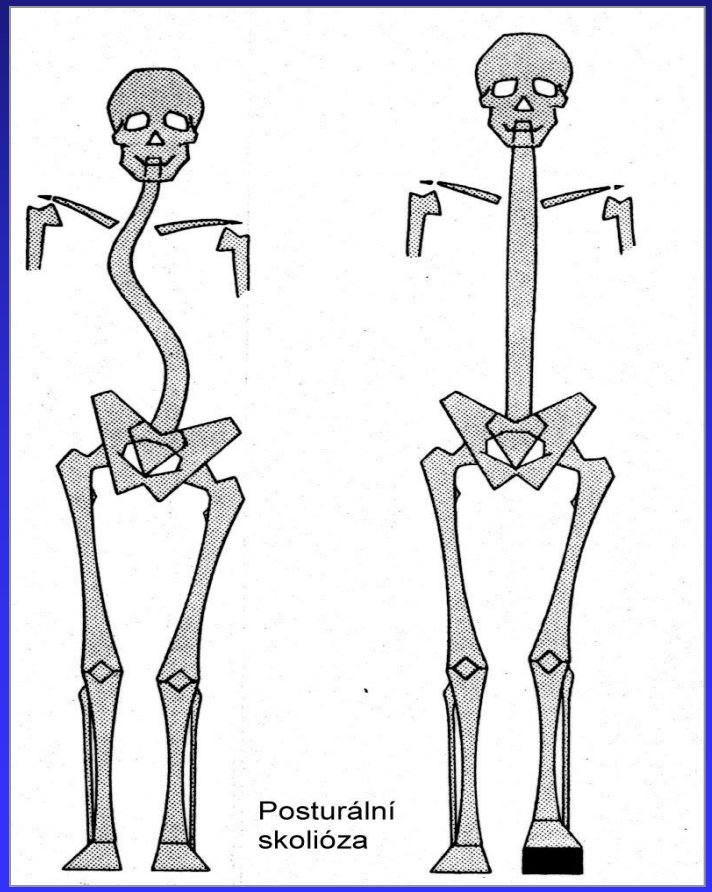
Scoliosis in other syndromas

- Osteochondrodystrofy
- Ehlers – Danlos
- Marfan
- Morquio
- O. imperfecta

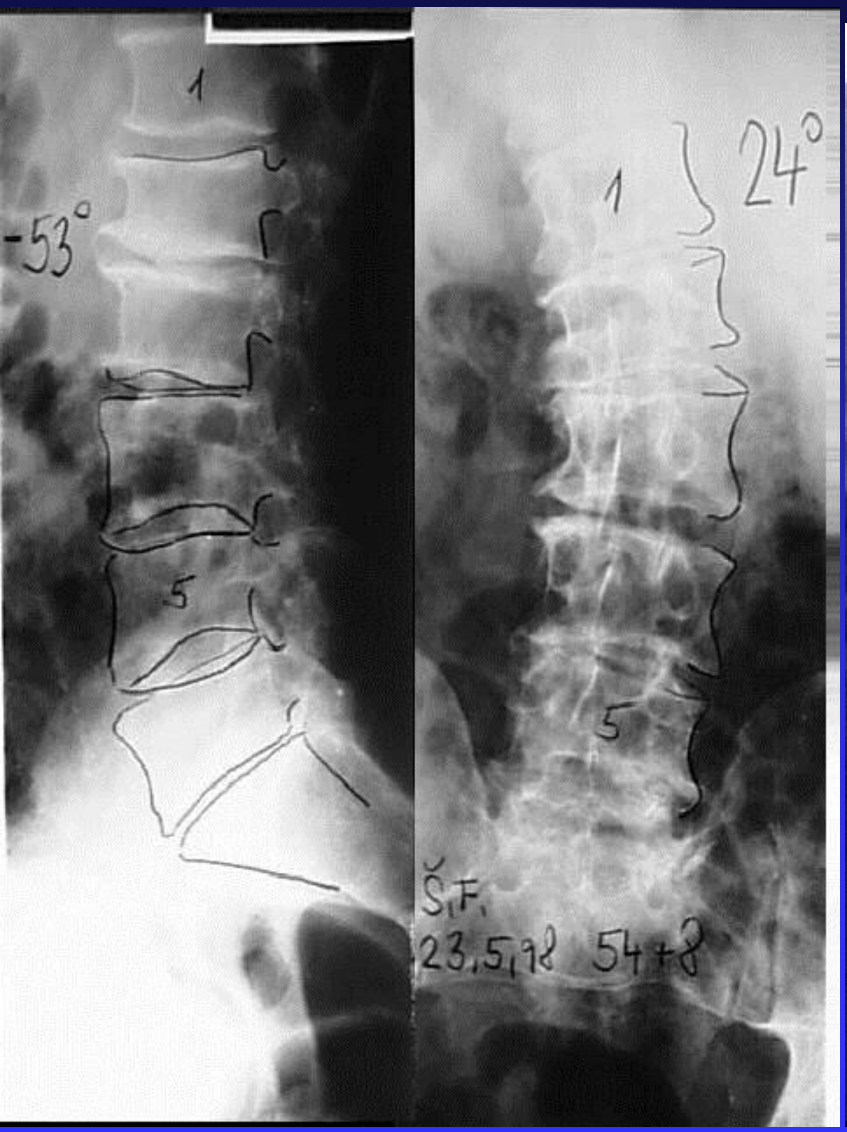


