Assessment of scoliosis patient

Scoliosis

- The Scoliosis Research Society (SRS) definition of scoliosis is a

  lateral curvature of the spine greater than 10° as measured by the Cobb method on a standing x-ray of the thoraco-lumbar spine

Assessment of scoliosis patient

- Evaluation of clinical history
- Clinical examination and assessment
- Radiological assessment

Clinical history
Age

Infantile idiopathic scoliosis	0-3 yrs
Juvenile idiopathic scoliosis	4-9 yrs
Adolescent idiopathic scoliosis	10-20 yrs
Congenital scoliosis	From birth
Pubertal growth spurts	10-14 in girls 12-16 in boys

- The alveoli - 10 fold increase till 4 years of age.
- Scoliotic deformity limits the space available for lung growth
- Significant scoliosis before 5 years of age - disabling dyspnea or cardiorespiratory failure.

Clinical history
Gender

Male : female	
Infantile scoliosis	1:1 to 2:1
Juvenile scoliosis	1:3 in < 6 yrs 1:6 in >6 yrs
Adolescent scoliosis	1:6

- As the degree of scoliosis increases the ratio tilts more in favour of females.

Clinical history
Birth and developmental history

- Full term / pre mature delivery
- H/o birth asphyxia
- Deformity of back or other regions noted during birth
- Mile stones
- Family history & siblings history
- Menarche in girls

Clinical history
Birth and developmental history

- H/o birth asphyxia & delayed mile stones –CP
- Delayed motor milestones or regression of motor mile stones – N.M disorder
- Multiple congenital anomalies – Syndromic children

Clinical history

Complaints which needs special attention

- C/o Pain associated with deformity
- C/o Weakness in limbs
- C/o Bowel bladder disturbance

Clinical examination

- Morphometric measurements
- General and systemic examination
- Spine examination & curve assessment
- Neurological assessment

Morphometric measurement

- Standing height
- Sitting height
- Arm span
- Weight

Standing height

- Measured in supine position till 5 yrs of age
  Measured in standing position > 5 yrs
- **First sign of puberty : > than 0.5 cm /month**
- Standing height = subischial ht(lower limb)+
  sitting ht(trunk)
- **Lower limb has earlier growth spurt compared to trunk.**
- Standing Ht at 5 yrs-60% of adult Ht
  puberty-86% of adult ht

Sitting height

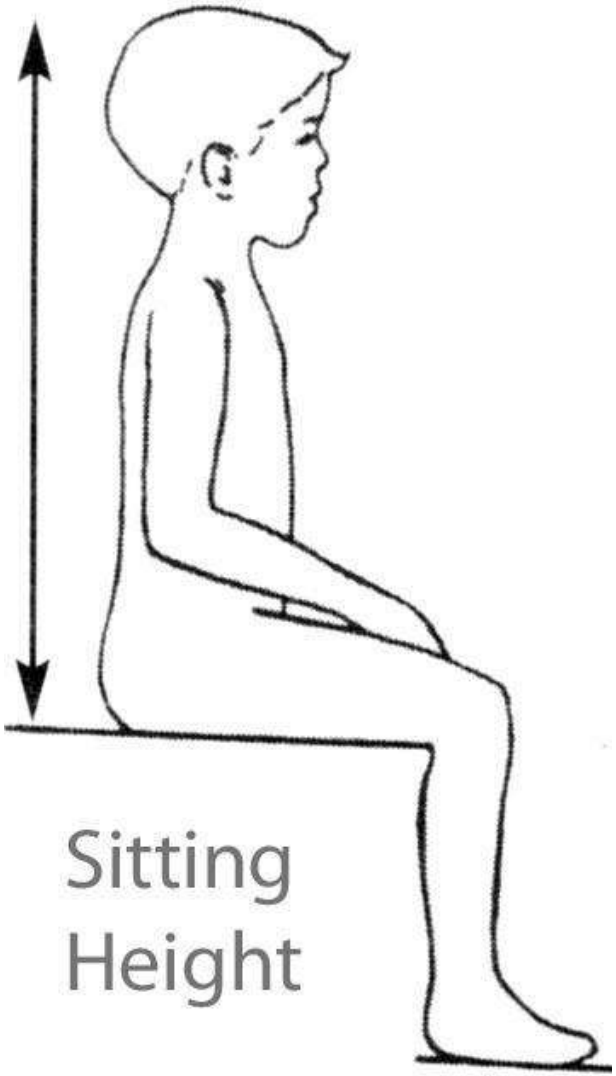
- Measured in

  lying down position in age <2 yrs

  sitting position in age >2 yrs.
- **More relevant in scoliosis –directly correlates with spinal column growth**
- Onset of puberty sitting ht

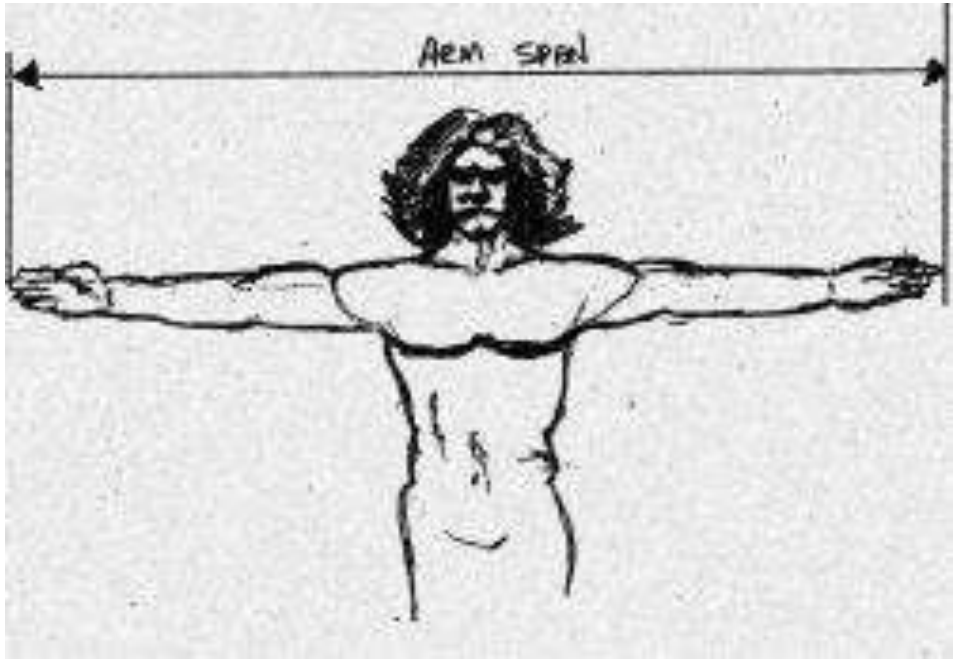
  75 cm - girls

  78 cm - boys



Arm span

- Arms raised to horizontal position and distance between tips of middle finger measured.
- Standing height = 97% of arm span.
- Height in a wheel chair bound patient.
- Estimate of standing ht in severely deformed spine.
- **Increased in Marfans synd.**



Weight

- Wt doubles between 10 & 17 yrs of age
- **In pt with 10 % over weight – brace may not work**
- In under wt girls menarche may be dalayed
- In parder willi syndrome obesity may mask scoliosis

General examination and systemic examination

- Inspection of skin and neurocutaneous markers
- Features of Connective tissue disorder
- Specific syndromic features
- Evaluation of cardiac ,respiratory and genitourinary system.

Neurocutaneous markers

Spinal dysraphism

Hairy patches

Dimples

Lipomatous lesion

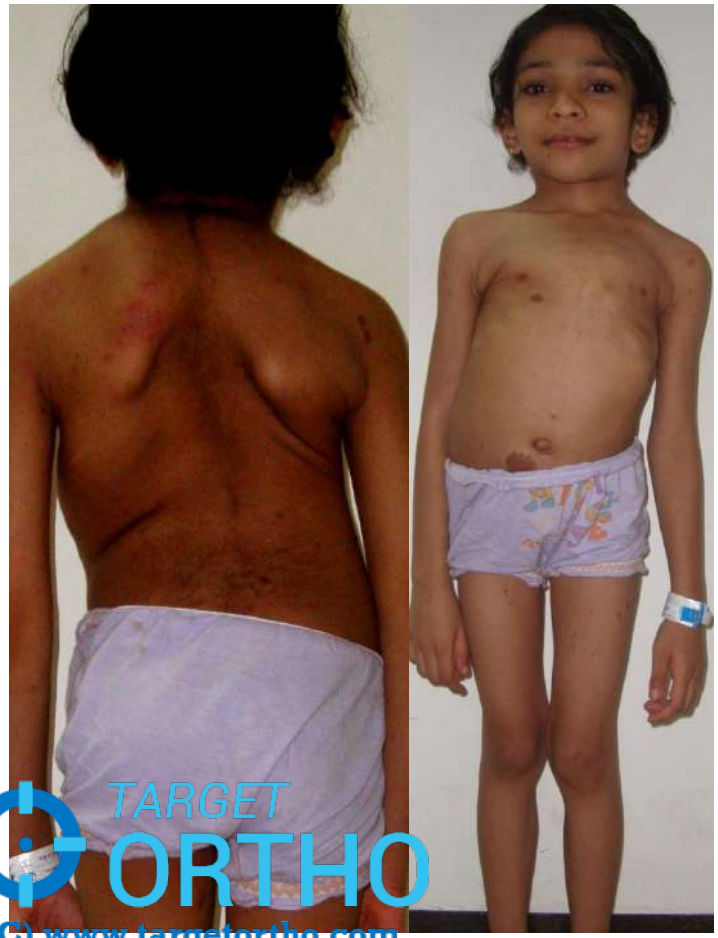
Neurocutaneous markers

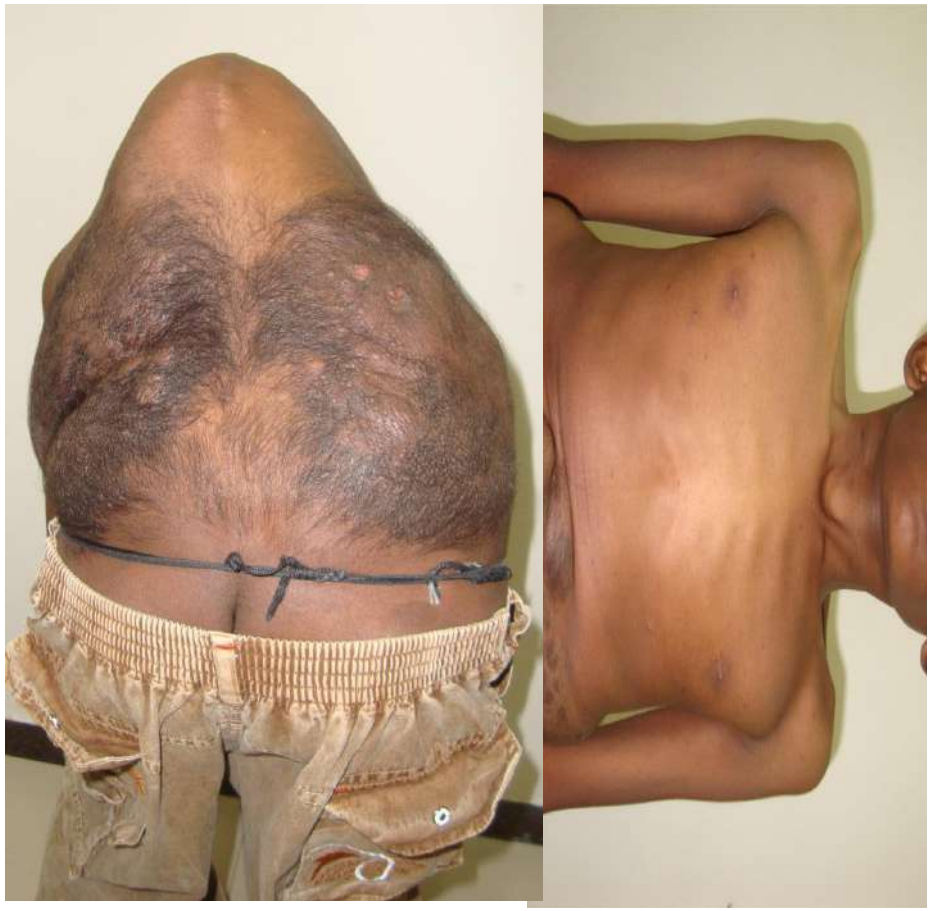
Neurofibromatosis

Café au lait spots

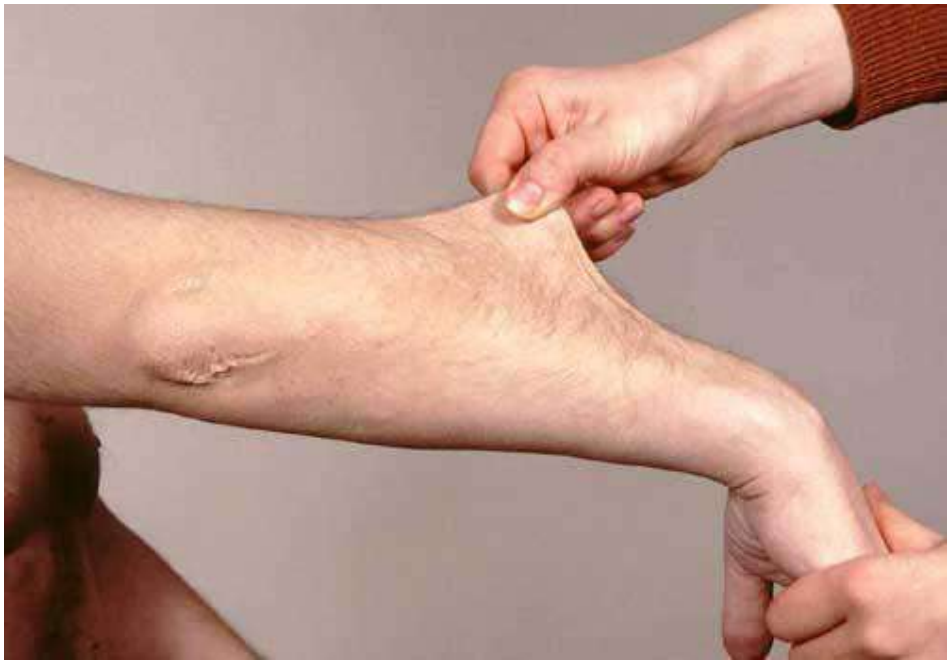
Skin tags

Axillary freckles

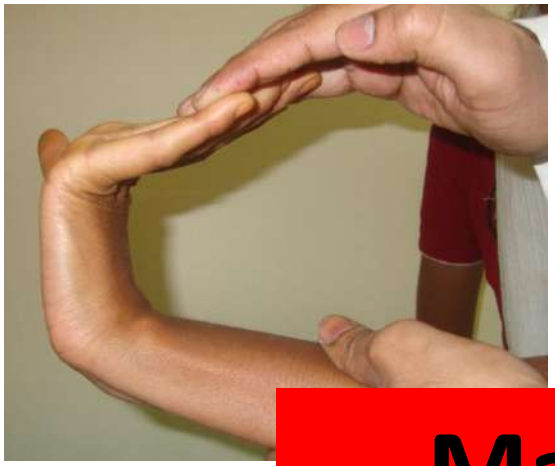


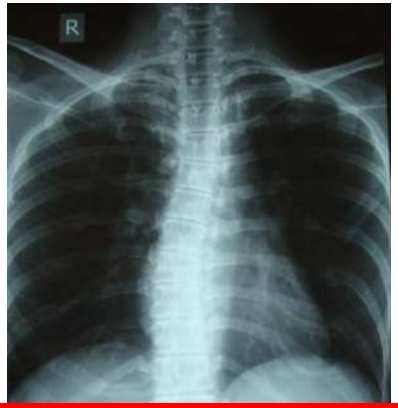


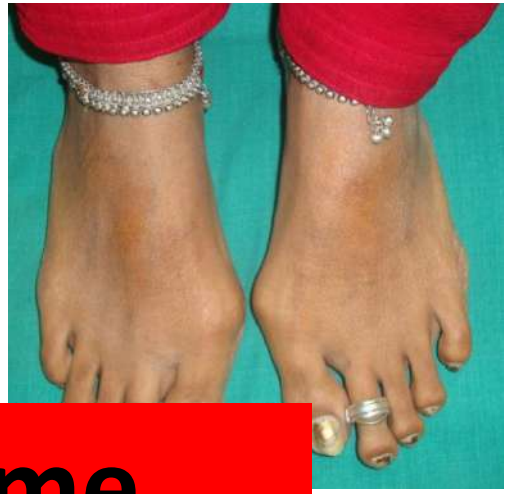
Ligamentous laxity



Look for other specific syndromic features







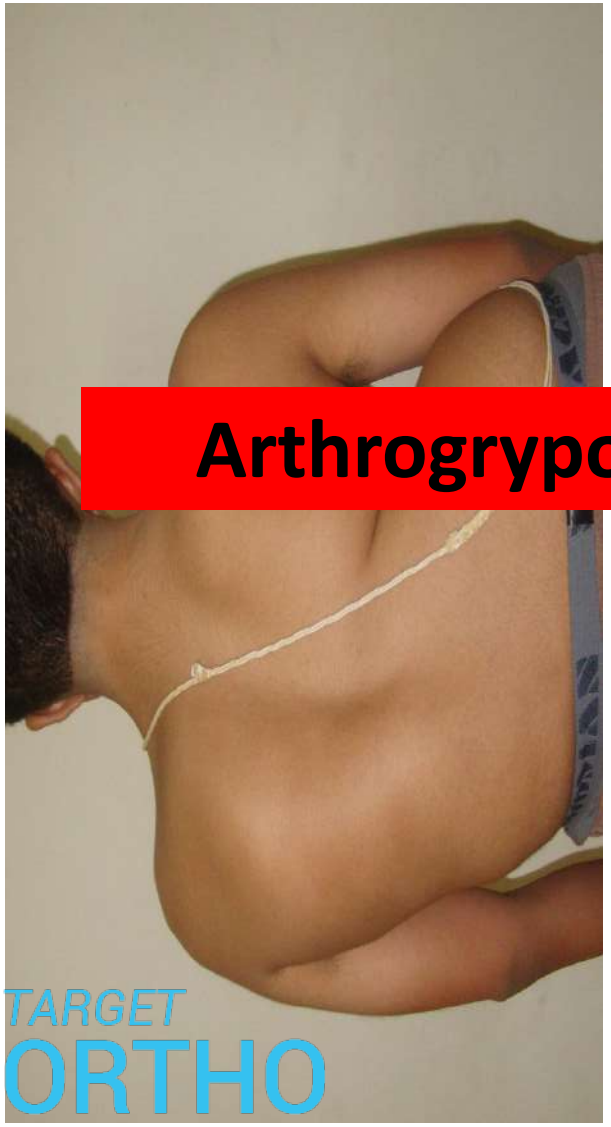
Marfans syndrome

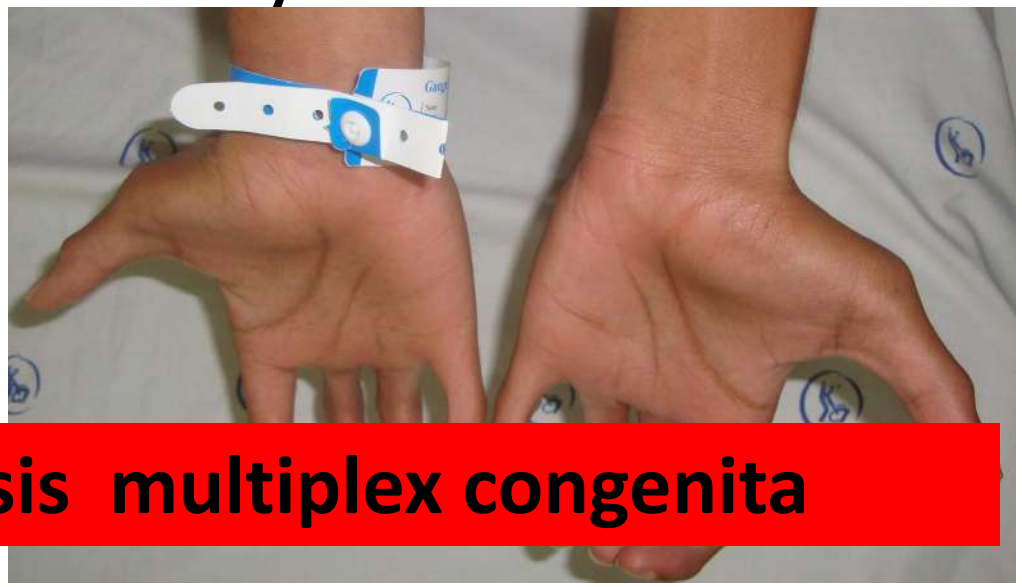
Major and minor criteria for the diagnosis of Marfan syndrome

Skeletal findings
Major manifestations - need four of the following:
Reduced upper to lower segment ratio (0.85 versus 0.93 in normals)
Arm span exceeding height (ratio >1.05)
Arachnodactyly of fingers and toes with positive wrist and thumb signs*
Scoliosis >20° or spondylolisthesis
Pectus carinatum
Pectus excavatum requiring surgery
Reduced extension of elbows (<170°)
Medial displacement of medial malleolus causing pes planus
Protrusio acetabuli of any degree
Minor manifestations
Pectus excavatum of moderate severity
Joint hypermobility
High arched palate with crowding of teeth
Facial features
Dolichocephaly
Malar hypoplasia
Enophthalmos
Retrognathia
Down-slanting palpebral fissures
Family/genetic history
Major manifestations - need one of the following:
A parent, child or sib who meets these criteria independently
Presence of a mutation in FBN1 known to cause the Marfan syndrome
Presence of a haplotype around FBN1 inherited by descent known to be associated with unequivocally diagnosed Marfan sydnrome in the family

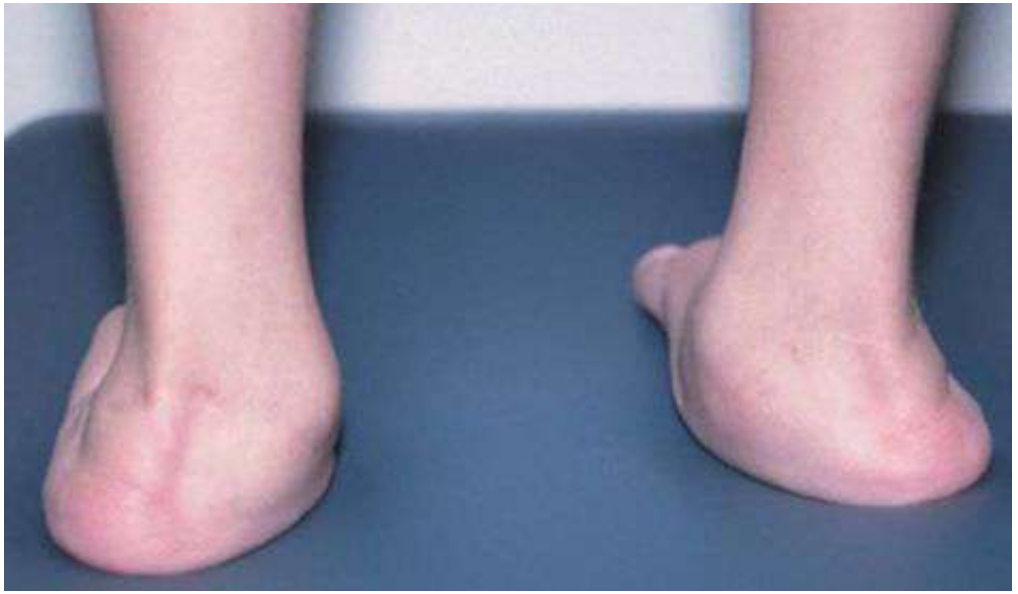
Cardiovascular findings
Major manifestations - need one of the following:
Dilatation of the ascending aorta involving the sinuses of Valsalva, with or without aortic regurgitation
Dissecting of the ascending aorta
Minor manifestations
Mitral valve prolapse
Mitral regurgitation
Dilatation of the pulmonary artery, in the absence of valvular or peripheral pulmonic stenosis, below age 40
Calcification of mitral annulus below age 40
Dilatation or dissection of descending thoracic or abdominal aorta below age 50
Ocular findings
Major manifestations
Ectopia lentis
Minor manifestations
Flat cornea (measured by keratometry)
Increased axial globe length (measured by ultrasound)
Hypoplastic iris or hypoplastic ciliary muscle causing decreased miosis
Myopia
Retinal detachment
Other findings
Major manifestations
Dural ectasia affecting the lumbosacral spinal canal
Minor manifestations
Spontaneous pneumothorax
Apical blebs
Cutaneous striae distensae
Recurrent or incisional hernias