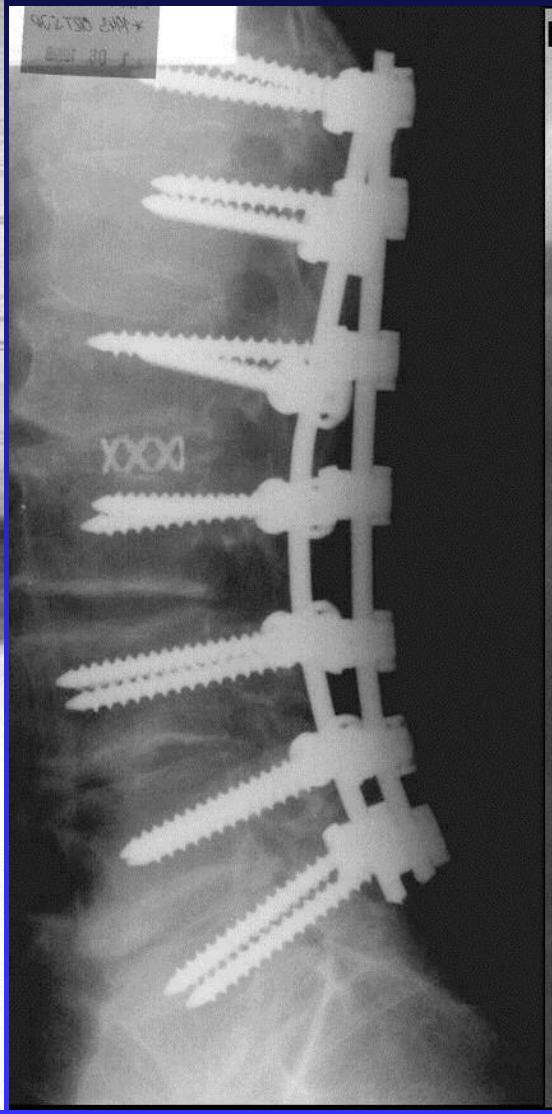
Secondary curves

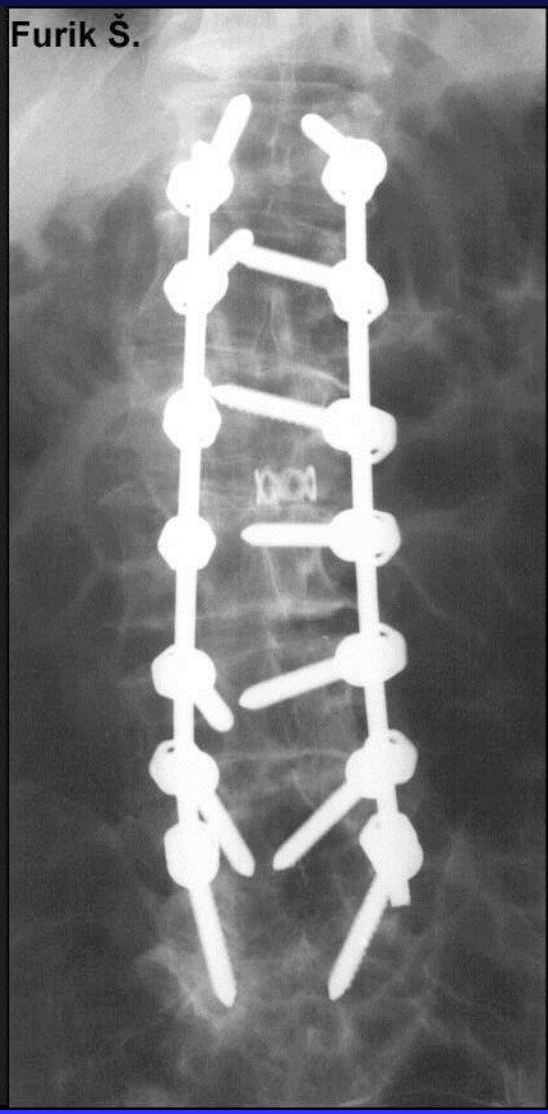
- Postural
- Inflamations
- Tumours
- Hysteria
- Degenerative



Degenerative scoliosis







Complications of surgical therapy

Neurological complications

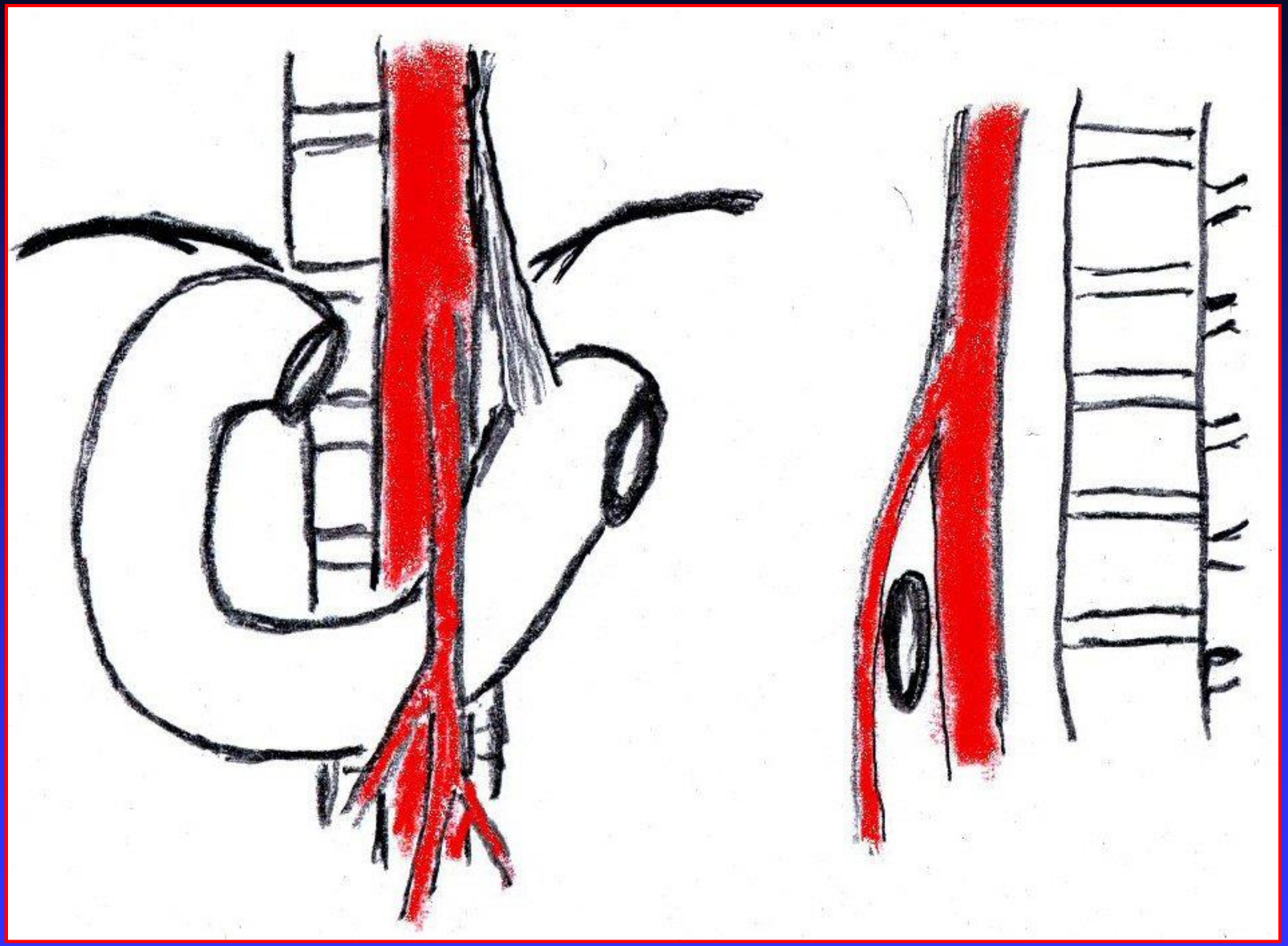
- ✓ perioperative – implantation of instruments
- ✓ overcorrection
  - ✓– mechanical (spinal cord distraction)
  - ✓- vascular