Look for other specific syndromic features





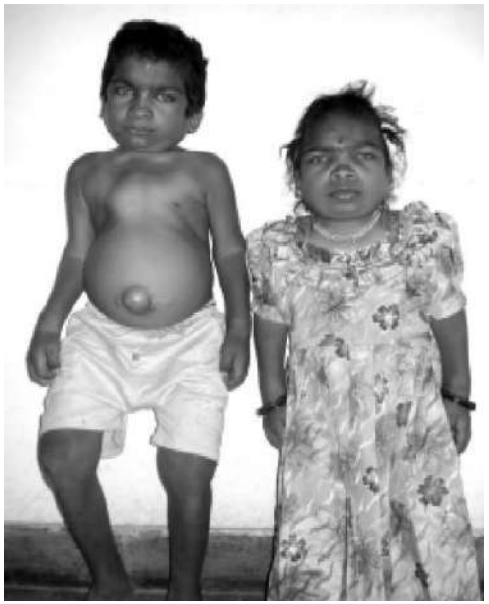
Arthrogryposis multiplex congenita



Look for other specific syndromic features

- **Mucopolysaccharadoses**

1. Coarse fascial features
2. Dwarfism
3. MR



- **Epiphyseal dysplasias**

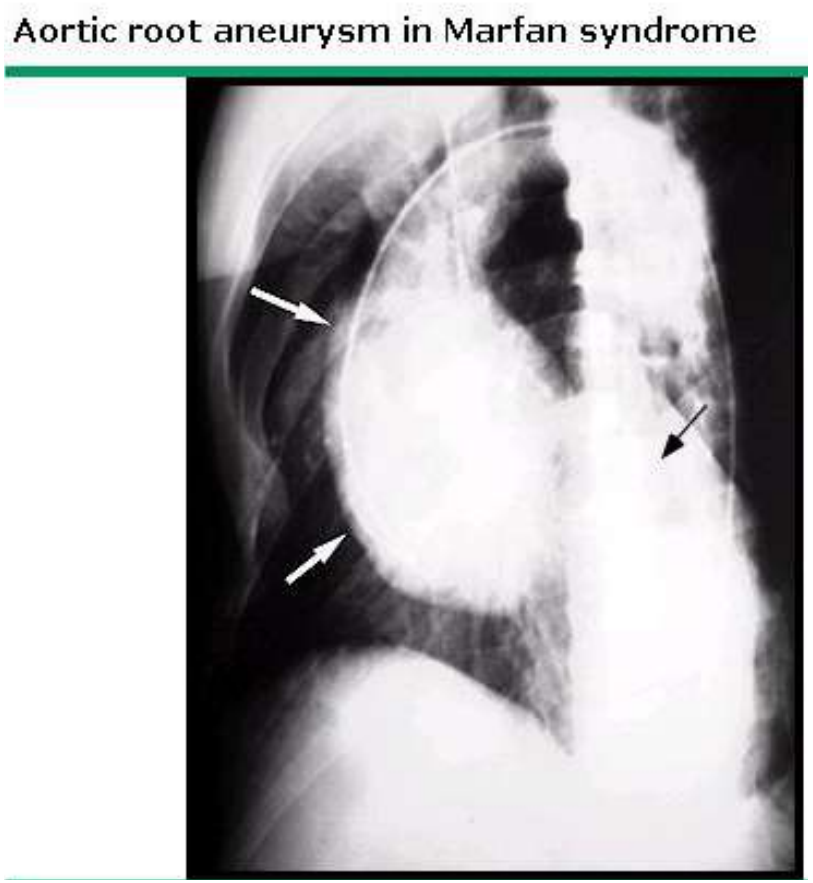
1. Multiple joint involvement
2. Joint stiffness

Systemic examination

- **Cardiovascular system**

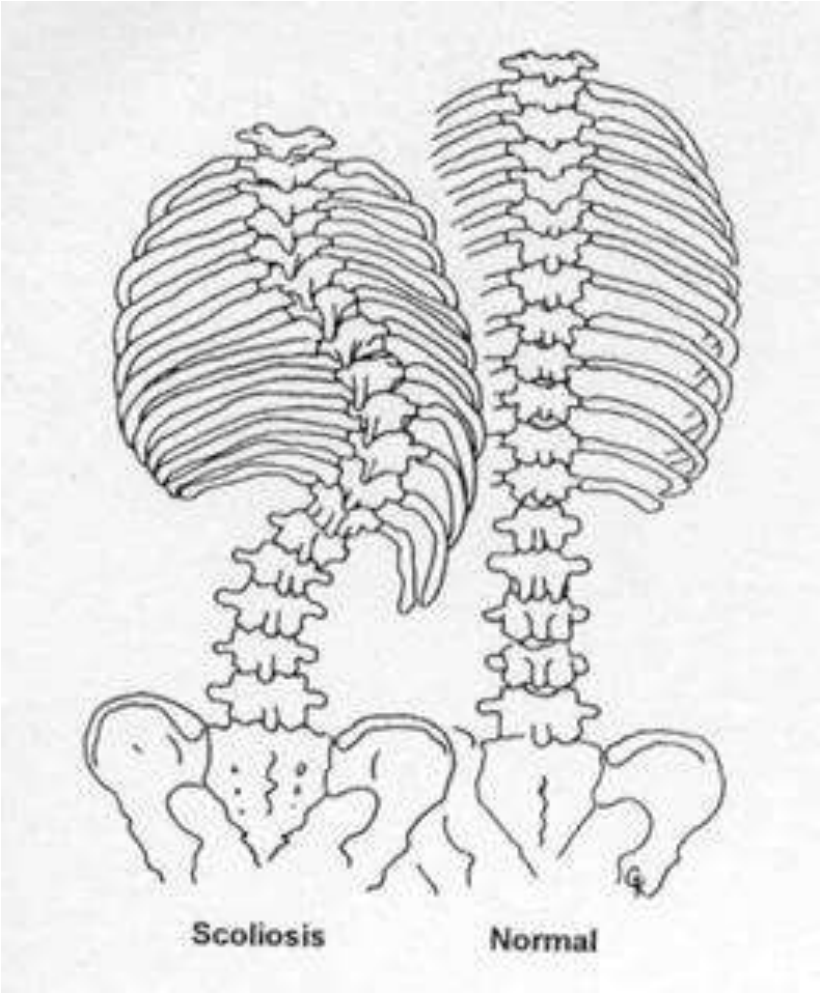
1. 7 % of congenital scoliosis pt have congenital heart problems(septal & valvular)

2. Aortic root involvement- connective tissue disorder



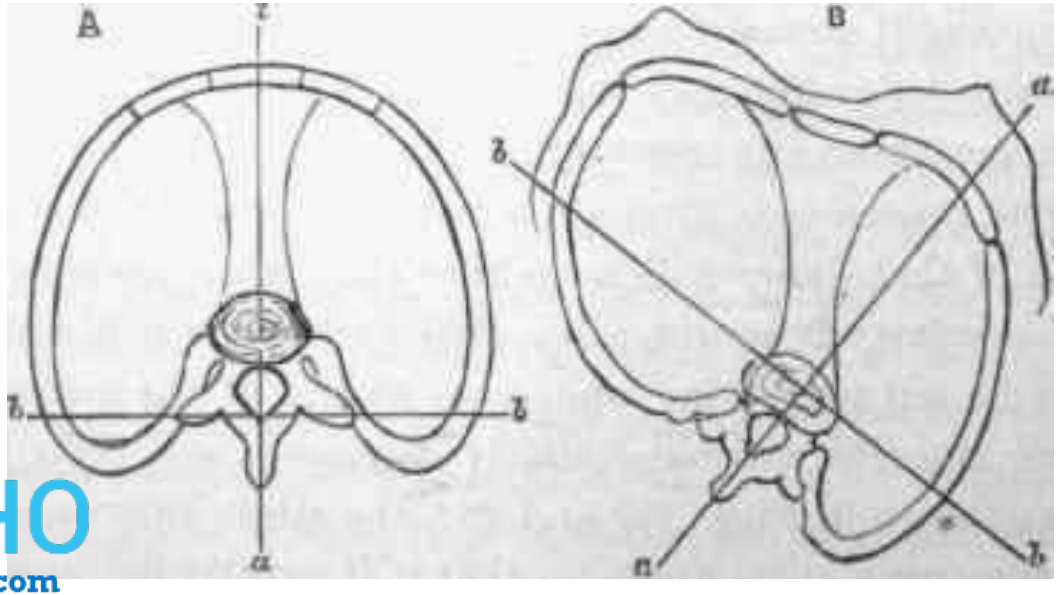
Systemic examination

- **Repiratory system**
- Lung growth completed by 8 yrs with golden period before 5 yrs
- Pulmonary function affected in patents with thoracic curves.
- Thoracic curves > 100°: decrease vital capacity (< 70% of predicted).
- Thoracic curves > 120°: respiratory failure & cor pulmonale



Systemic examination

- **Respiratory system**
  1. Rapid shallow breathing pattern.
  2. The oxygen cost(energy expenditure) of breathing increased three to five times.
  3. Surgery, pneumonia or sepsis may further increase the oxygen cost of breathing.



Systemic examination

Abdomen

- **Hepatosplenomegaly - storage disorders**
- Umblical **hernia**
- Inguinal hernis

Genitourinary system

- **6-12% incidence in congenital scoliosis**
- **Ectopic kidney** - care in anterior approach
- **Renal agenesis**
- PUJ obstruction with hydronephrosis

Spine examination & Curve assessment

- **Inspection**

1. Paraspinal muscle wasting /spasm
2. Plane and side of deformity
3. Shoulder level
4. Coronal & sagittal balance assessment

- **Palpation**

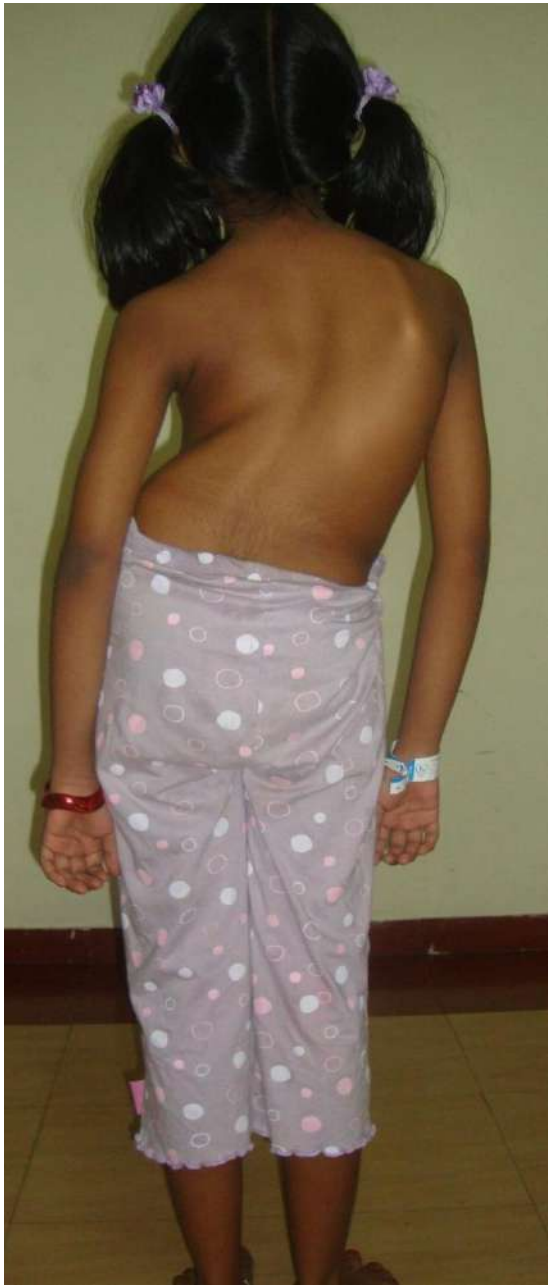
1. Spinal Tenderness
2. ASIS level
3. Limb length discrepency

- **Curve assessment**

1. Adams forward bending test
2. Flexibility of curve

Clinical examination

- Examination to be done after adequate exposure



Paraspinal muscle

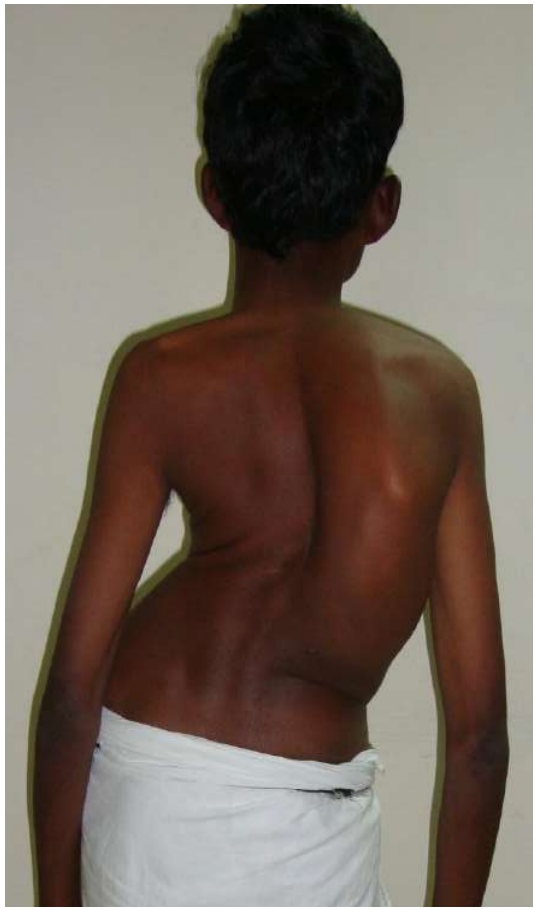
- **Paraspinal muscle spasm**

1. Nerve root irritation – disc prolapse – functional scoliosis
2. Infection
3. Deep median furrow visible

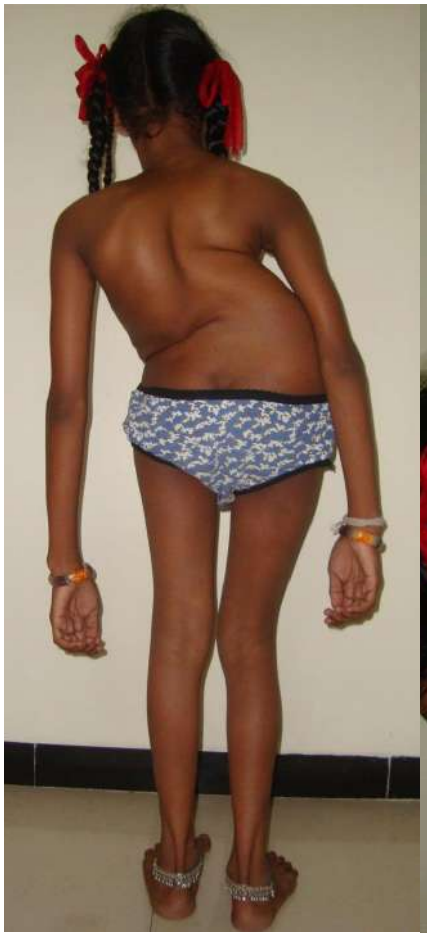
- **Paraspinal muscle atrophy**

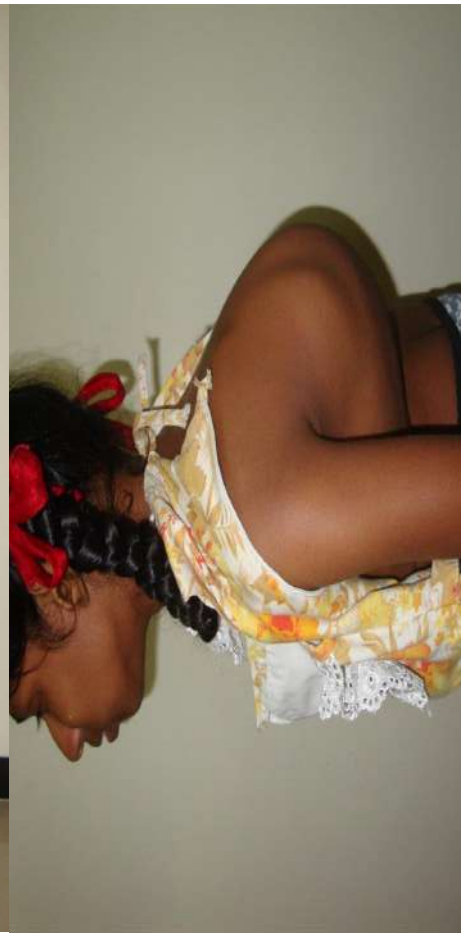
1. Neuromuscular scoliosis

Inspection
Plane of deformity



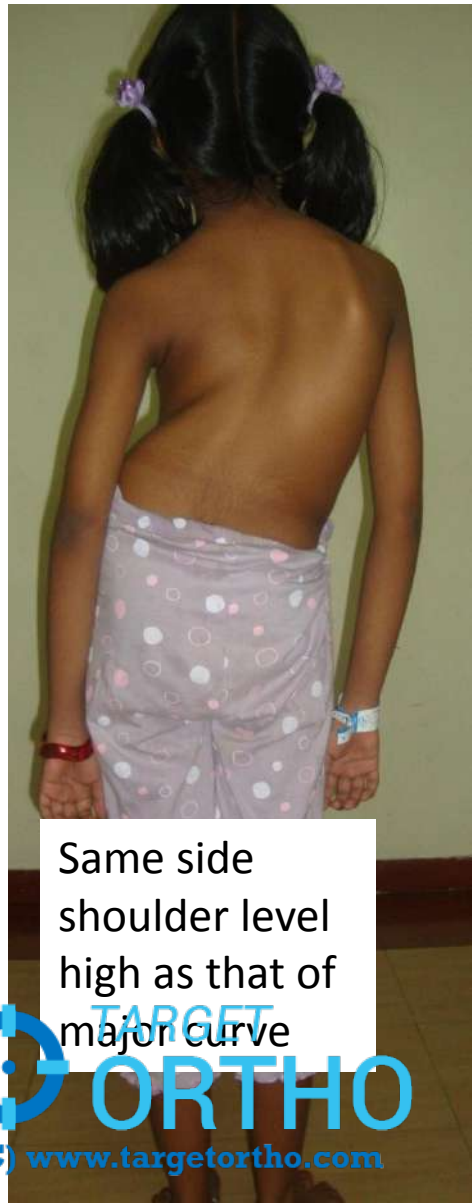
Scoliosis





Kypho Scoliosis

Inspection
Shoulder level

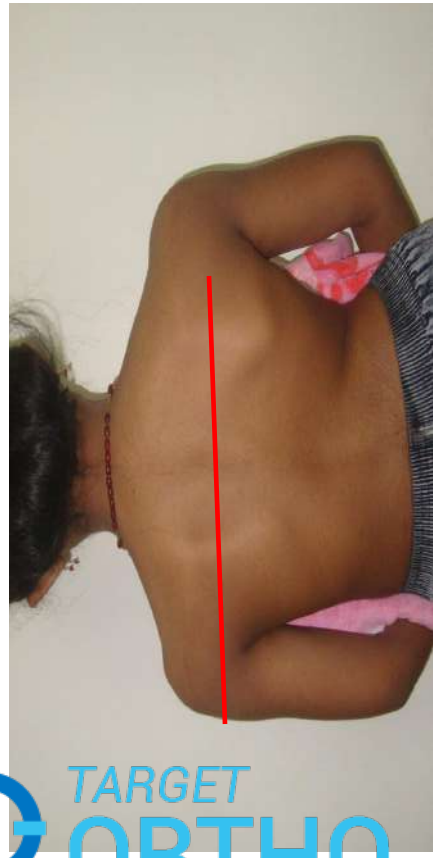


Same side shoulder level high as that of major curve

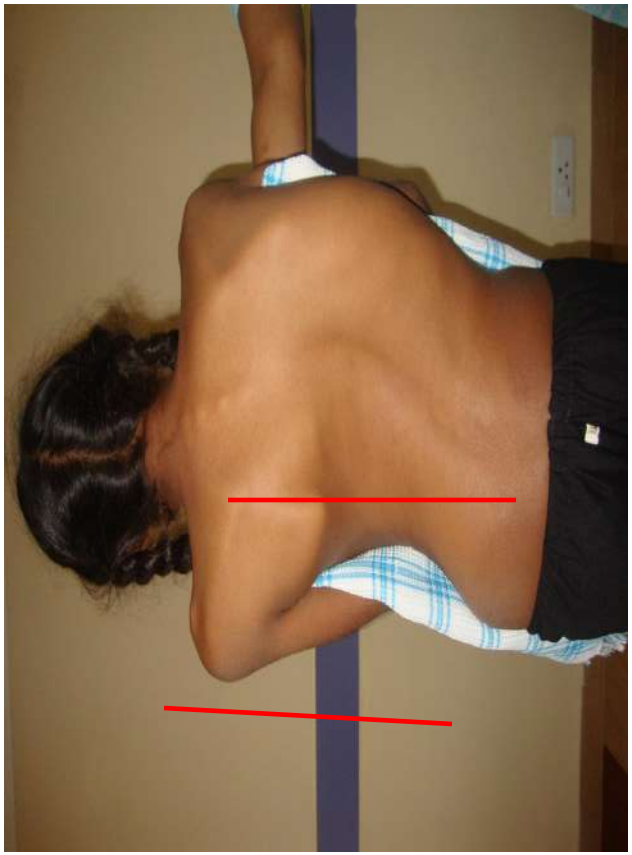
Opposite side shoulder level high –proximal structural curve

Coronal balance

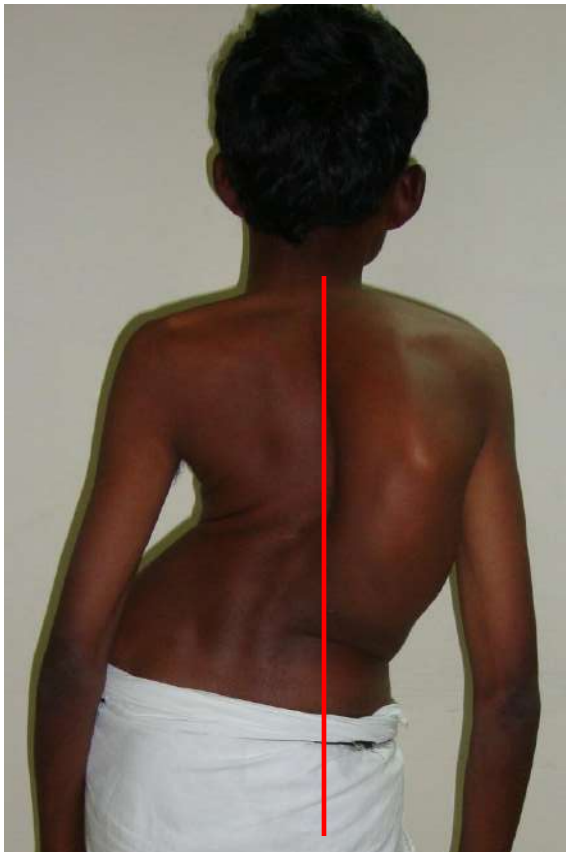
- Head should be centered over the pelvis
- Plumb line from C7 spinous process should fall between the gluteal cleft