Cast syndroma

– vascular duodenal compression

- ✓ acute (postop., plaster)
- ✓ chronical (Wilke syndroma)

Duodenal compresion in third part between a. mesent. sup. and aorta with partial duodenal obstruction

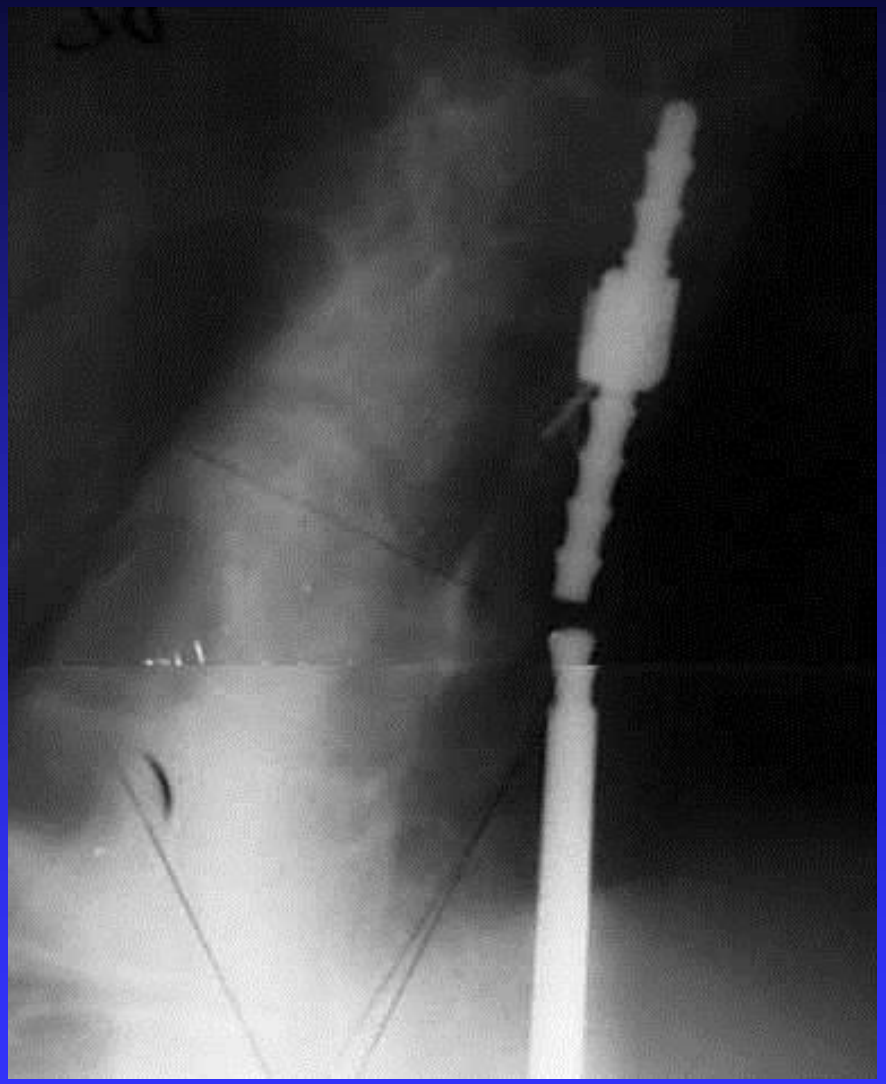


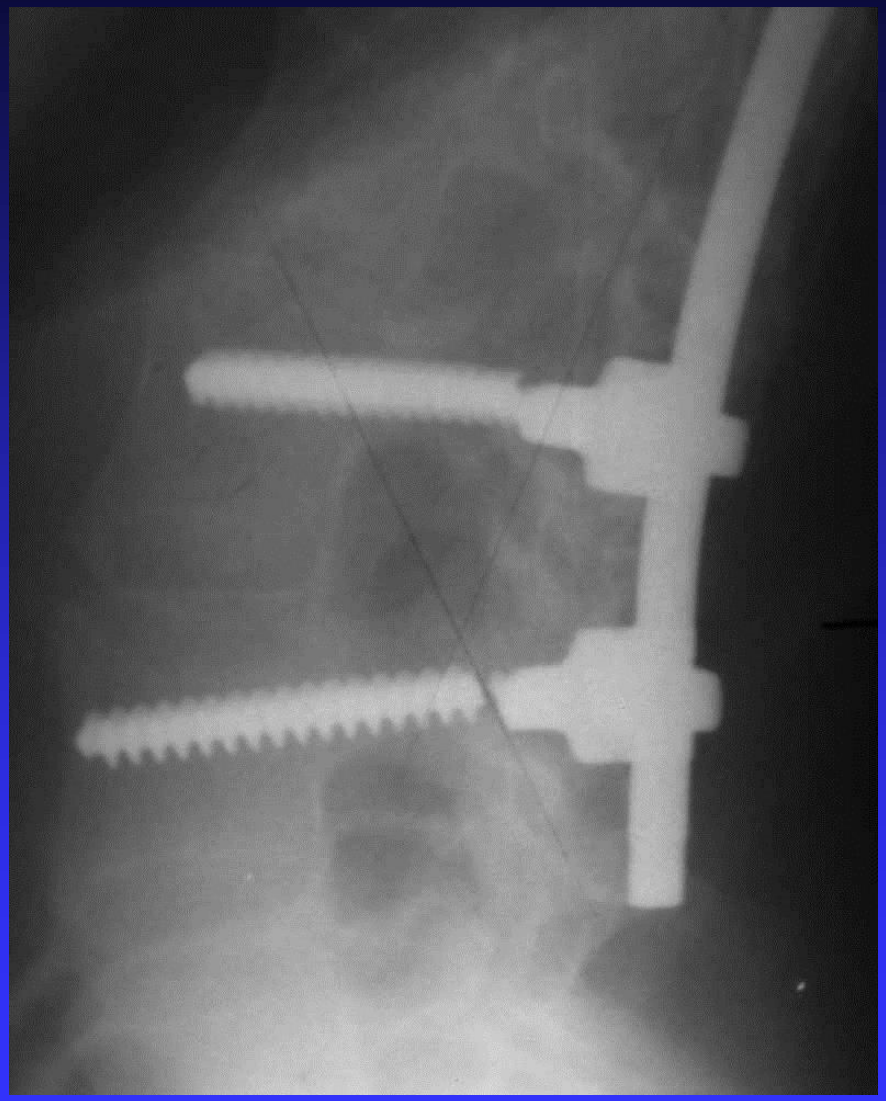
Therapy of cast syndroma

- ✓ intravenous nutrition
- ✓ nasogastric drain
- ✓ left side body position
- ✓ (side to side duodenojejunoanastomosis)

Later complications

- ✓ Pseudoarthrosis (loss of correction, pain, loosening of instrumentation)
- ✓ Bending of fusion during growth period
- ✓ Fracture in fusion



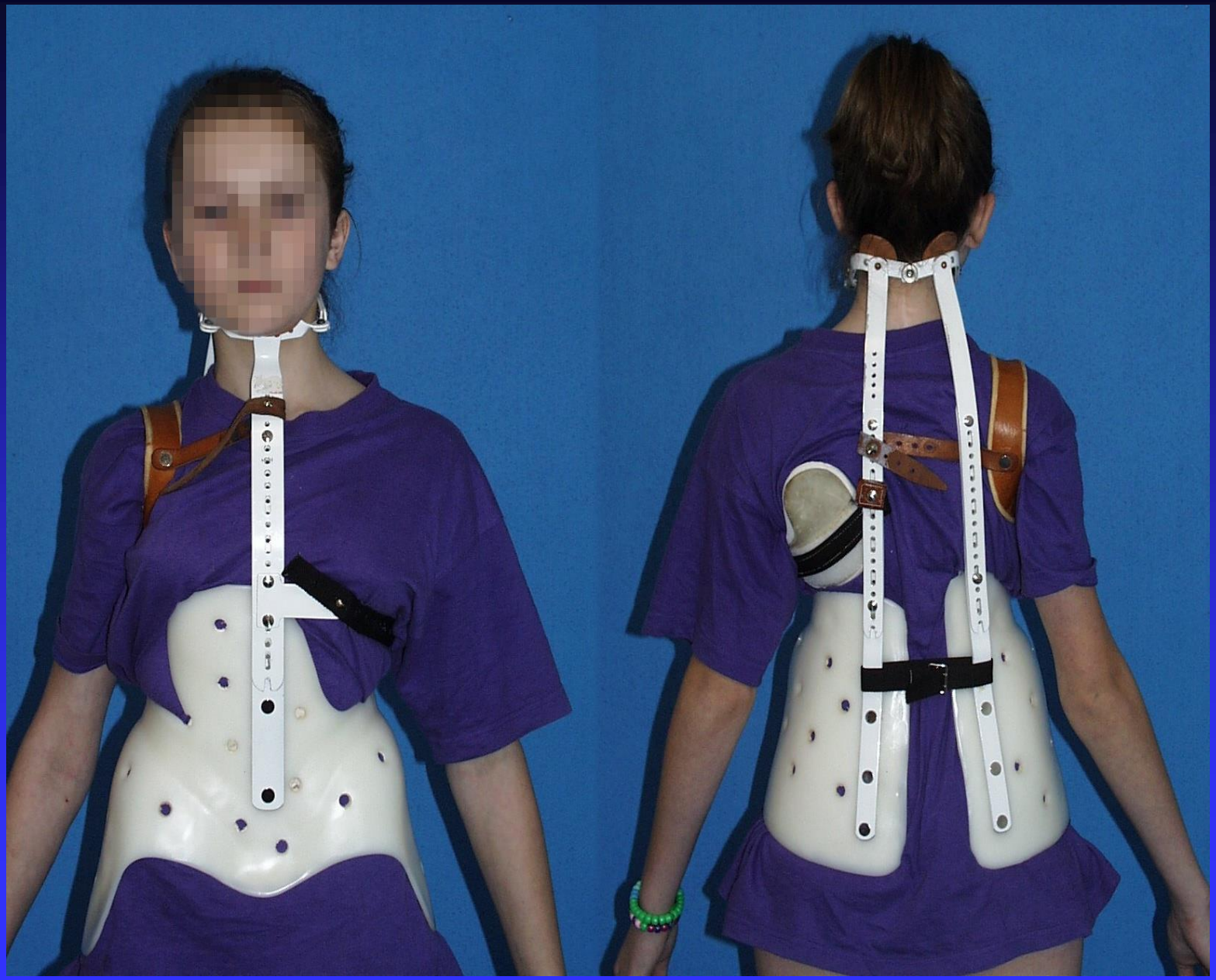


Infection complications

- ✓ superficial
- ✓ deep
- ✓ punction, antibiotics
- ✓ surgical revision, drainage