Balanced spine

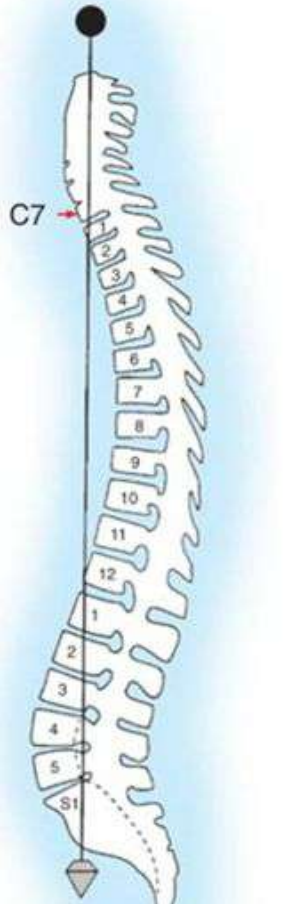


Trunkal shift

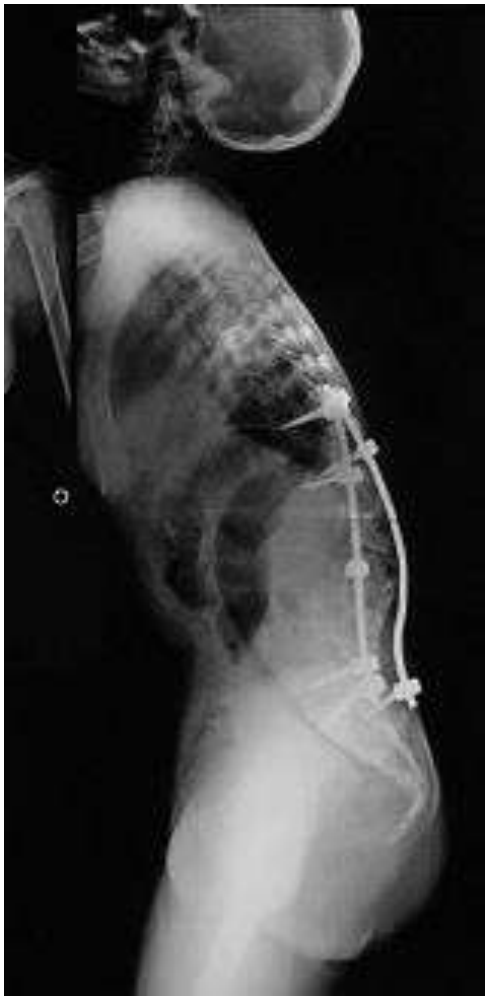


Rt side coronal imbalance

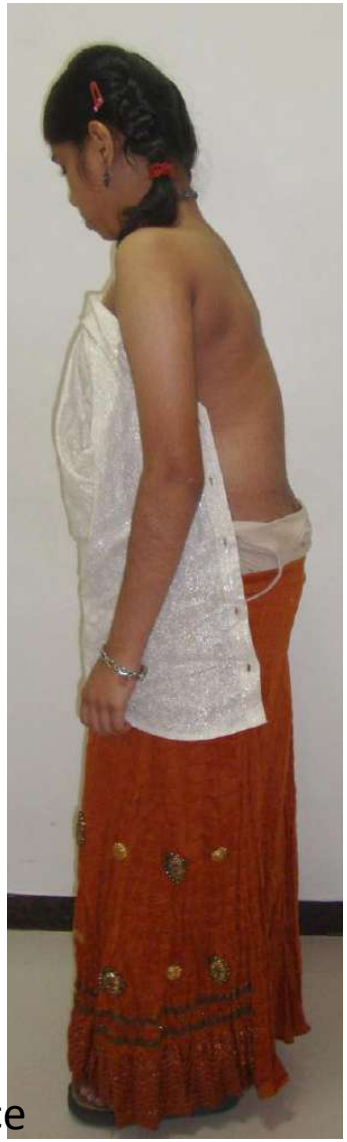
Sagittal balance



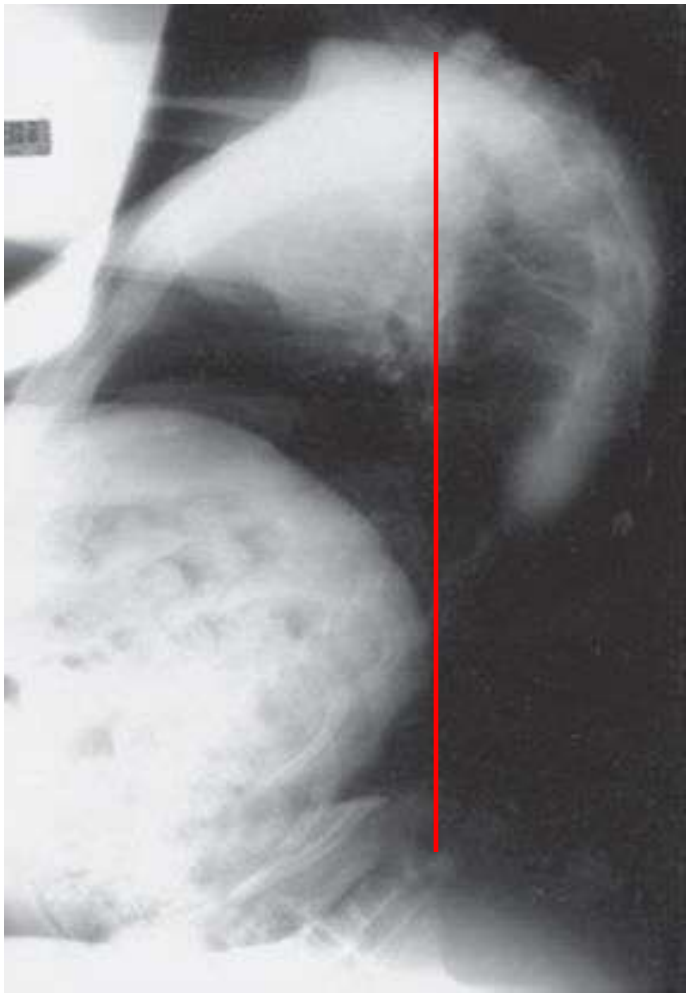
Plumb line from C7 passes through posterosuperior corner of S1



Positive sagittal imbalance



Sagittal balance



Negative sagittal imbalance

Palpation

- **Spinal tenderness**

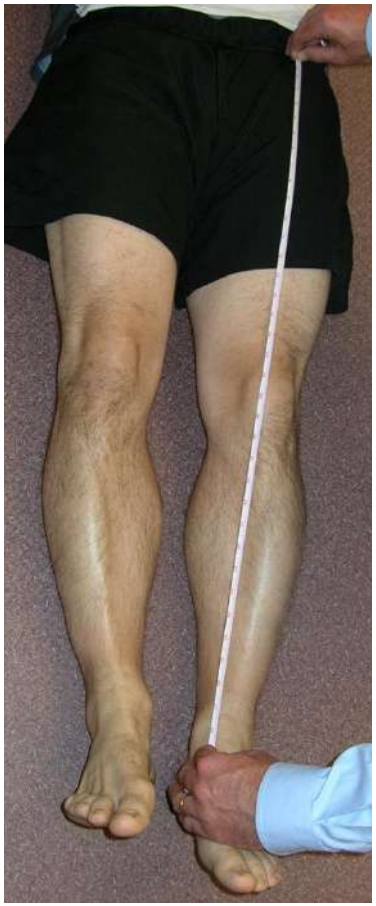
1. Red flag sign

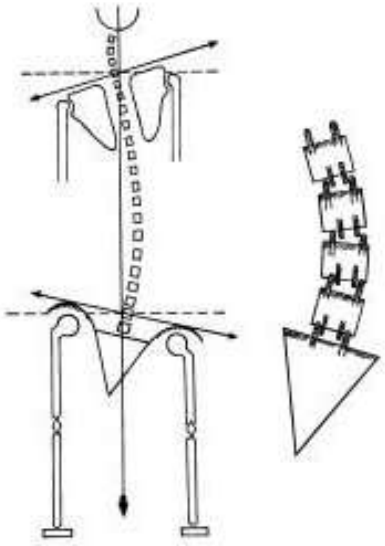
2. Suspect infection / disc pathology

Palpation
Anterior superior iliac spine level

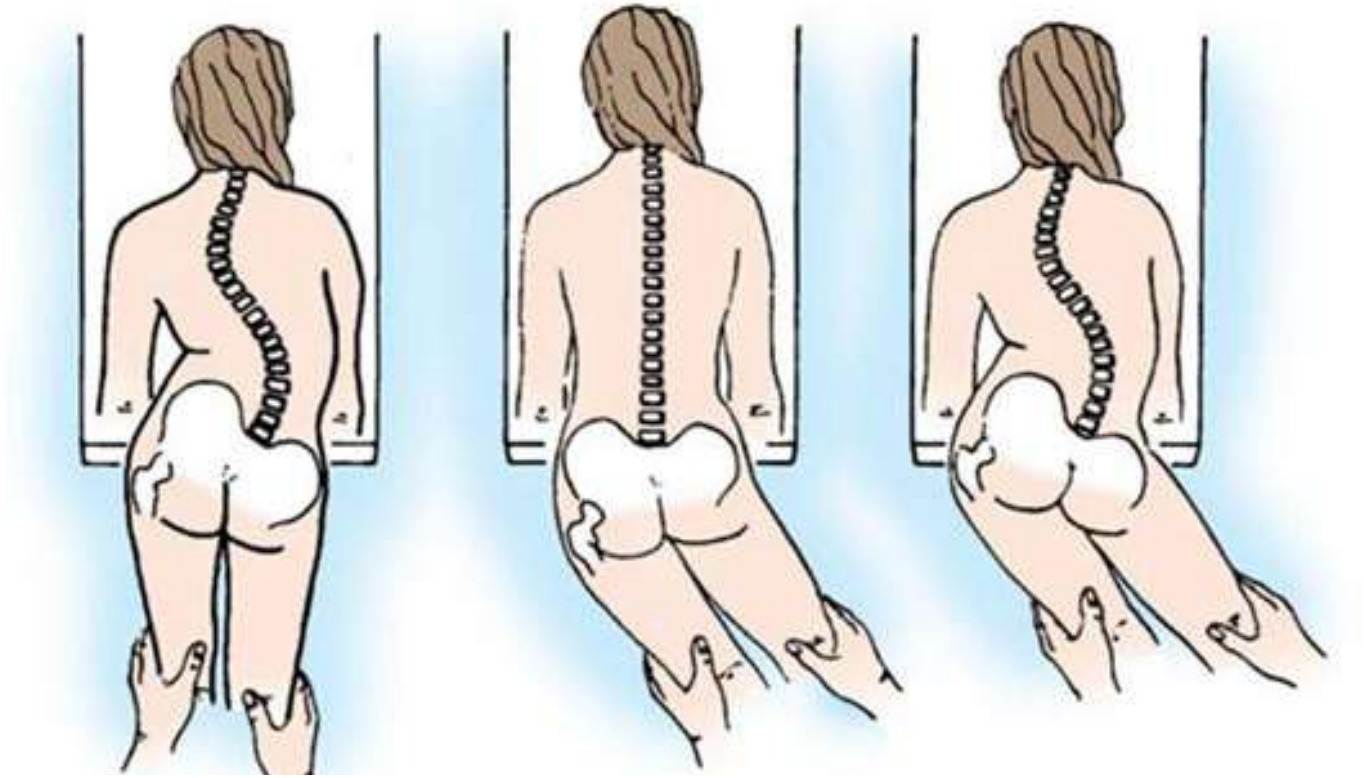
- Asymmetry of ASIS –leg length discrepancy or fixed pelvic obliquity

- LLD - compensatory scoliosis – corrects when the leg lengths are evened out





Palpation
ASIS & fixed pelvic obliquity



Neuromuscular scoliosis

1.Pelvic obliquity correcting by manuvre –**pelvic femoral muscle contracture .**

2.Not correcting with manuvre-**fixed pelvic obliquity** .

3.Severe pelvic obliquity needs anterior & posterior arthrodeses.

Range of movements

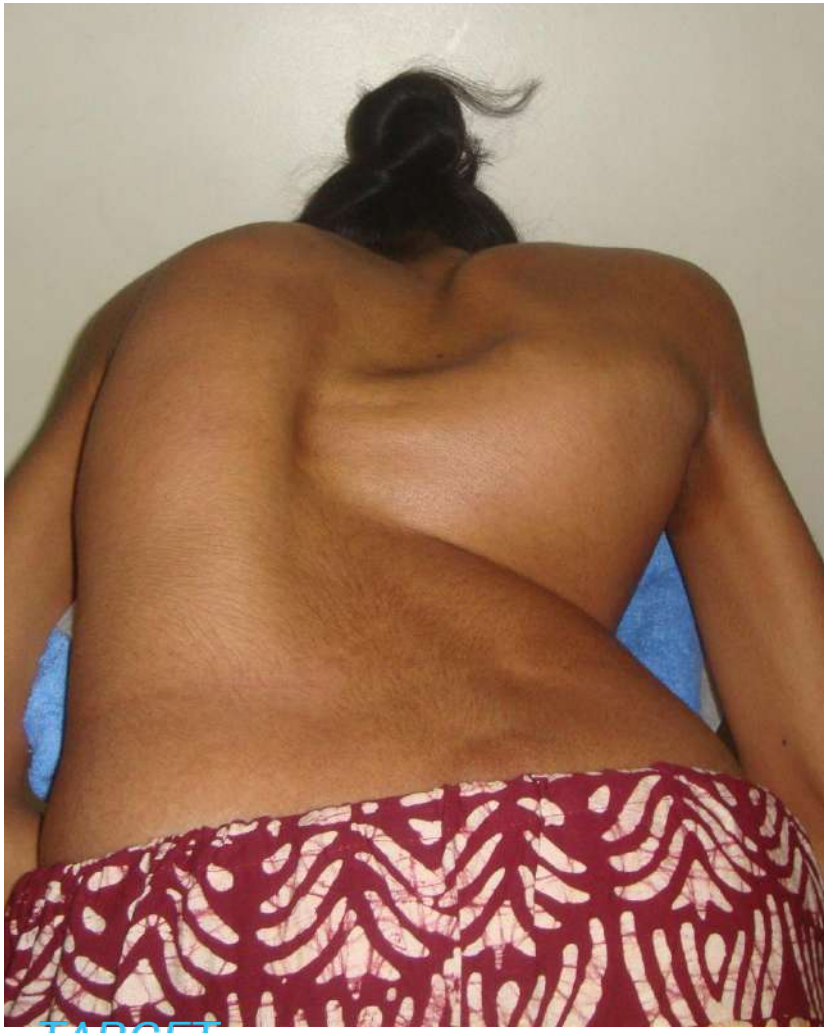
- **Ascess**

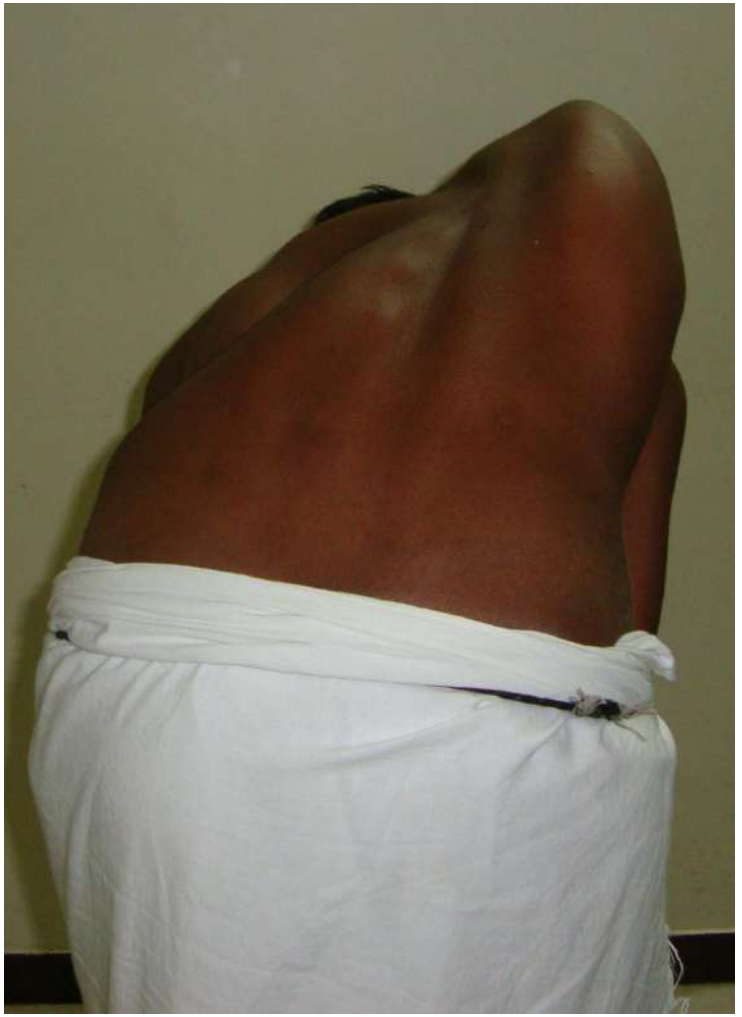
1. Flexion (adams forward bending test)
2. Extension
3. Side bending (flexibility of curve)

- **Restricted movements**

1. Lumbar muscle spasm
2. Tightness of the hamstrings
3. Rigid structural curve
4. Organic causes-infection,disc pathology

Assessment of the curve
Adams forward bending test





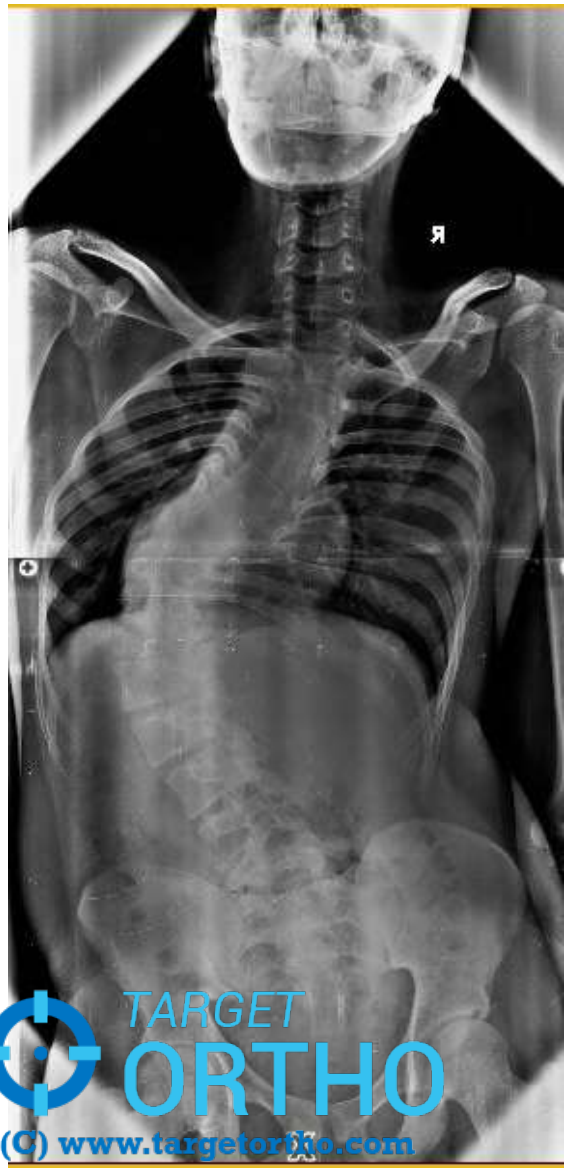
Rib hump becomes prominent on bending because of increased vertebral rotation

Use of the scoliometer

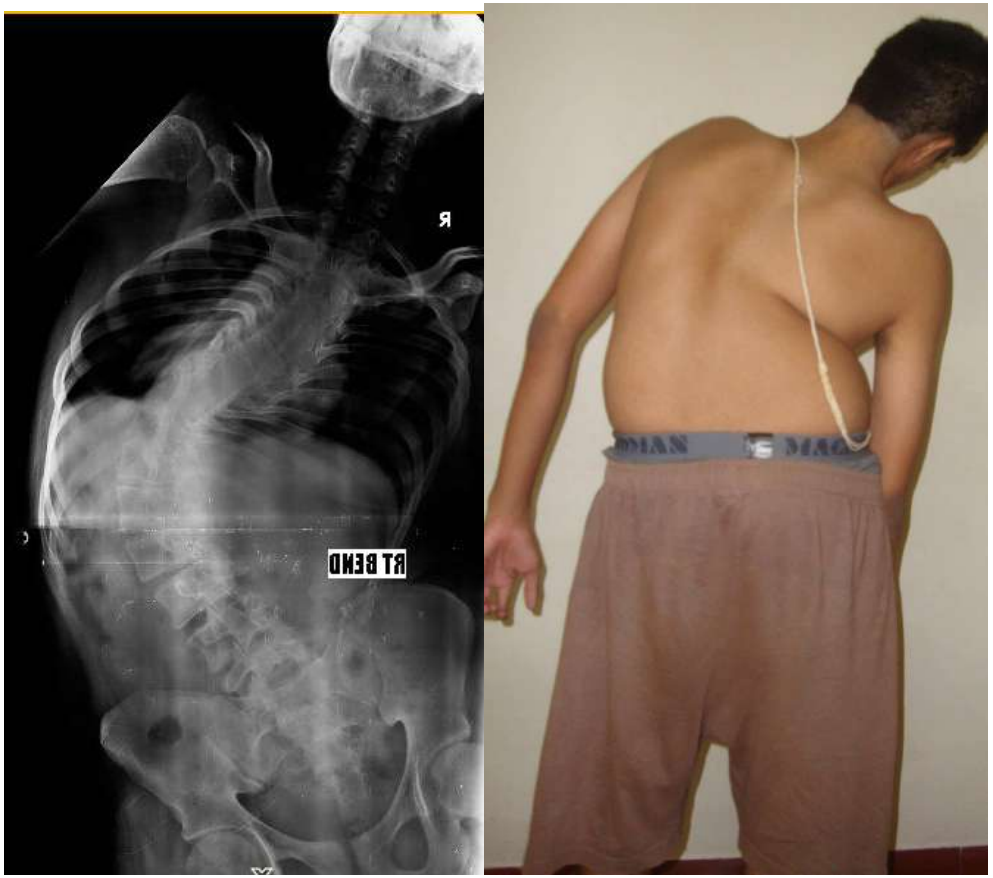
The scoliometer is run along the patient's spine from caudad to cephalad while the patient is in the position assumed for the Adams forward bend test. In the above photograph, the right thoracic prominence causes the right side of the scoliometer to deviate upward and the ball to deviate to the left.

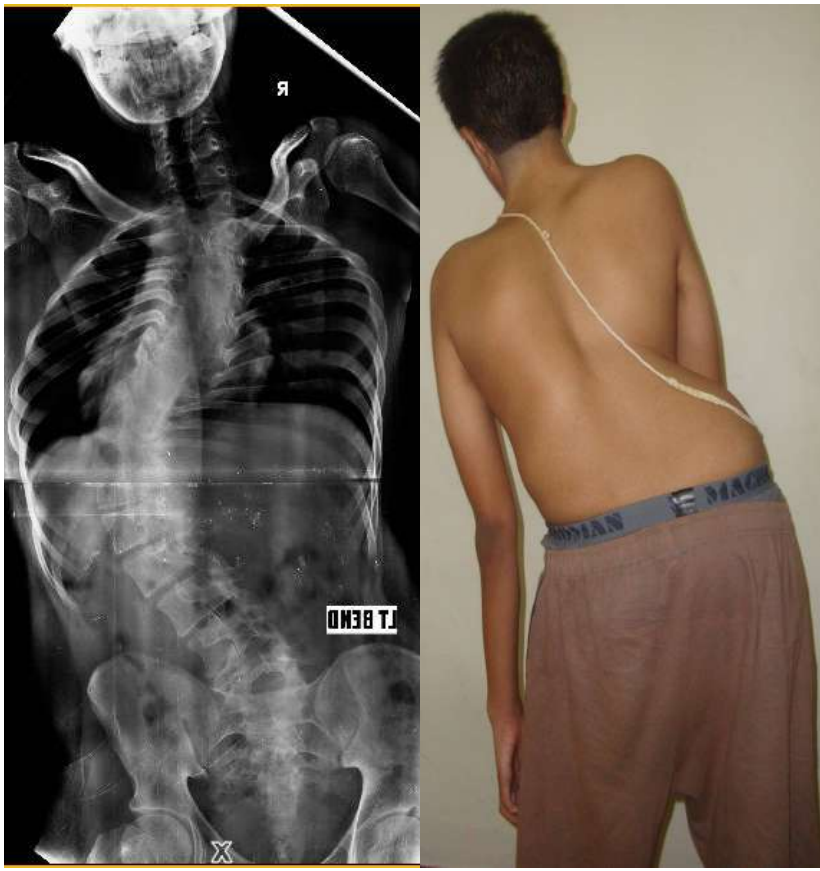
Trunk rotation of 7 deg = cobbs angle of 20 deg.

Assessment of flexibility of curve by side bending

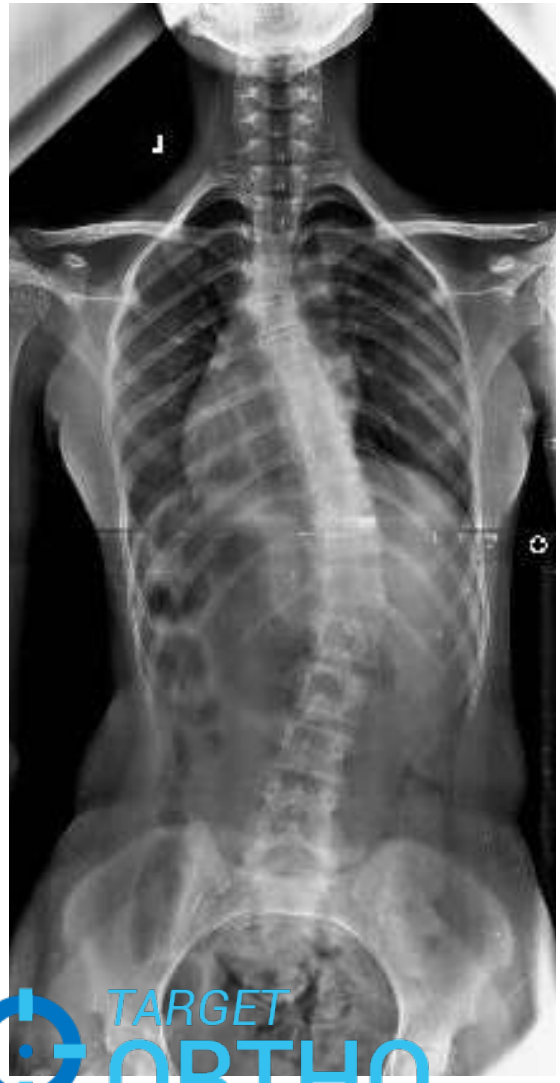


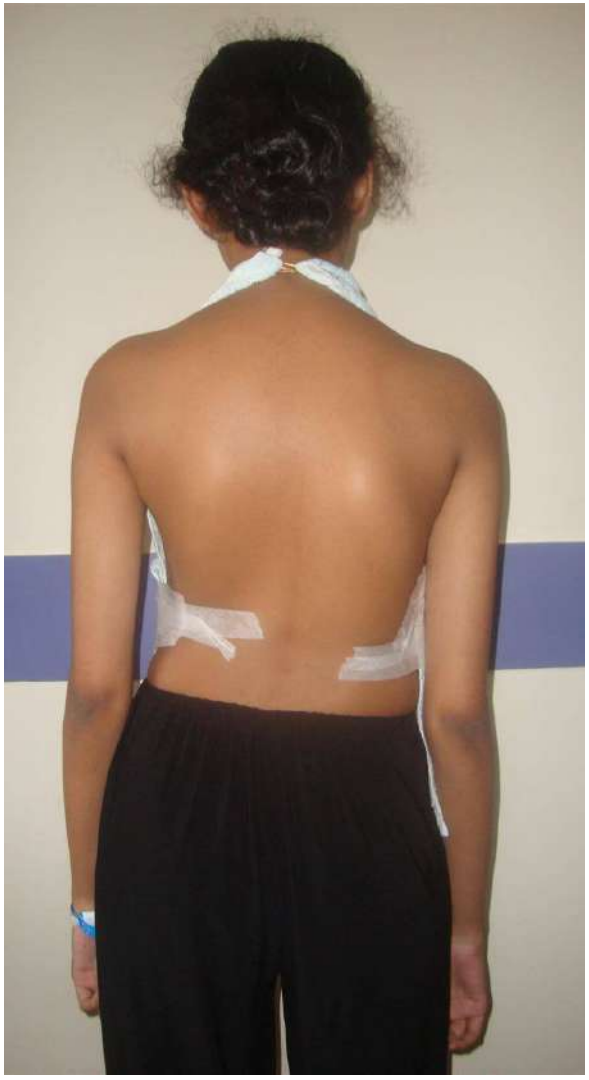
Rigid curve



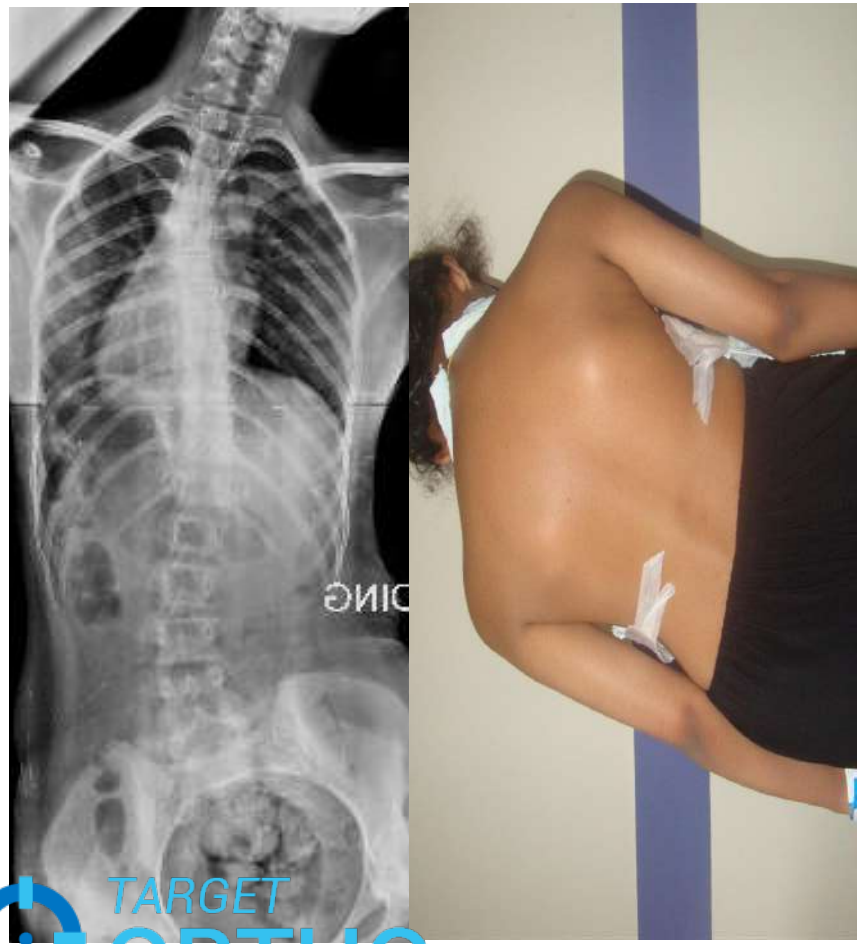


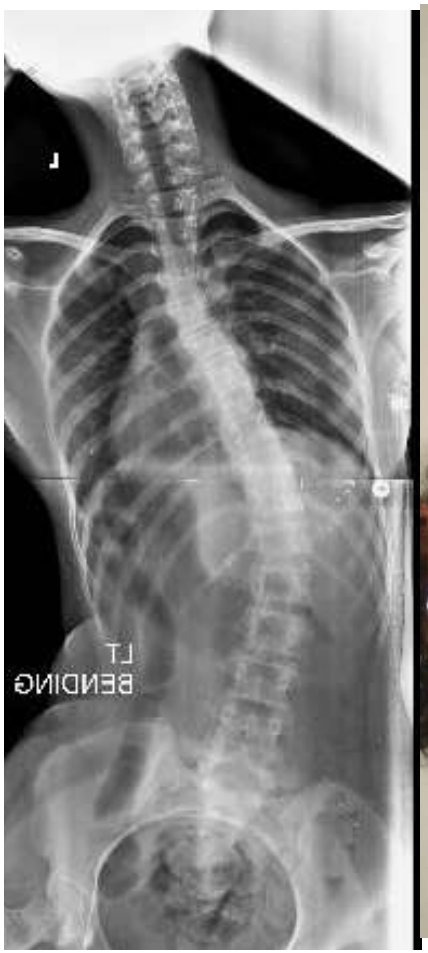
Assessment of flexibility of curve by side bending

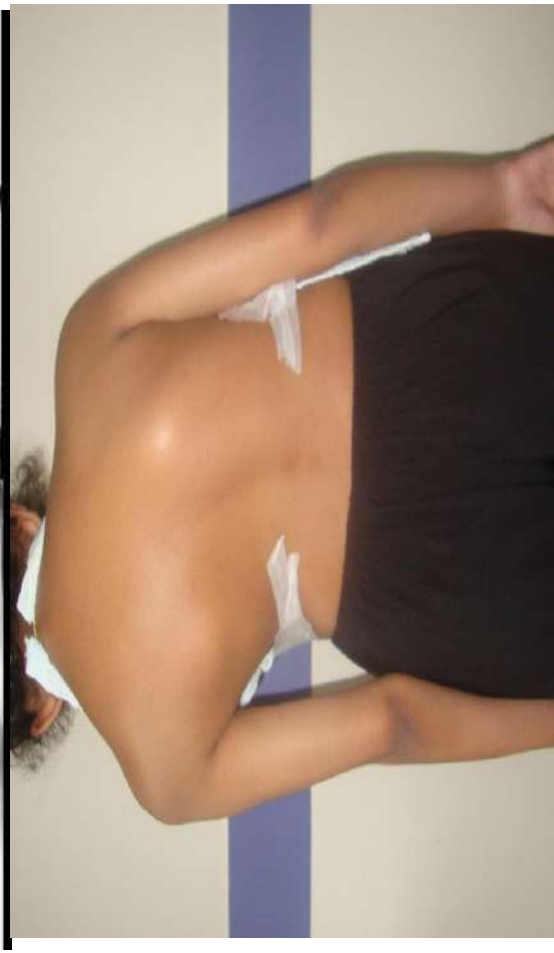




Flexible curve







Neurological assessment

- Higher mental functions
- Cranial nerve examination
- Gait
- Motor function
- Sensory function
- Reflexes

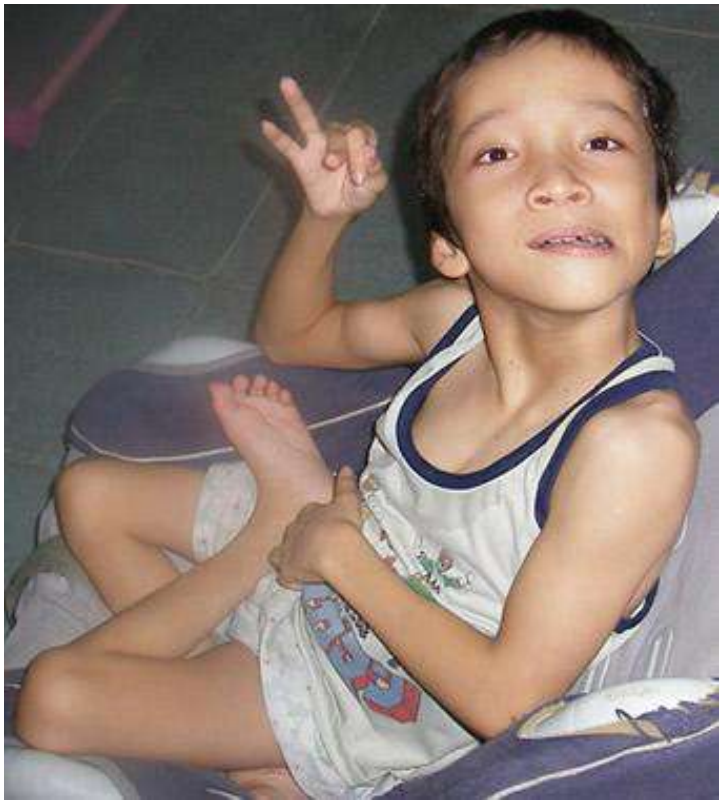
Higher mental function

- **Look for**

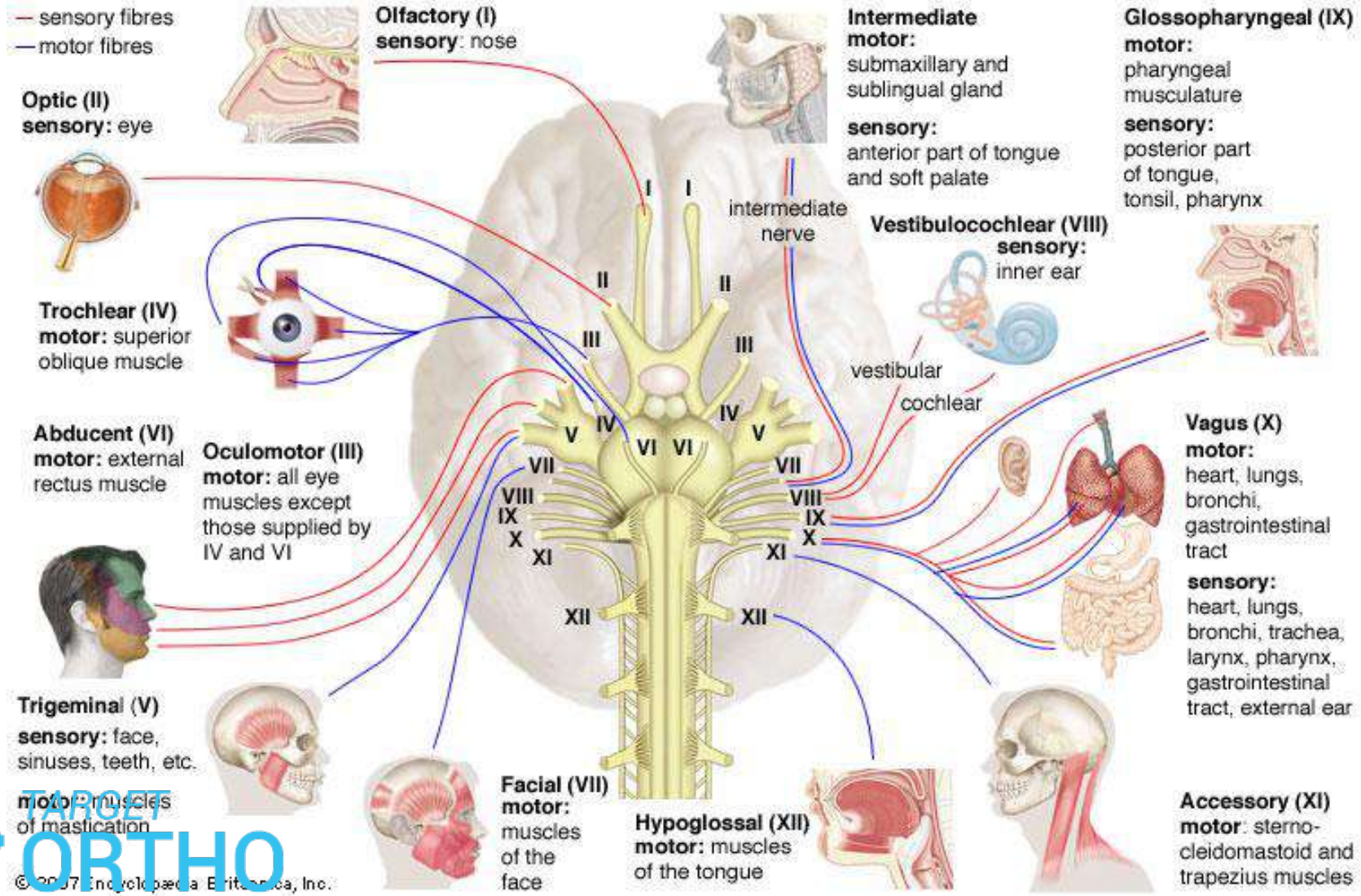
1. Consciousness
2. Alertness
3. Orientation
4. Speech

- **Altered in**

1. CP
2. Mucopolysaccharidosis
3. Syndromic children

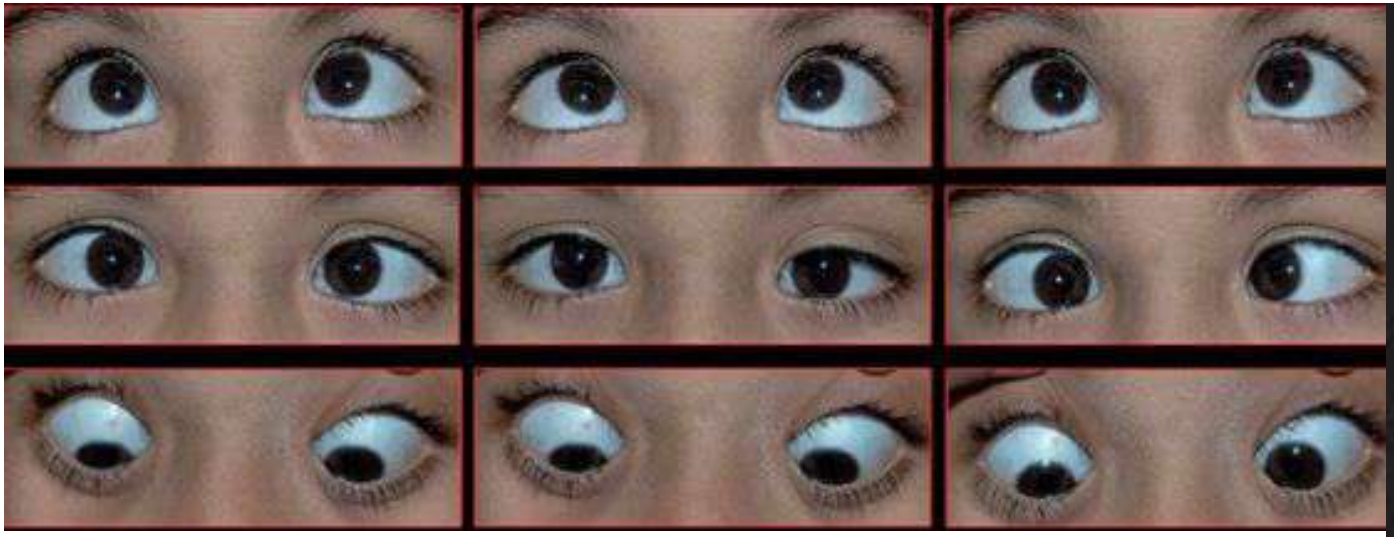


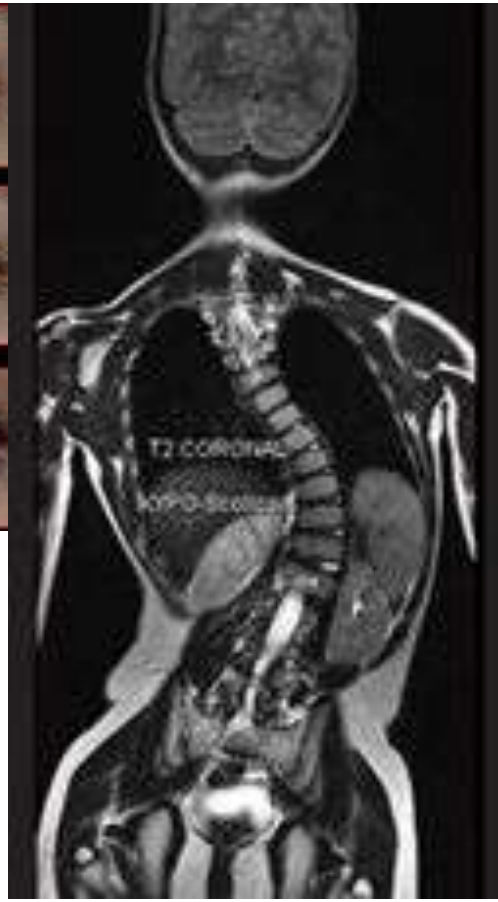
Cranial nerve examination



Cranial nerve examination

Horizontal gaze palsy with progressive scoliosis





1.HGPPS -absence of conjugate horizontal eye movements

2.Progressive scoliosis developing in childhood and adolescence

3.Mutations in the ROBO3 gene which are critical for the crossing of long ascending medial lemniscal and descending corticospinal tracts in the medulla

Gait

- **Watch for**

1. Balance while walking- shoulder level & waist line
2. Need for support while walking
3. Myelopathic gait – due to cord compression /streching in scoliotic curve
4. Spastic gait – CP /UMN causes of Neuromuscular scoliosis
5. Inability to walk- neuromuscular causes.