Possible postoperative fixations

1. Milwaukee brace
2. Plaster cast
3. Orthosis



Halo - cast

C-Th junction

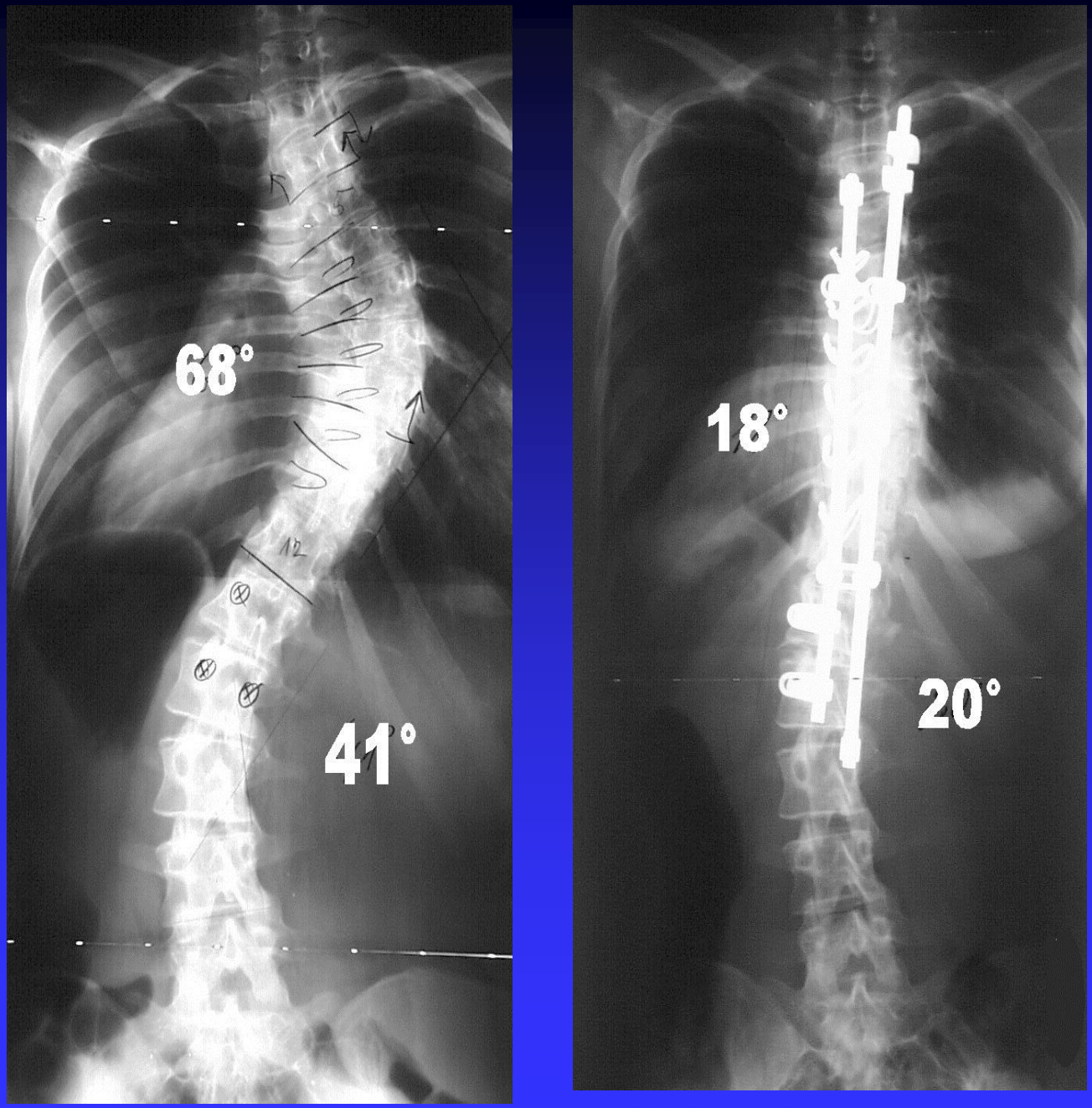
verticalisation

Pressure sores in plaster cast

- ✓ superficial – conservative treatment
- ✓ deep – surgical treatment – excision, suture

- ✓ Prevention – regular skin care


LÉKÁRNA FNSP BOHUNICE
MENTHOLUM
SPIRITUS DIL.
NEUŽÍVAT UNITÁRNĚ !