Motor functions

- The following motor function should be assessed in both upper & lower limbs

1. Bulk
2. Tone
3. Power

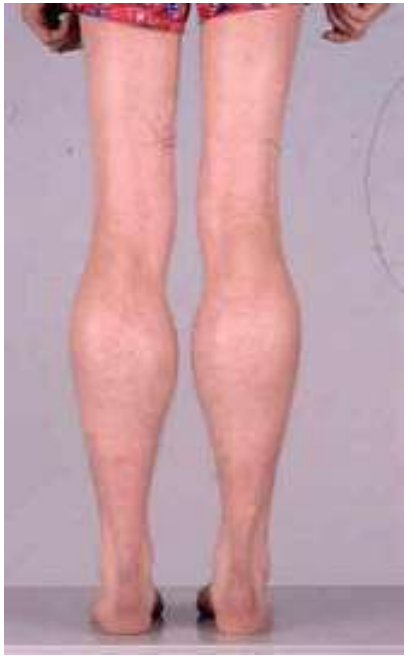
Motor function
Bulk

Atrophy

- Asymmetrical Calf muscle wasting – tethered cord
- Poliomyelitis
- Spinal muscular dystrophy

Hypertrophy

- Duchenne muscular dystrophy



Motor function
Tone

Hypotonia

- Poliomyelitis
- Spinal muscular atrophy
- Myelomeningocele

Hypertonia

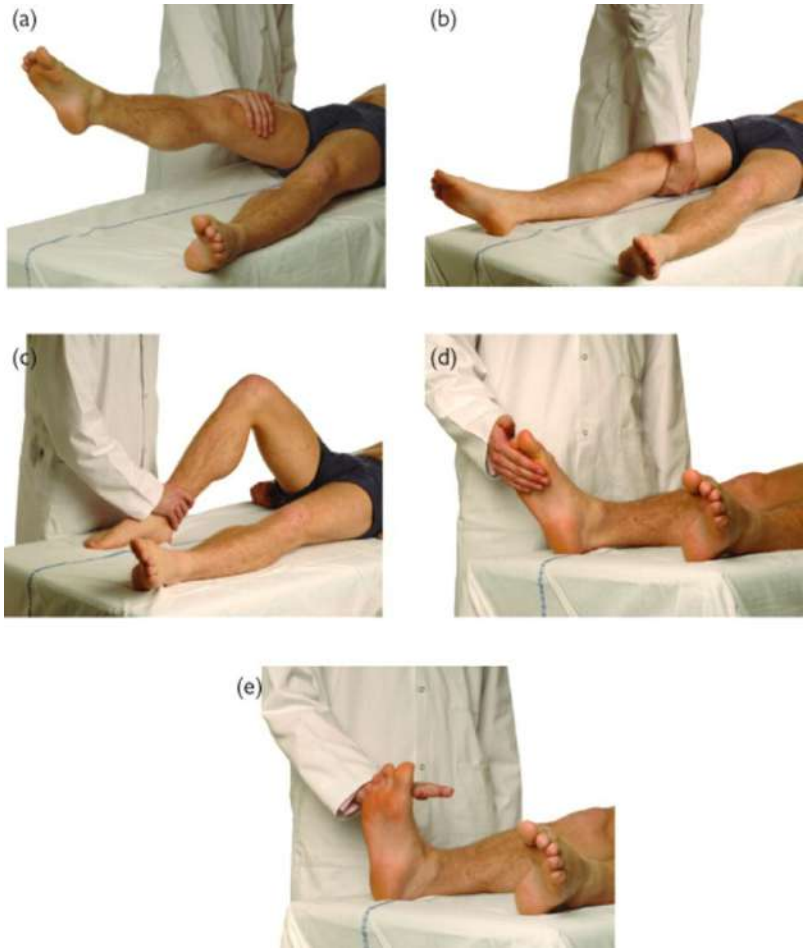
- Cerebral palsy
- Friedreich ataxia
- Charcot-Marie Tooth disease
- Mucopolysaccharidosis with craniovertebral jn stenosis.

Motor function
Power

- Normal power in idiopathic scoliosis

- Decreased power

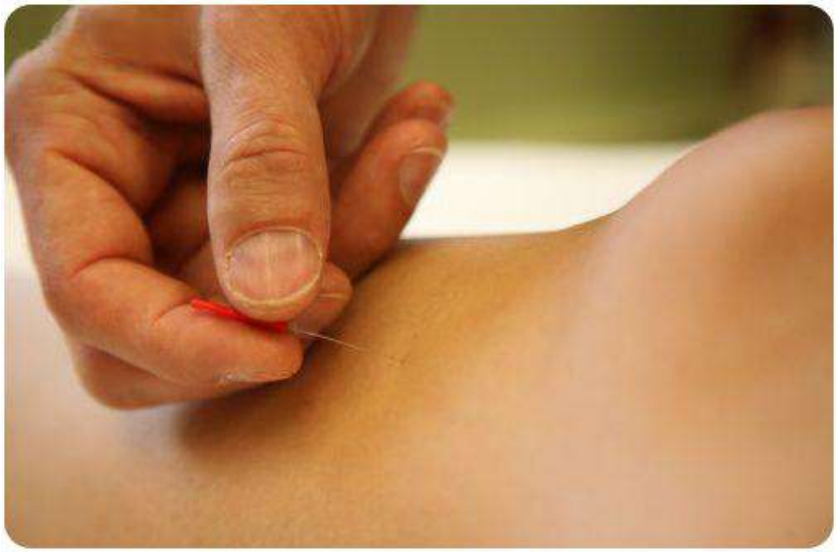
1. Neuromuscular scoliosis
2. Spinal cord anomalies



Sensory examination

- **Test for**

1. Light touch
2. Deep touch
3. Temperature
4. Pain



- **In syringomyelia** – pain & temperature sensation are lost ;crude touch & position sense preserved.

Superficial Reflexes

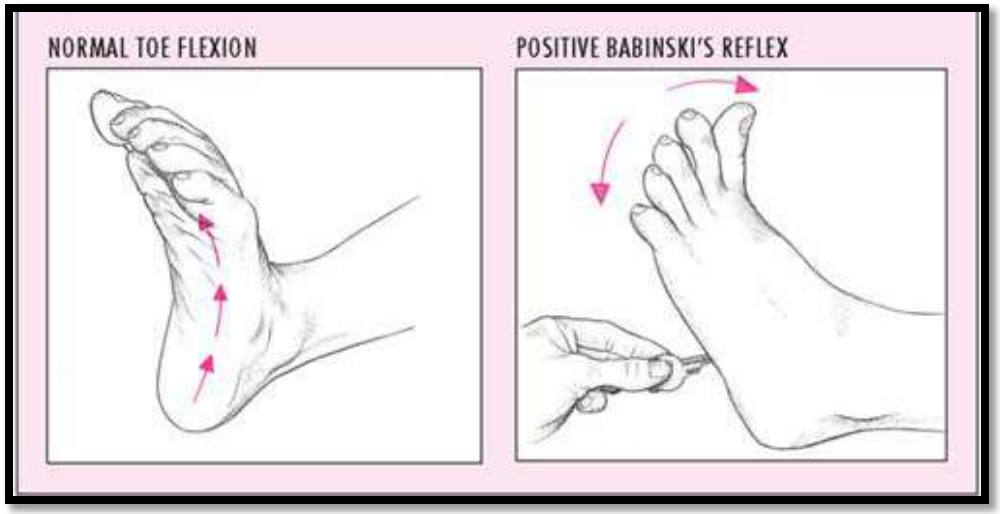
Abdominal reflex

- Mediated by T7-T12
- Asymmetrical abdominal reflex –UMN lesion above spinal level

1. Syrinx
2. Diastometomyelia
3. Spinal cord tumour

Plantar reflex

- Extensor plantar response in UMN lesion



Deep tendon reflexes

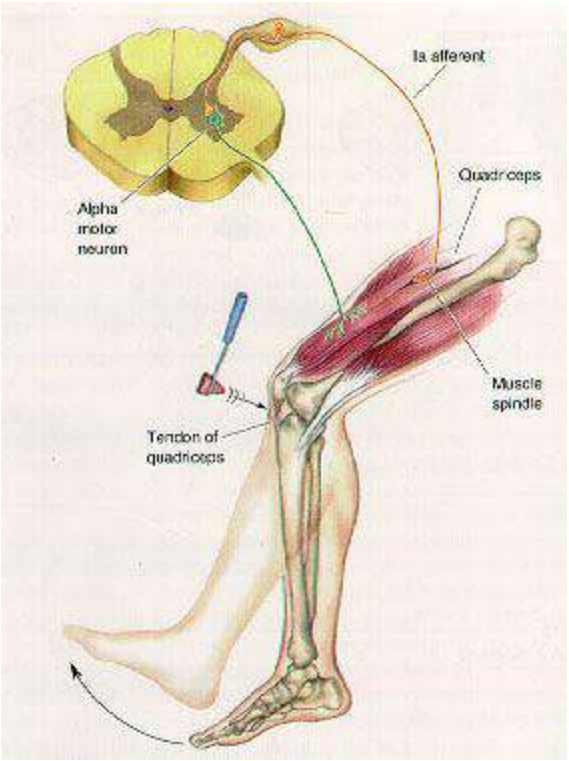
- **Upper limb**

1. Biceps
2. Supinator
3. Triceps

- **Lower limb**

1. Knee jerk
2. Ankle jerk

Exaggerated DTR *should alert about* ***UMN lesion***



Radiology in scoliosis

- X-ray
- Computed tomography (CT Scan)
- Magnetic resonance imaging (MRI)

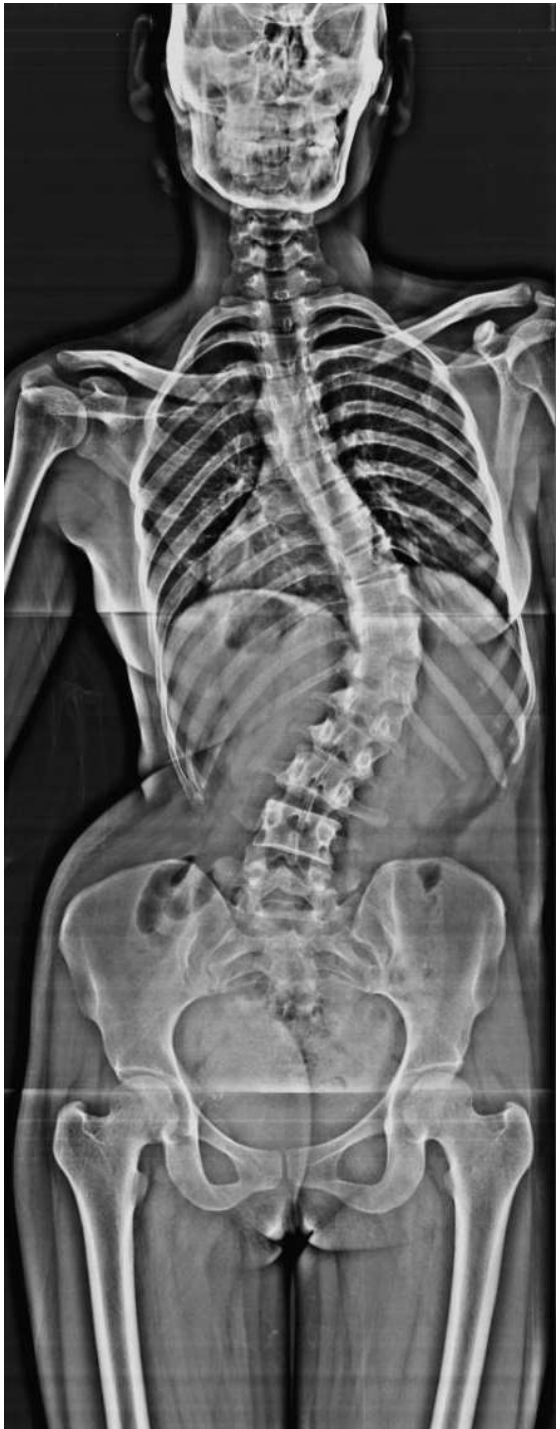
Whole spine X-ray

- Standing AP view
- Standing Lat view
- Stress views- bending view (supine)
  - traction view
  - fulcrum bending view

Standing AP view

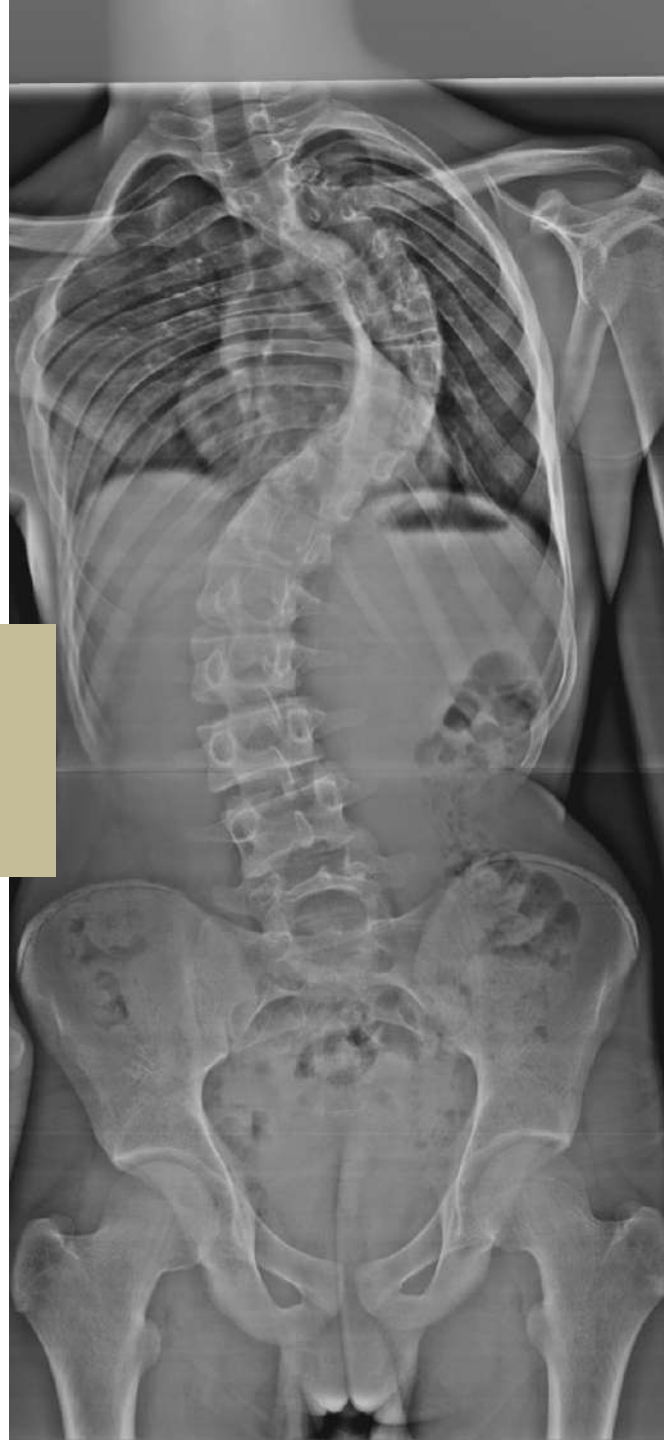
- Apex
- End vertebrae
- Neutral vertebrae
- Stable vertebrae
- Curve magnitude
- Coronal balance

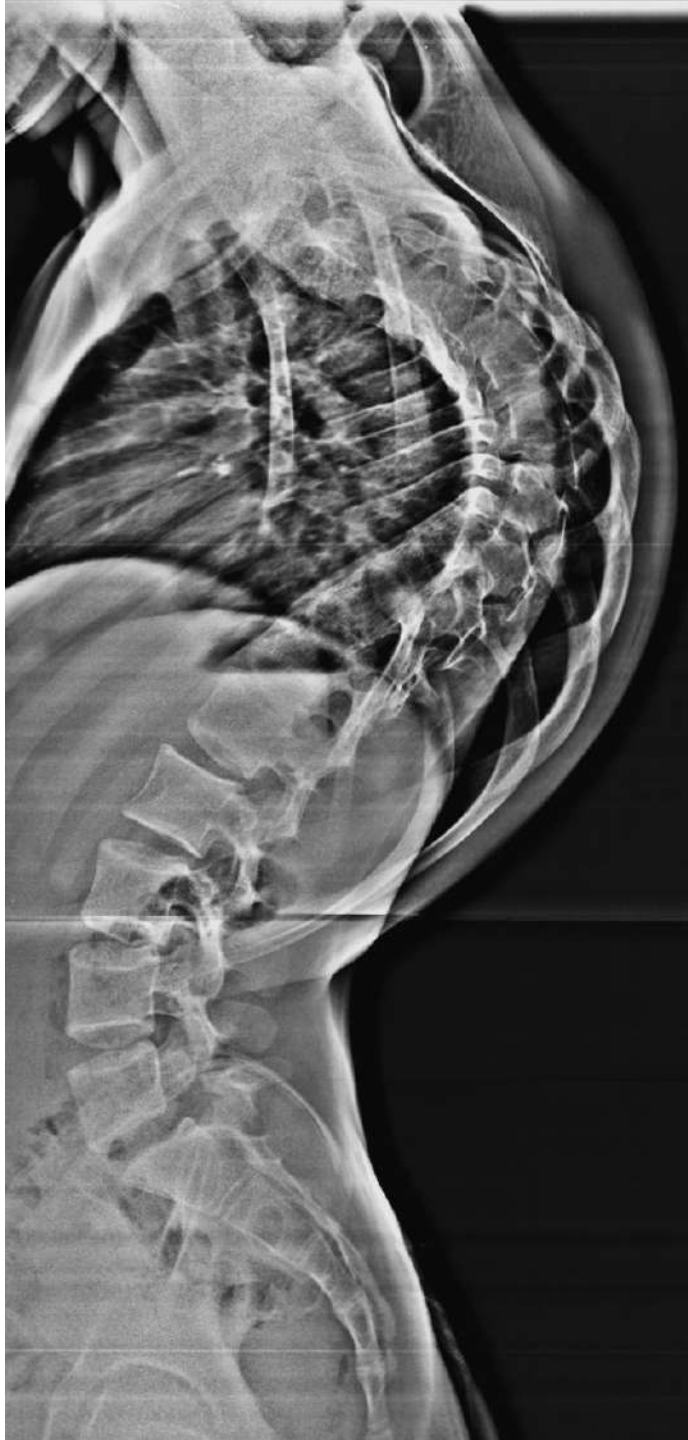
Whole spine xray

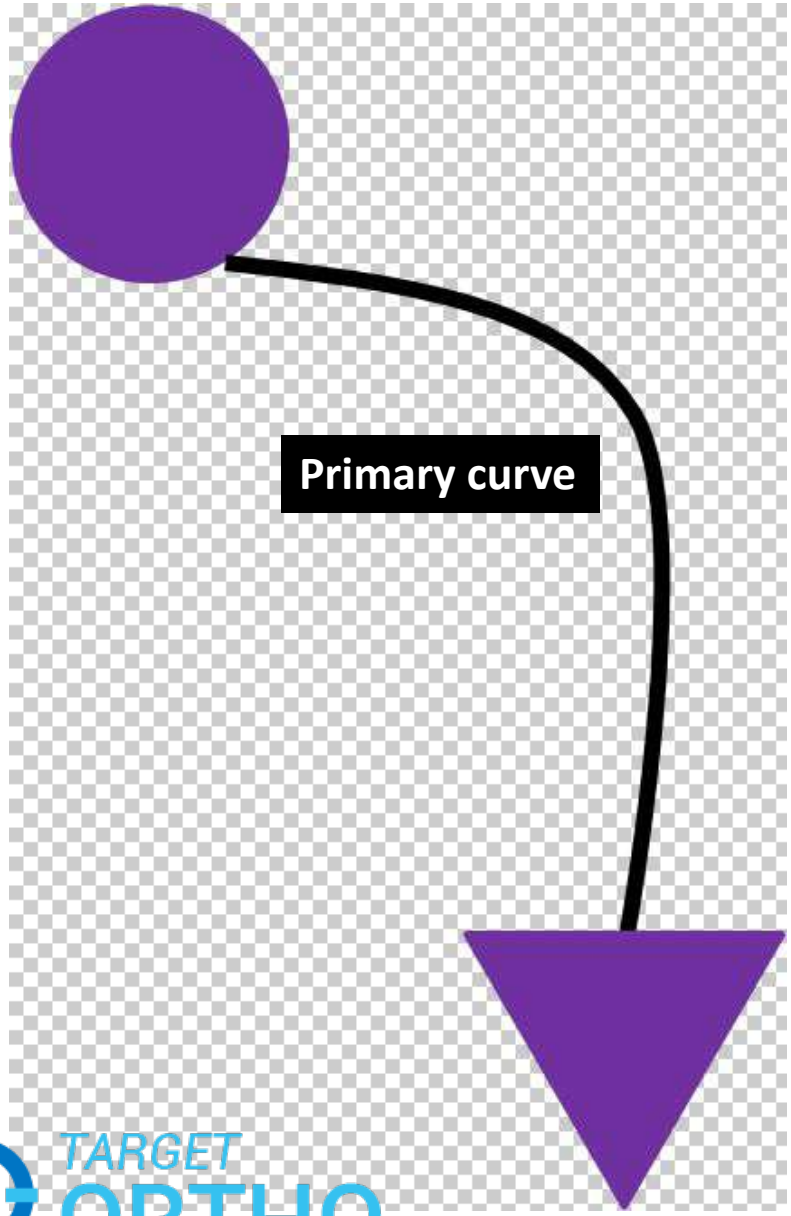


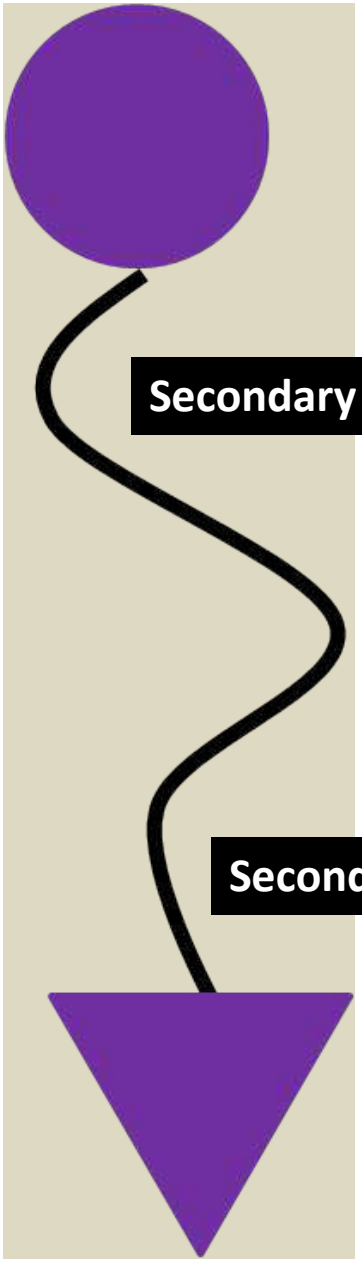
Why standing x ray

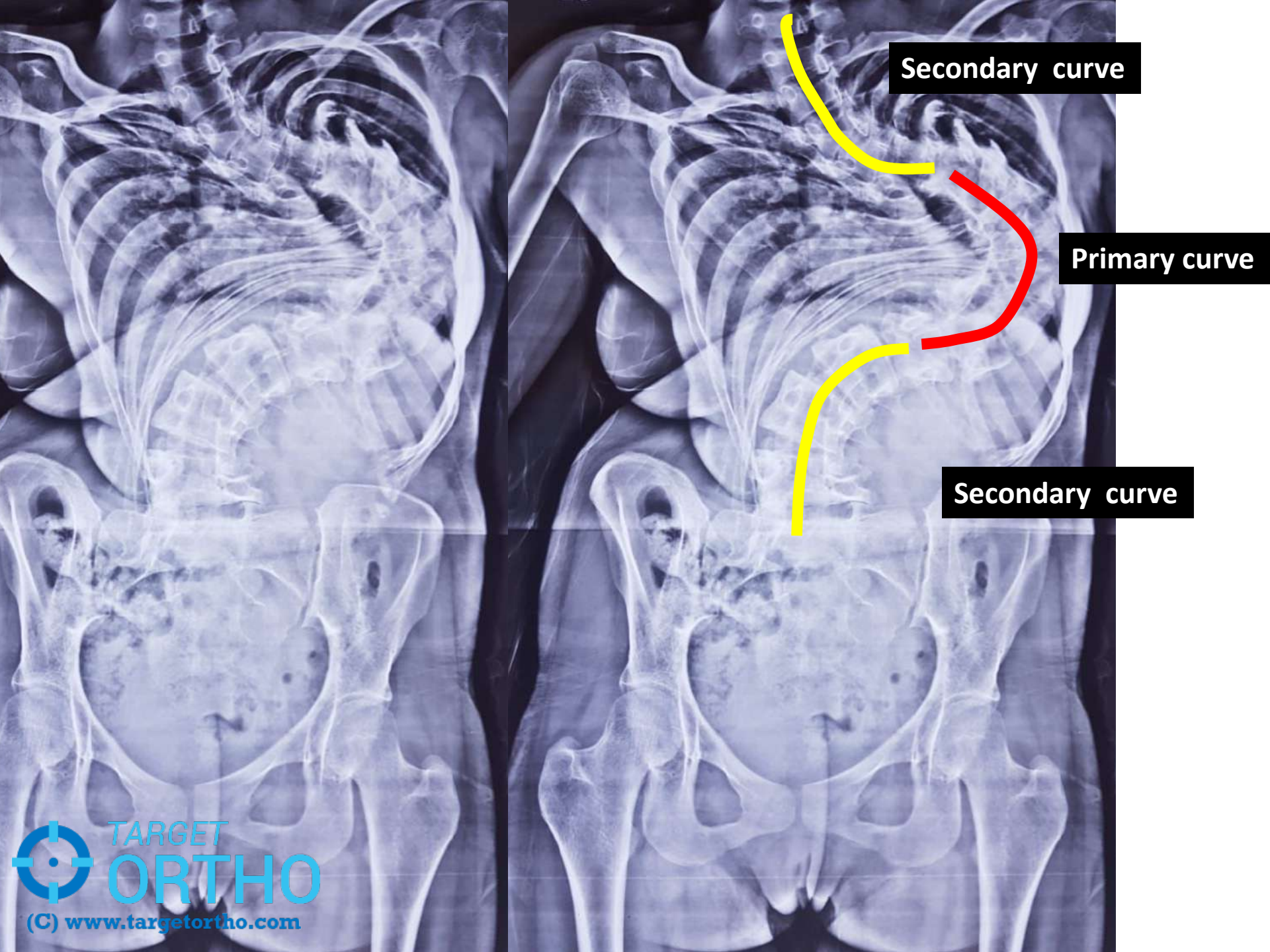
- Plane of deformity
- Side of deformity
- Severity of deformity
- Primary & secondary curve

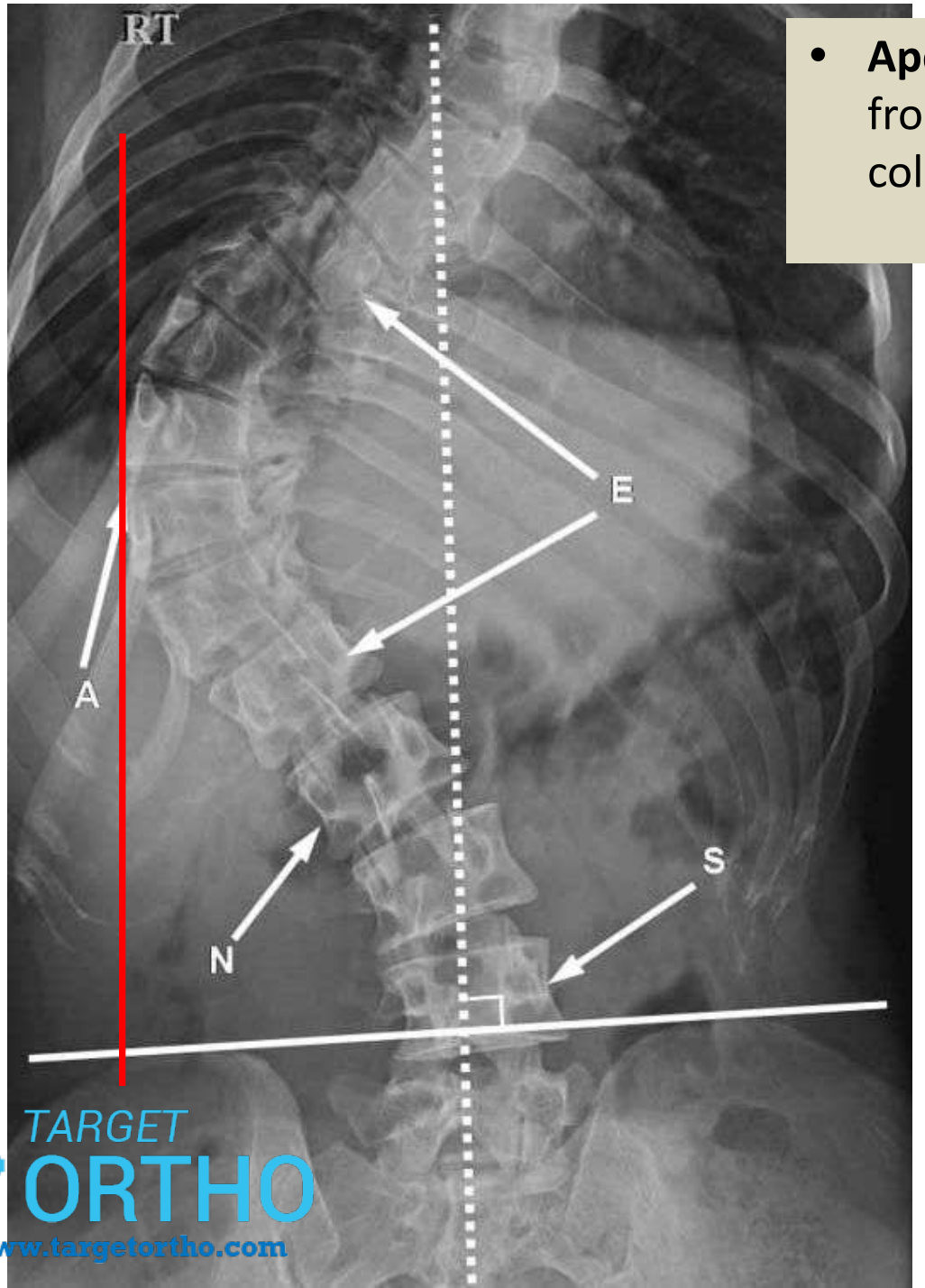




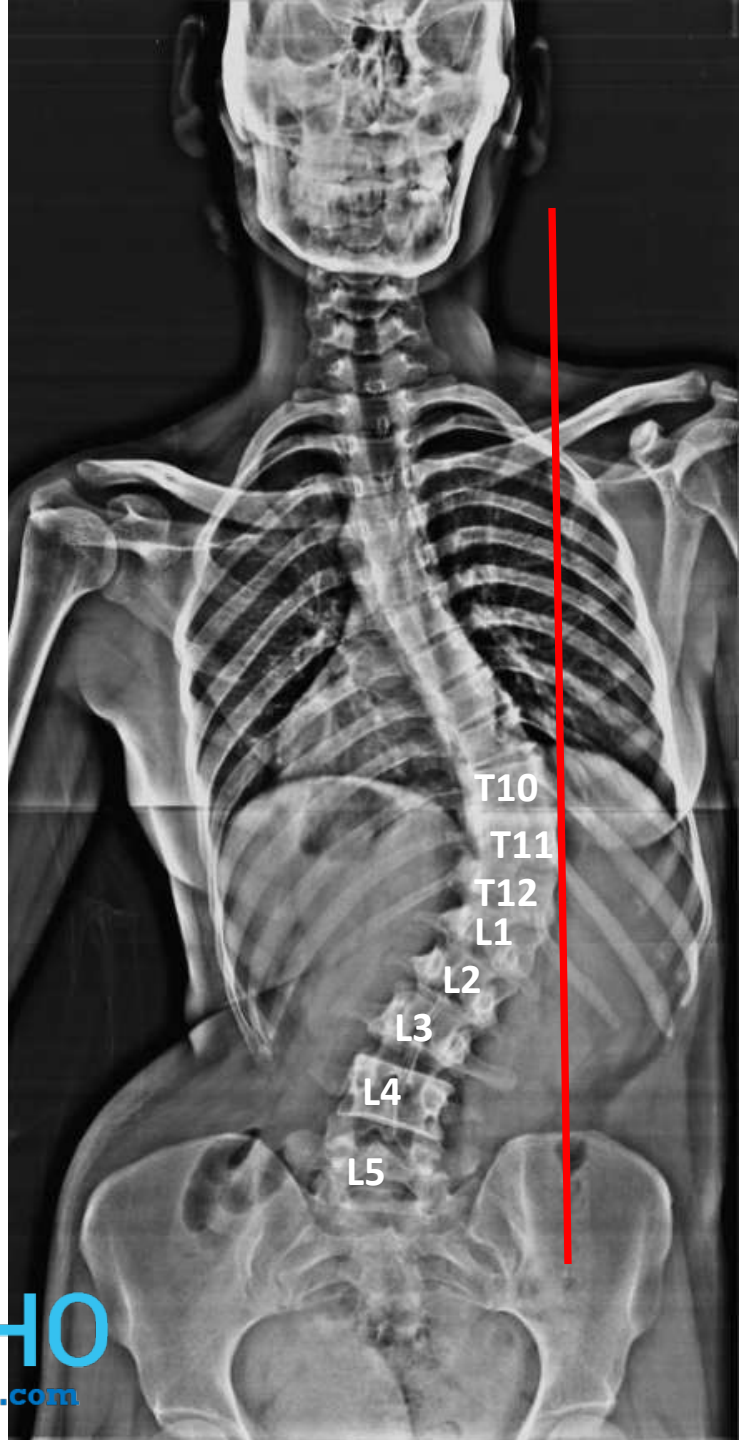


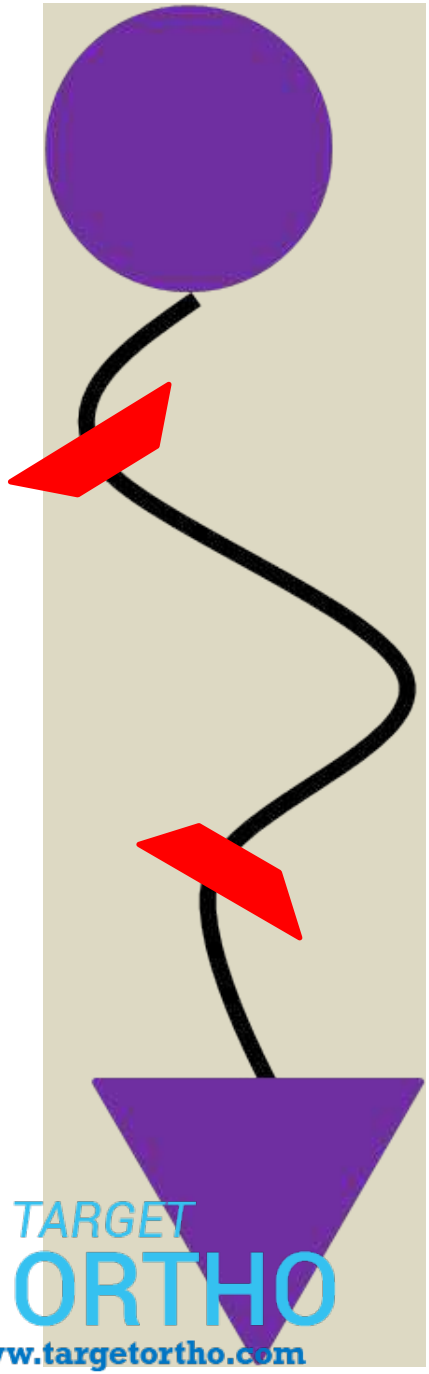




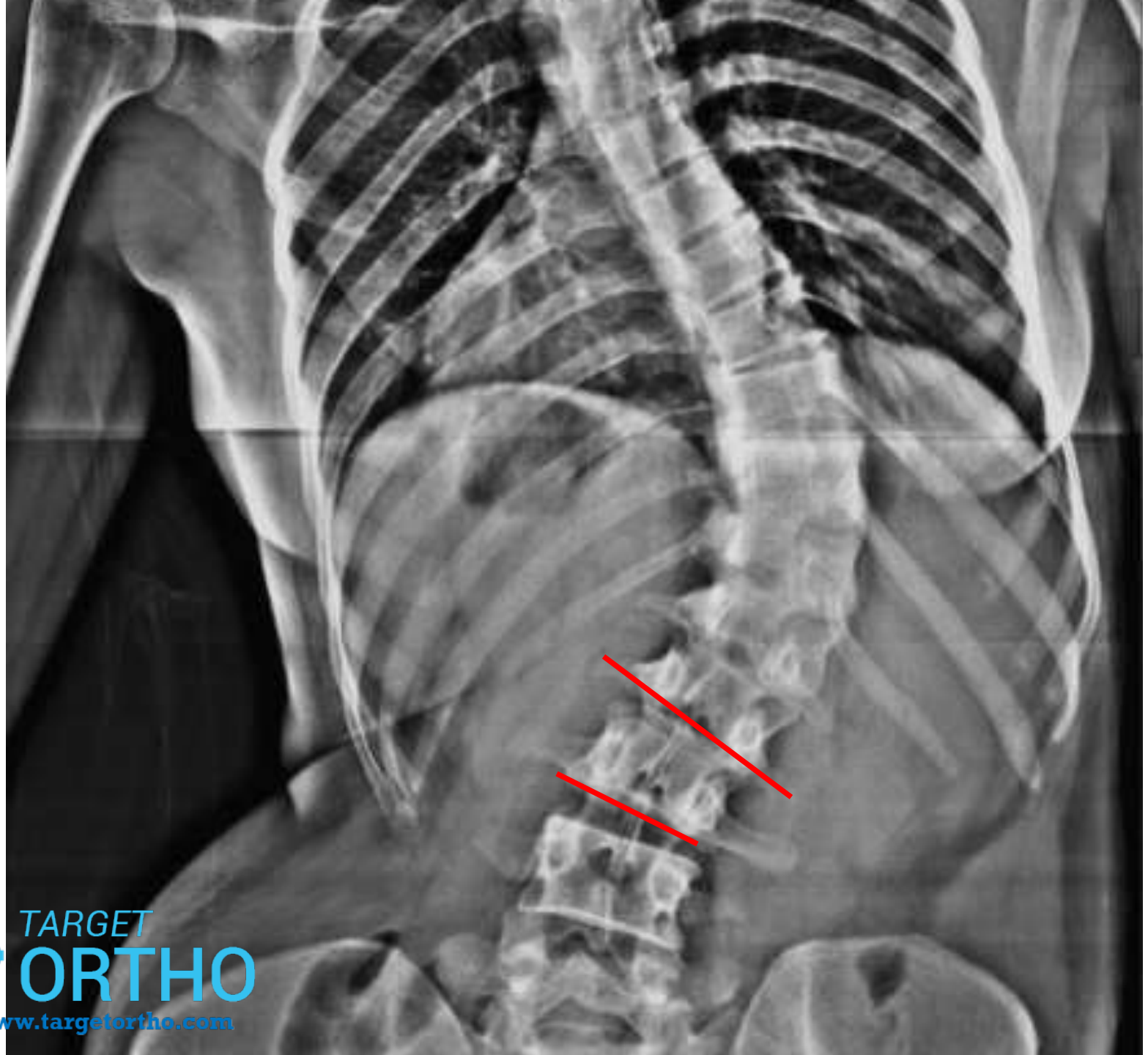


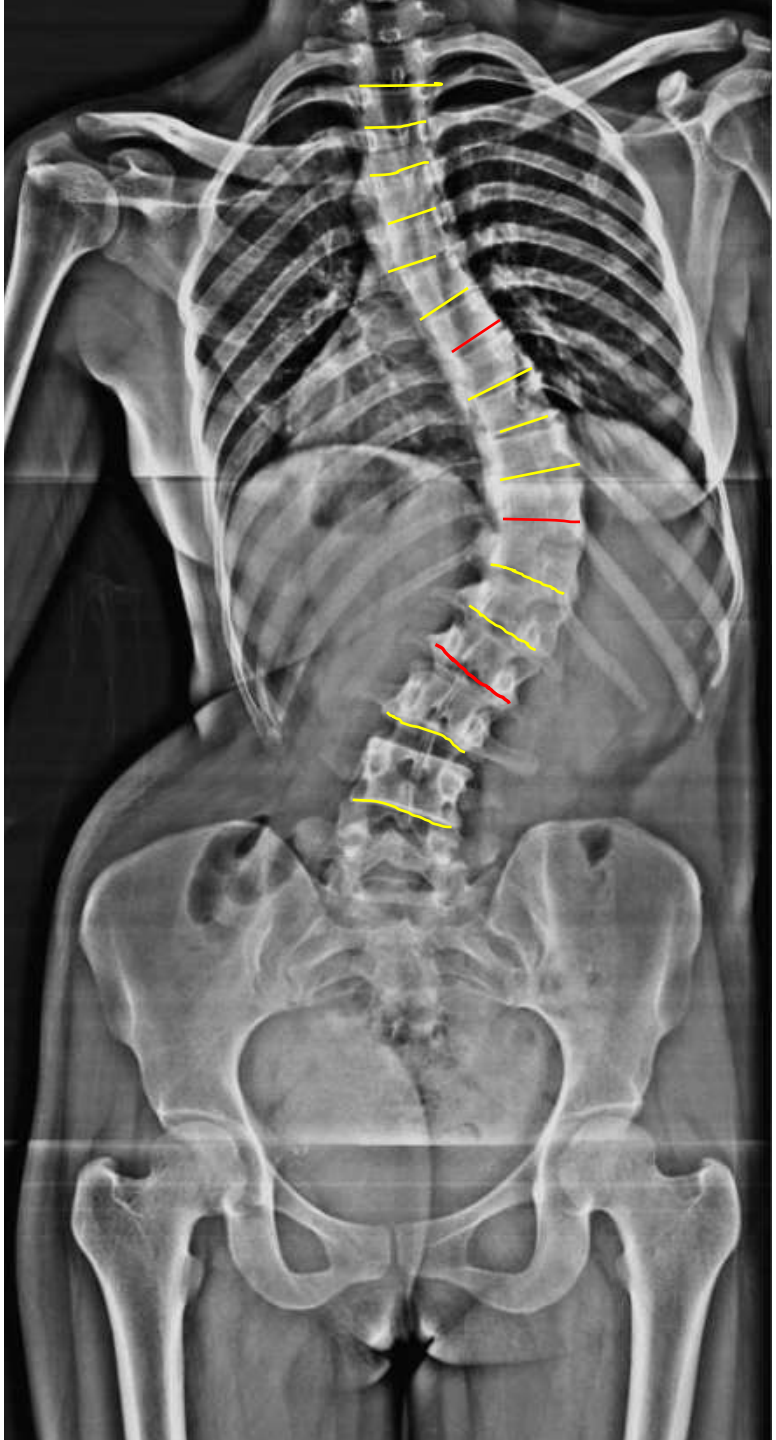
- **Apex vertebra(A)-** farthest deviation from the center of the vertebral column or **-(** greatest rotation)