68°
41°
18°
20°


adidas





Skin observation

- Microscopic defects
- Red colour of skin
- Oedema and secretion

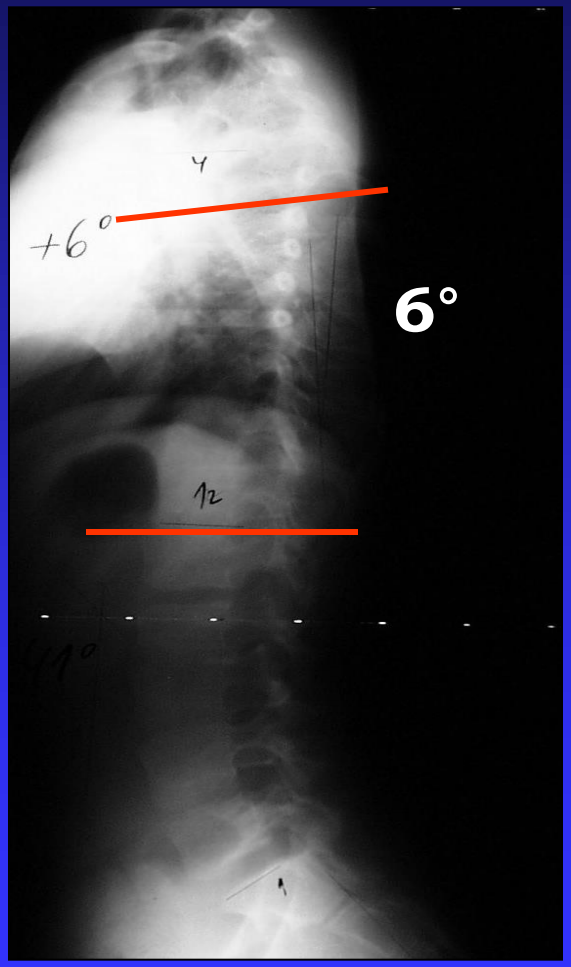
DEFORMITIES in SAGITTAL PLANE

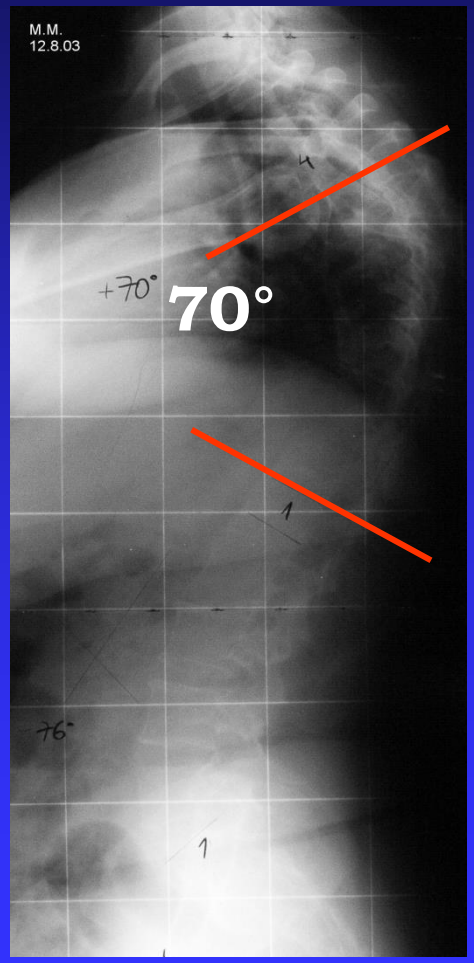
Etiological classification

HYPERKYPHOSIS

- Postural
- M. Scheuermann
- Congenital
- Neuromuscular
- in myelomeningocele
- Traumatic
- After surgical treatment