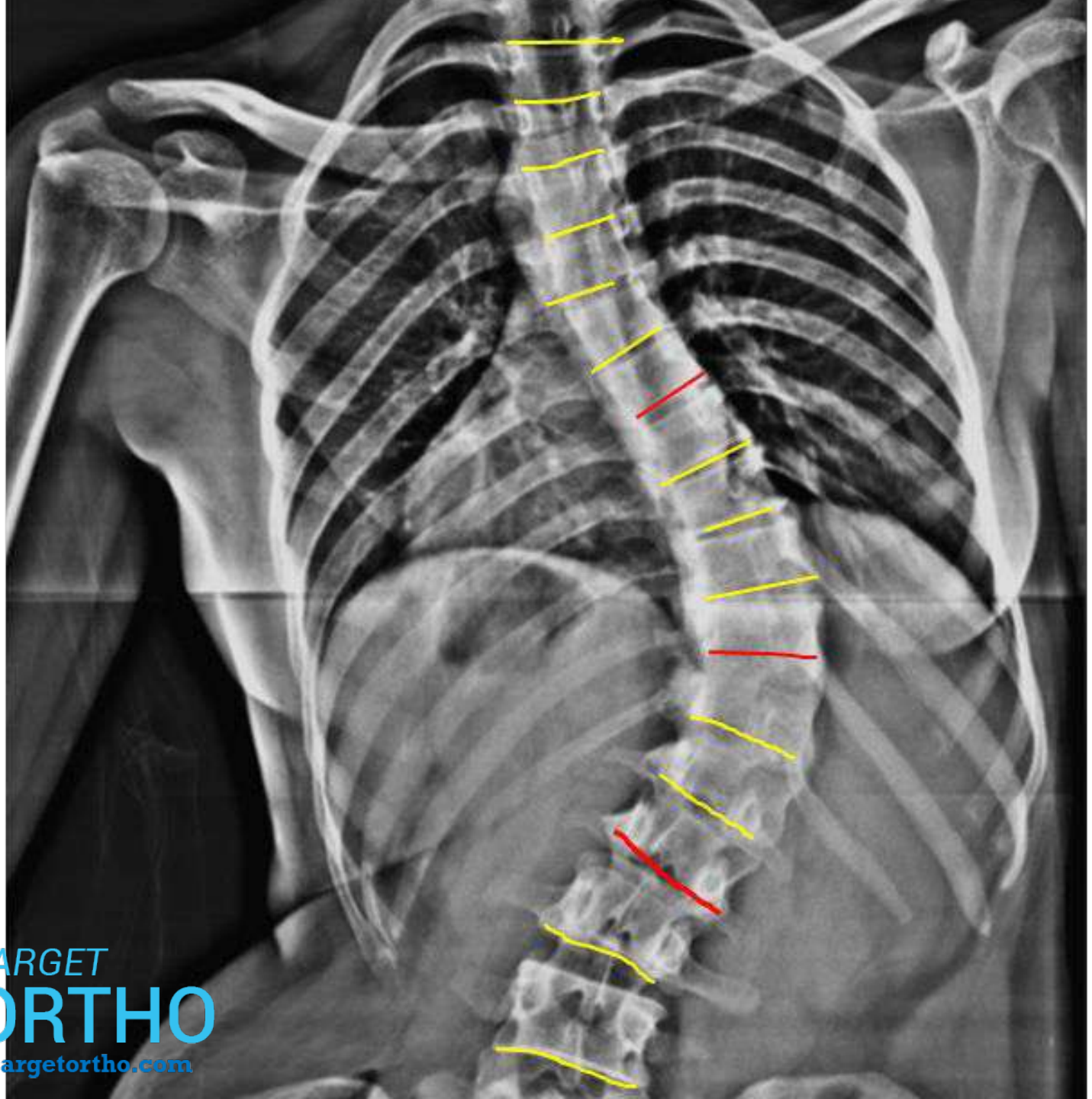


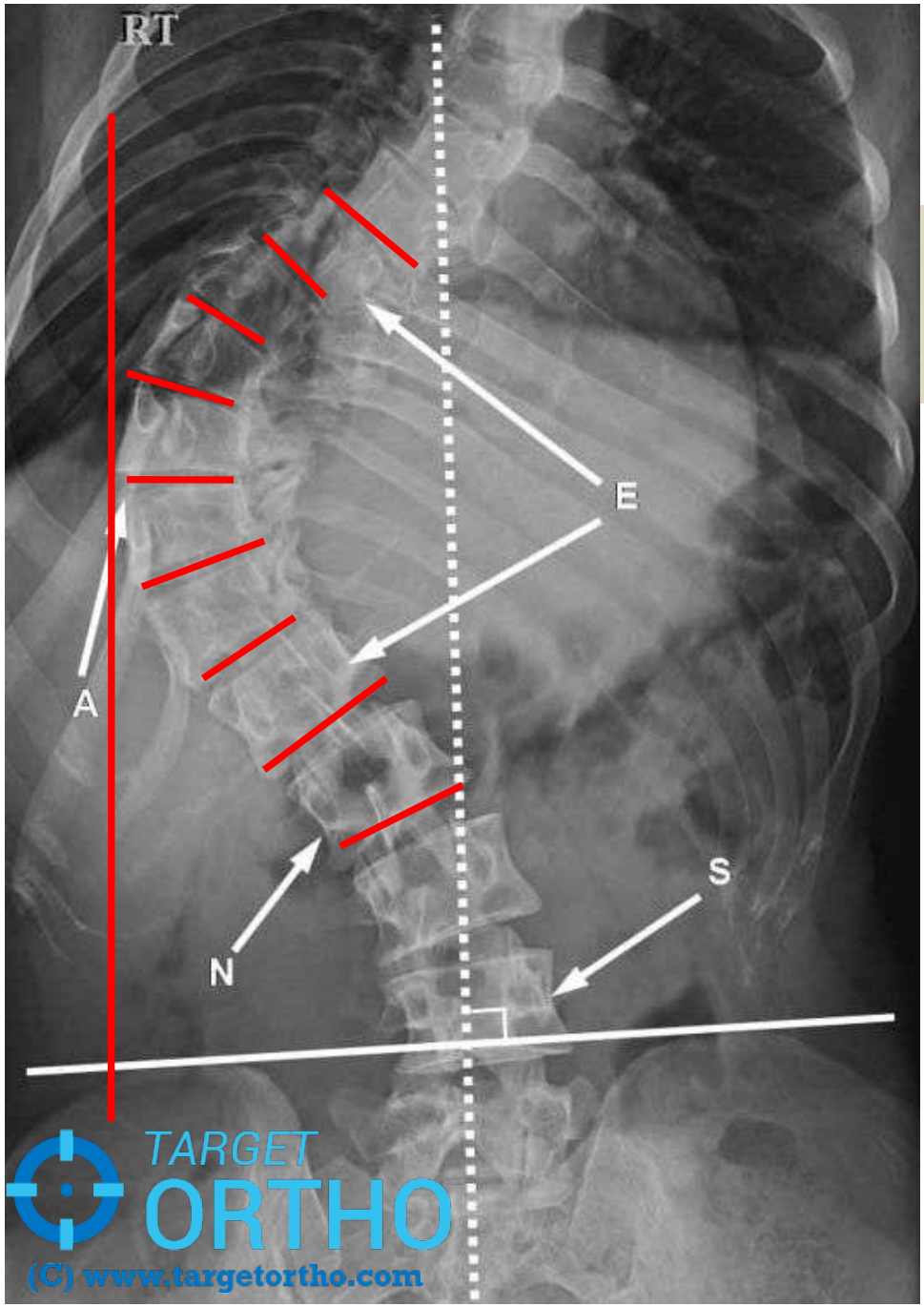


End vertebra





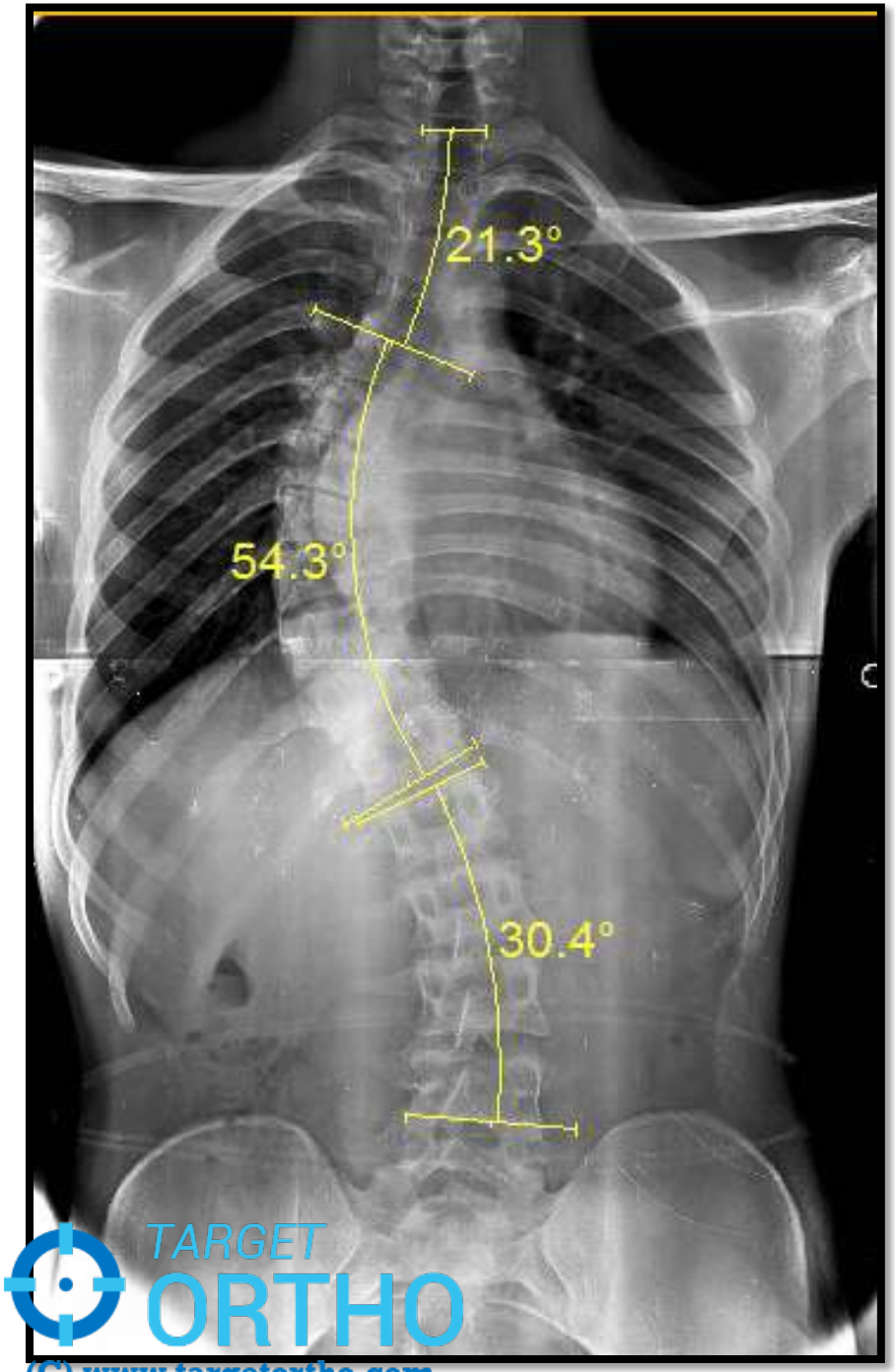


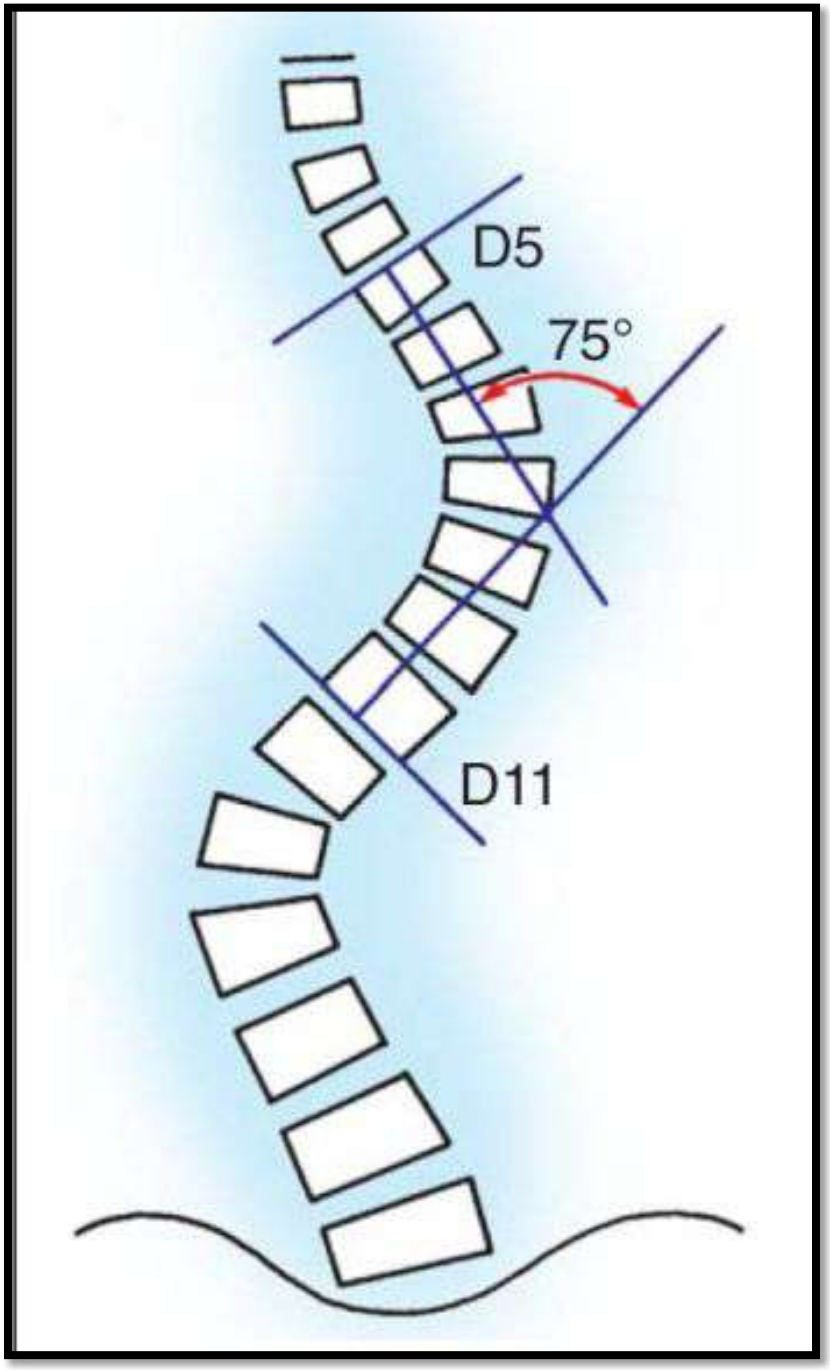


- **End vertebra(E)** - maximal tilt toward the apex of the curve

Cobbs angle

- Tangents along the **superior endplate of the superior end vertebra and the inferior endplate of the inferior end vertebra.**
- Endplates not visualized -the **borders of the pedicles used.**
- The Cobb angle - between the tangential lines or the angle between two lines drawn perpendicular to the tangents.





Cobbs angle

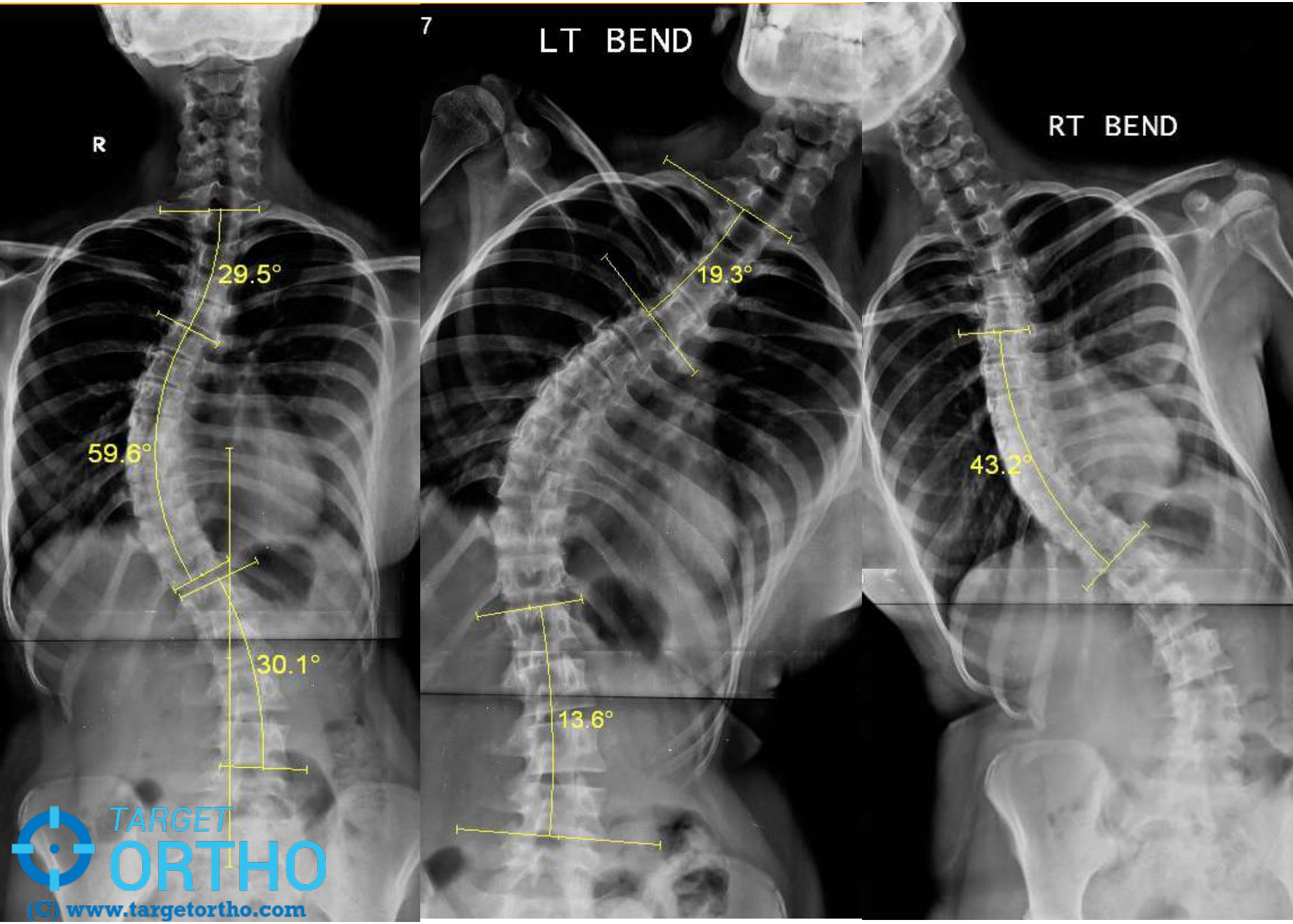
- The Scoliosis Research Society (SRS) definition of scoliosis - **lateral curvature of the spine greater than 10°**

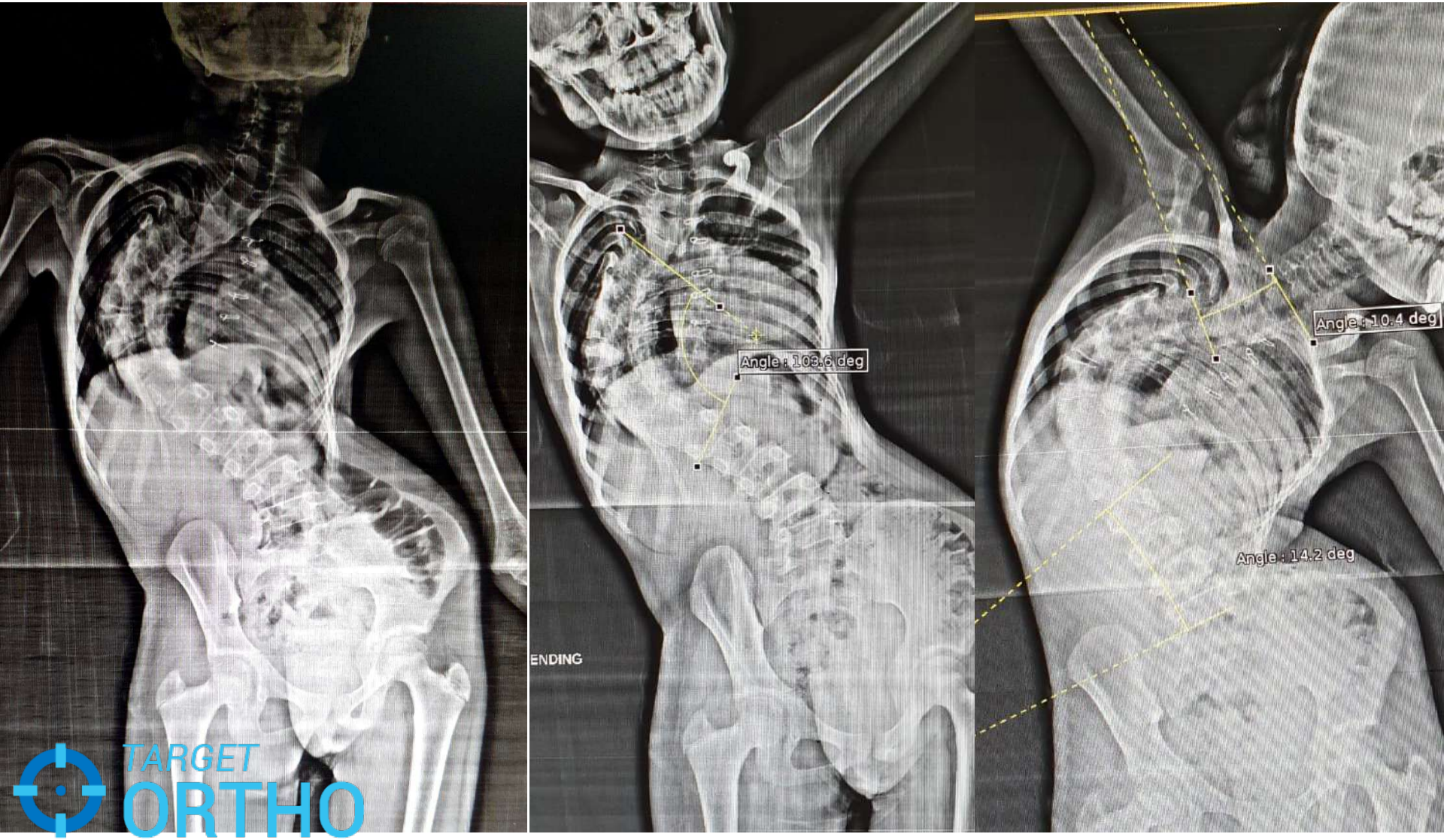
- **Structural curve –**

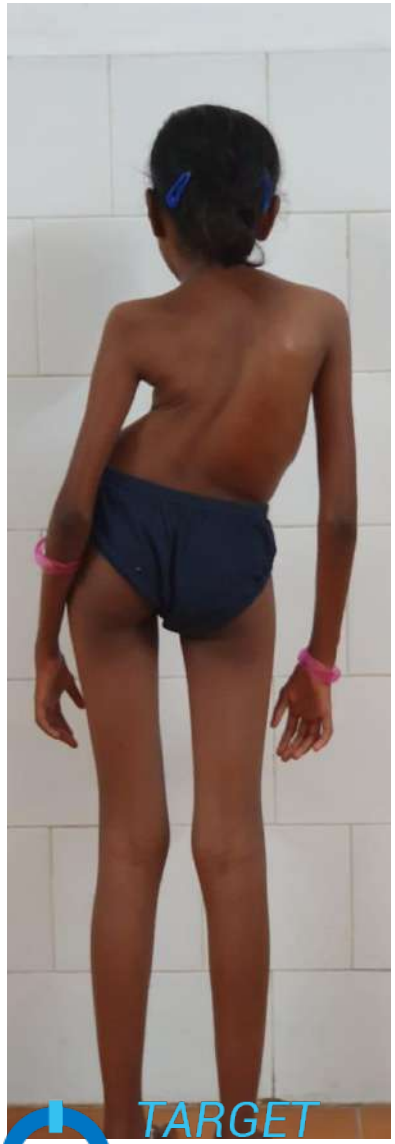
  side bending cobbs ≥ 25 deg

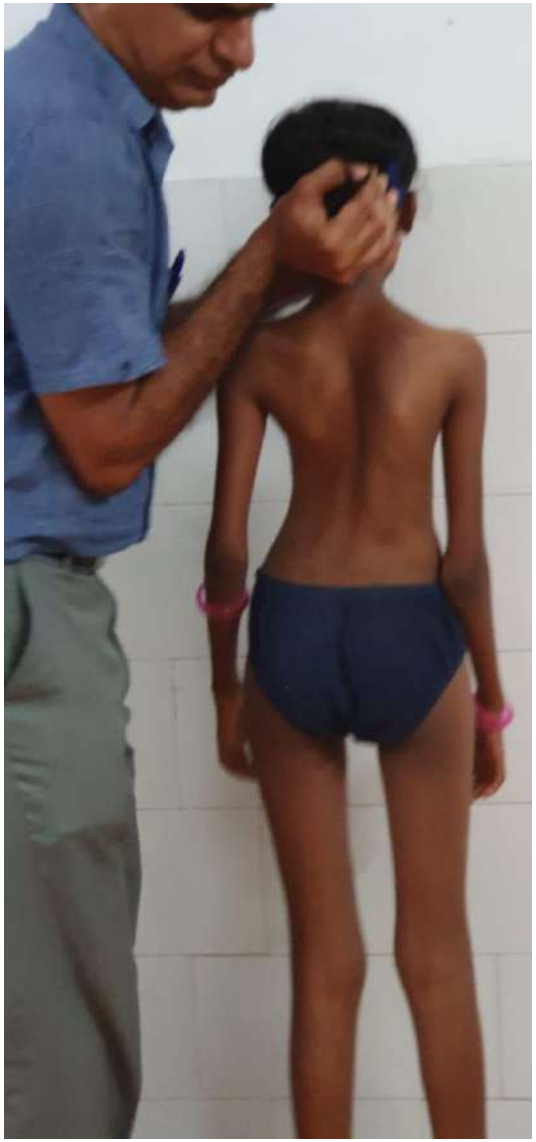
- **Non structural curve –**

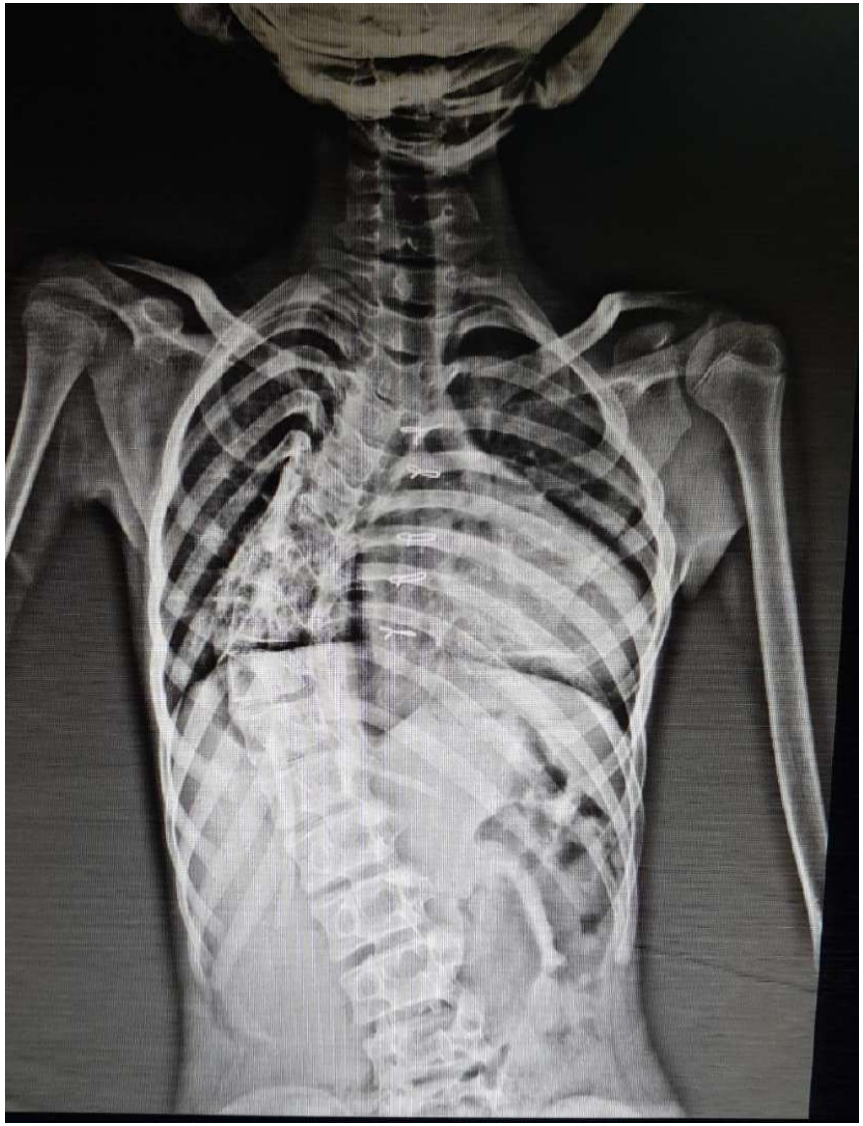
  side bending cobbs < 25 deg.