Hypo - Hyper kyphosis
normal range T5 – T12 = 20°- 40°





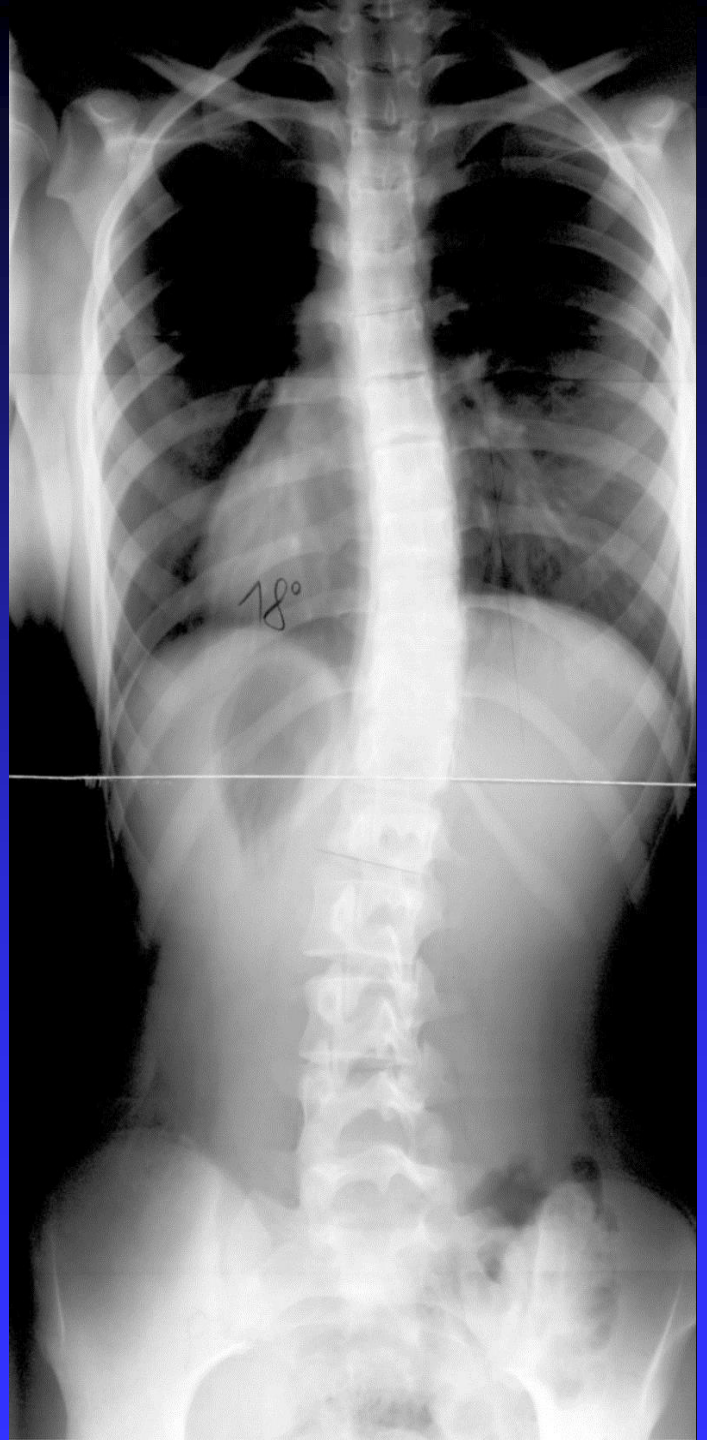
M.Scheuermann
kyphosis dorsalis juvenilis, adolescent kyphosis

- Vertebral plates incongruentio
- Intervetebral spaces decreasing
- Wedge vertebral deformities over 5°
- Kyphosis over 40°

Therapy

- Physiotherapy
- Milwaukee brace
- Surgical treatment


+42°
7 +8°
8 +5°
9 +6°
-62°


78°