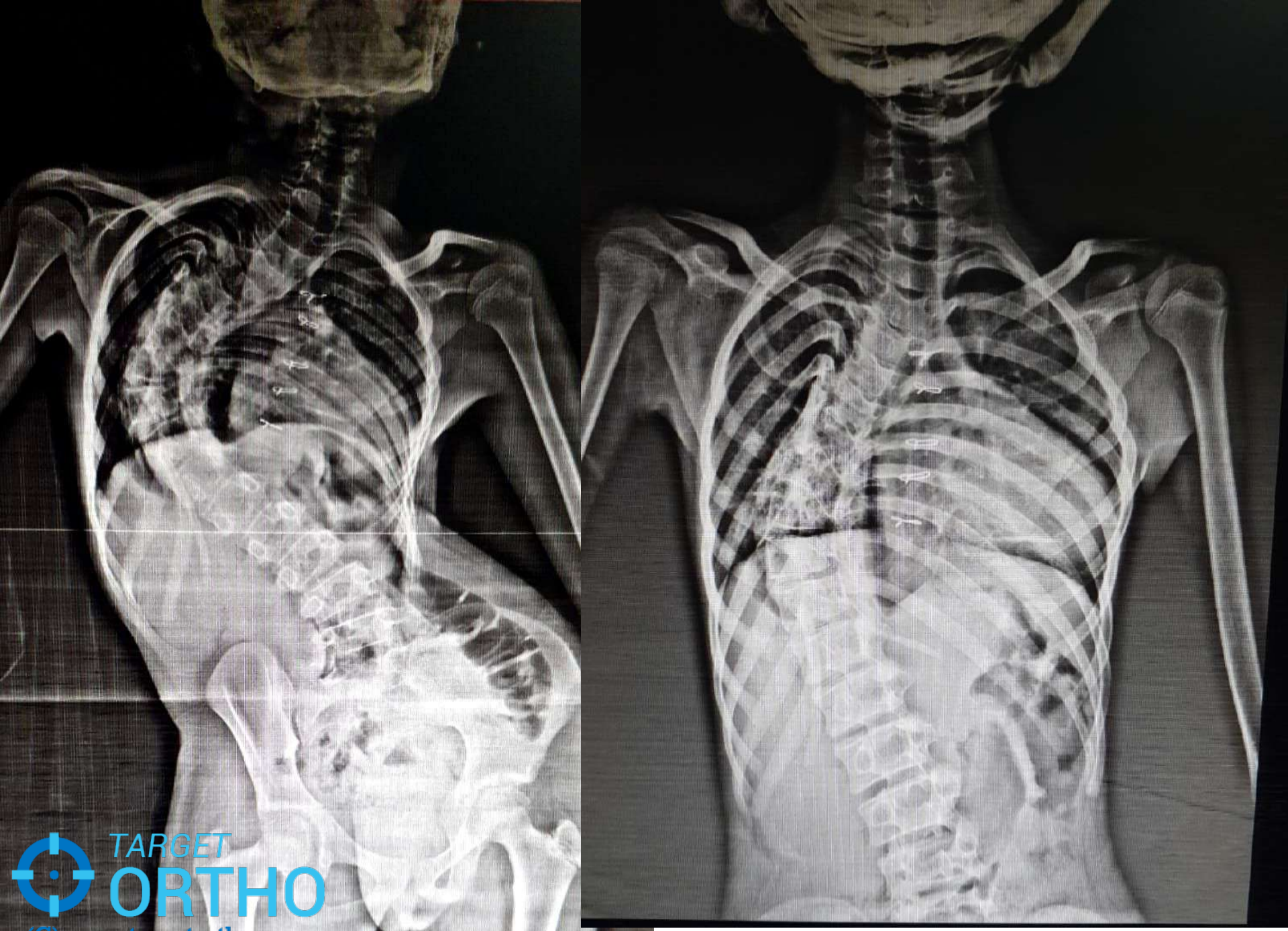

R
29.5°
59.6°
30.1°
7
LT BEND
19.3°
13.6°
RT BEND
43.2°
TARGET
ORTHO
(C) www.targetortho.com



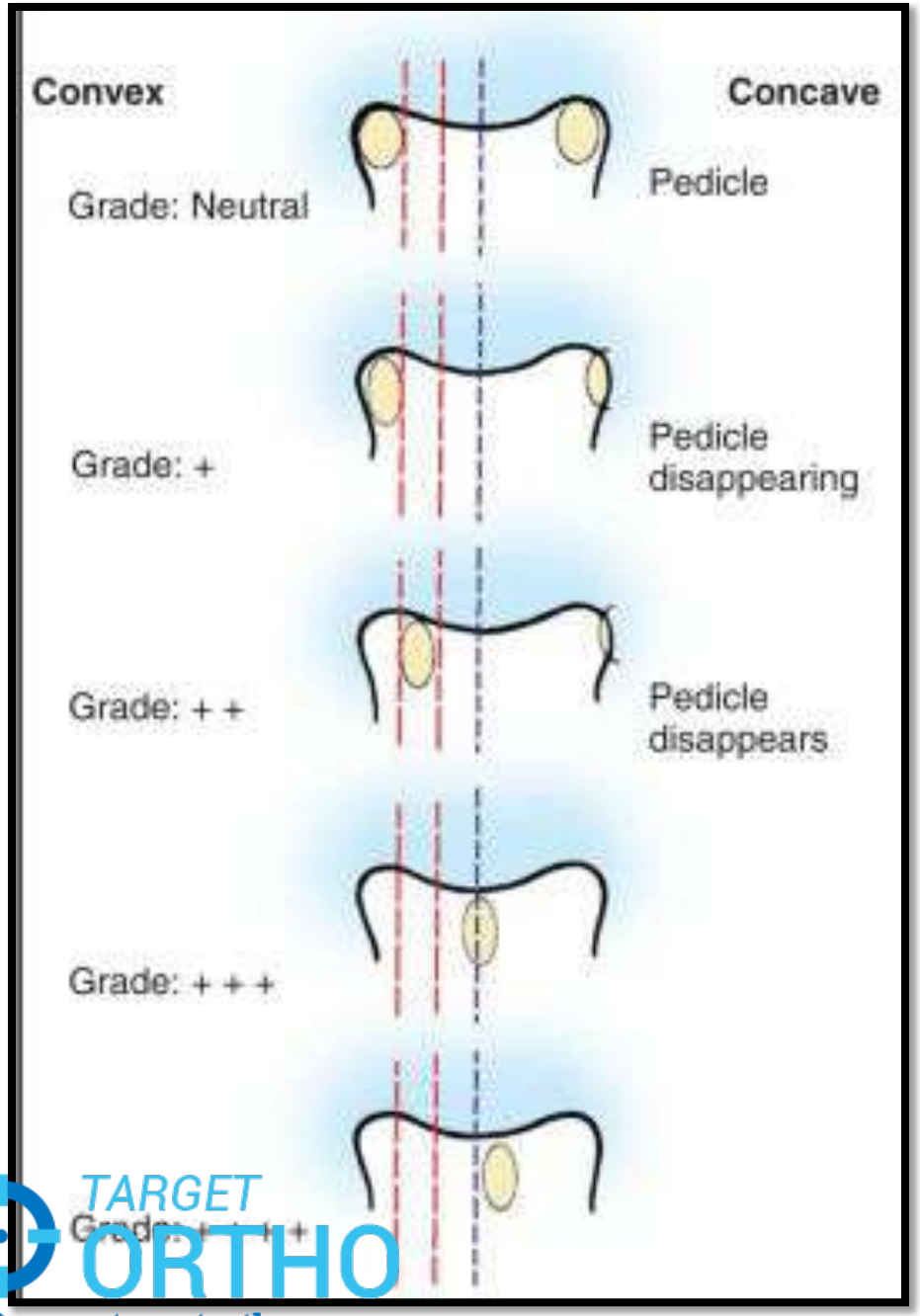


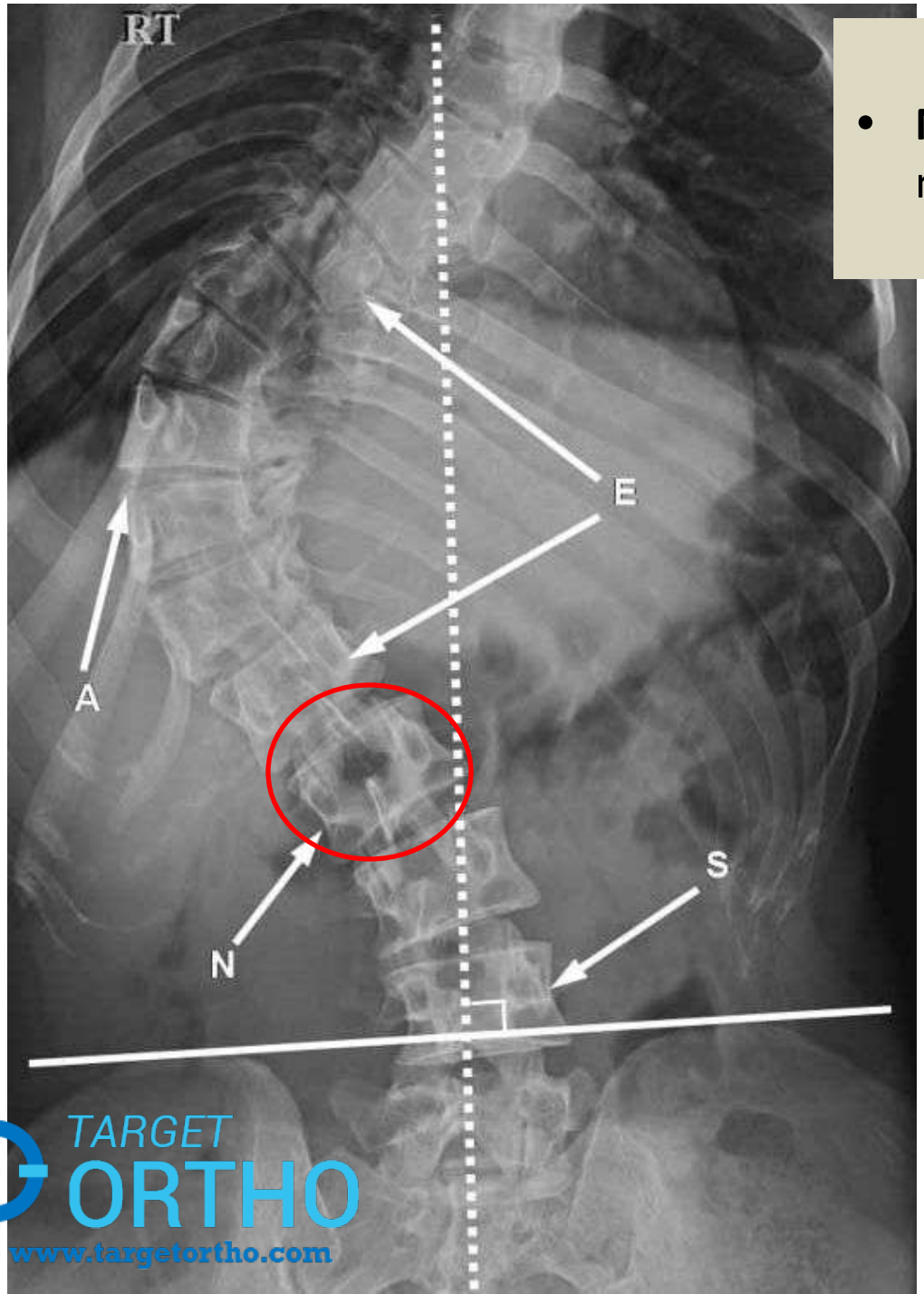




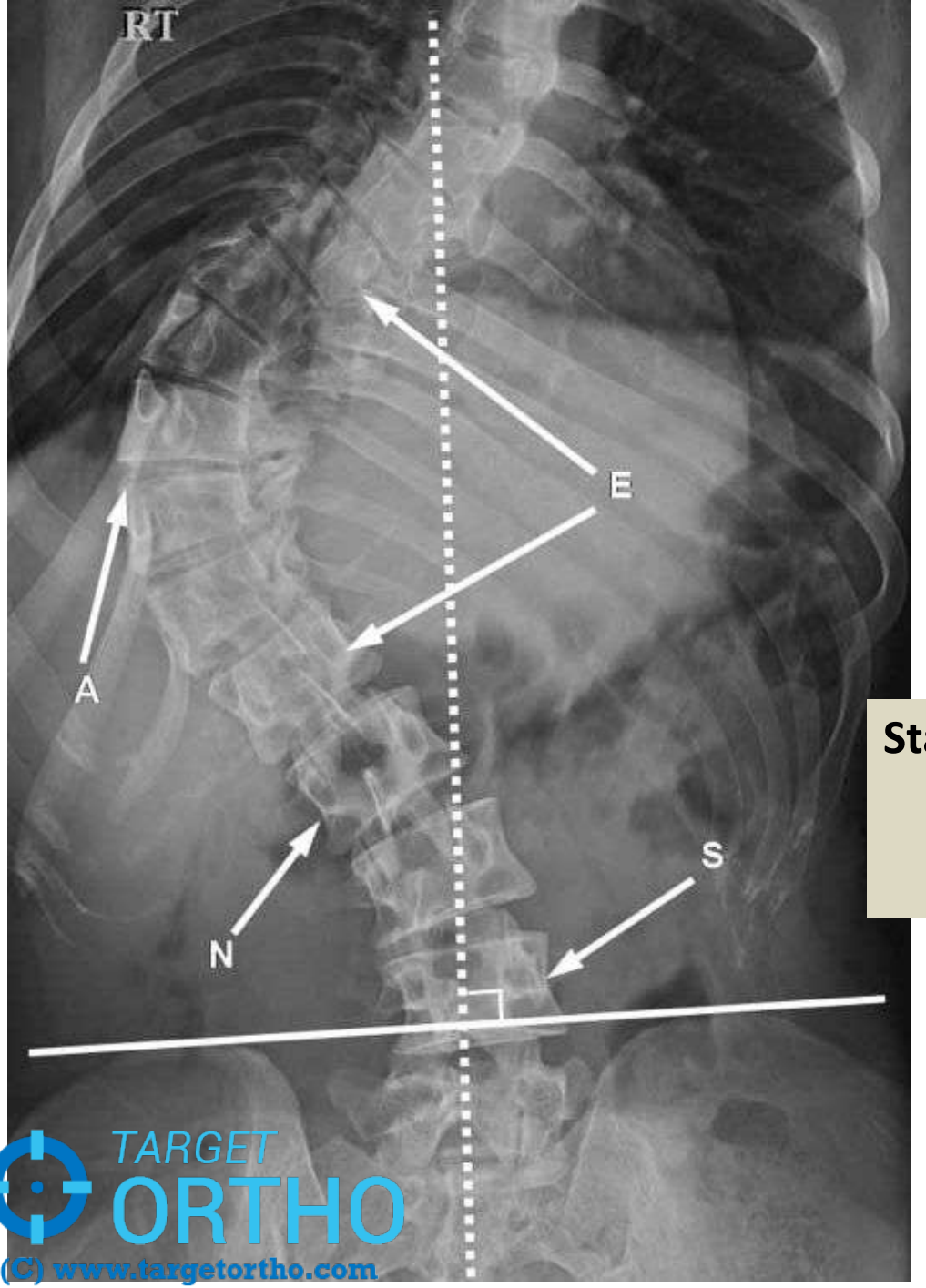


Vertebral body rotation



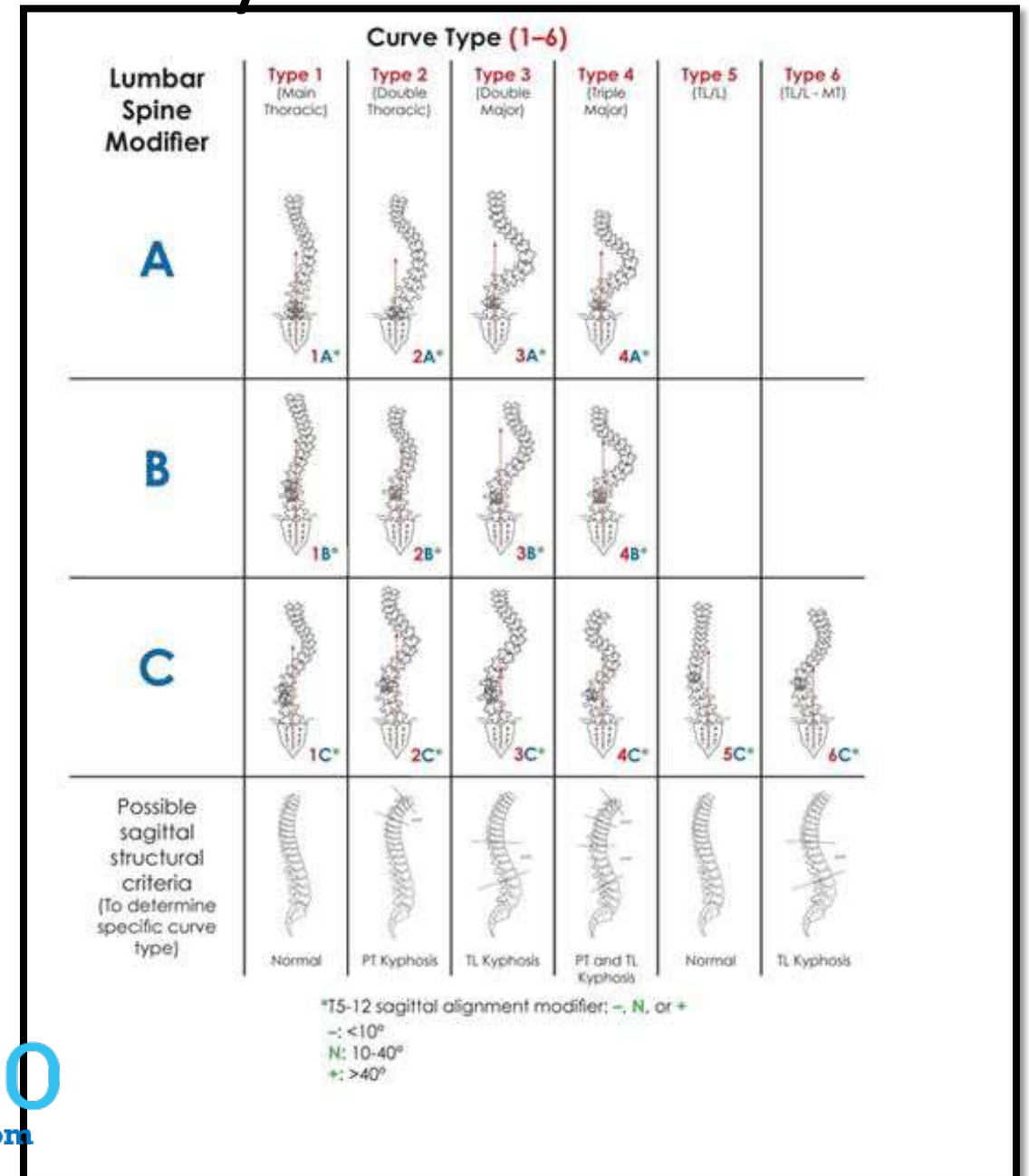


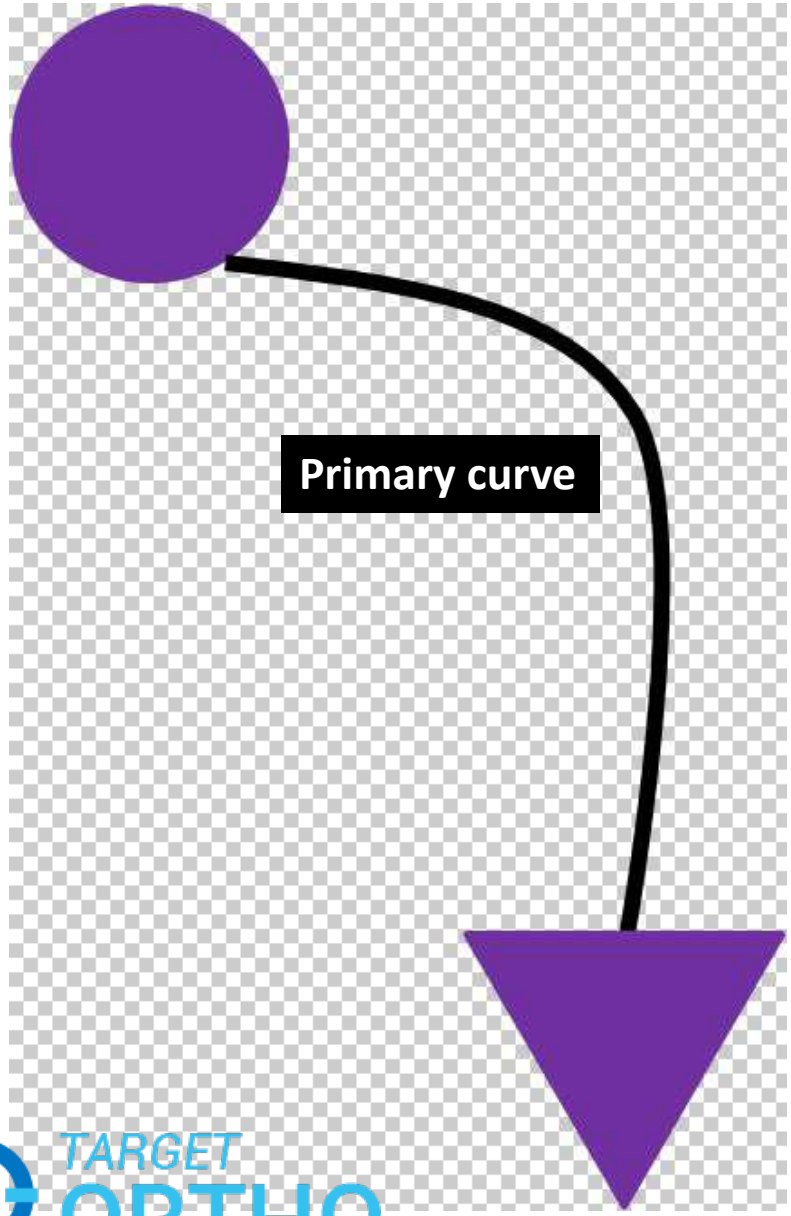
- **Neutral vertebra (N) -**is one that is not rotated.

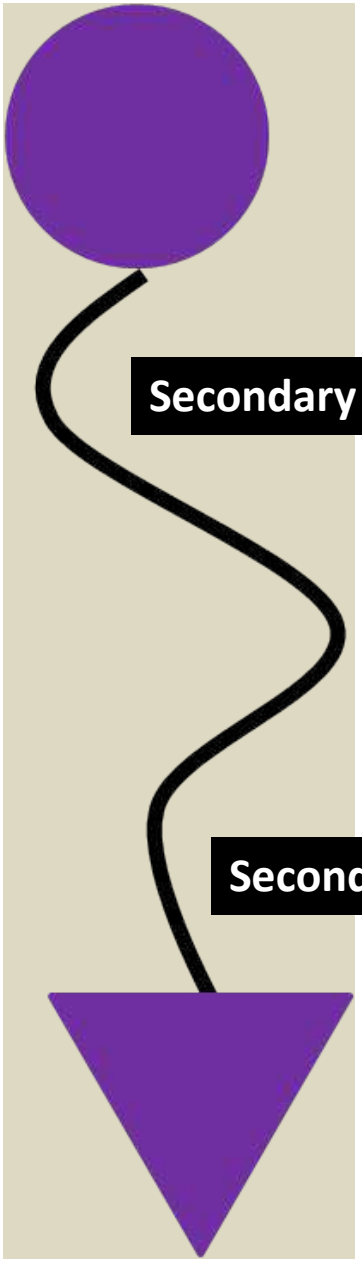


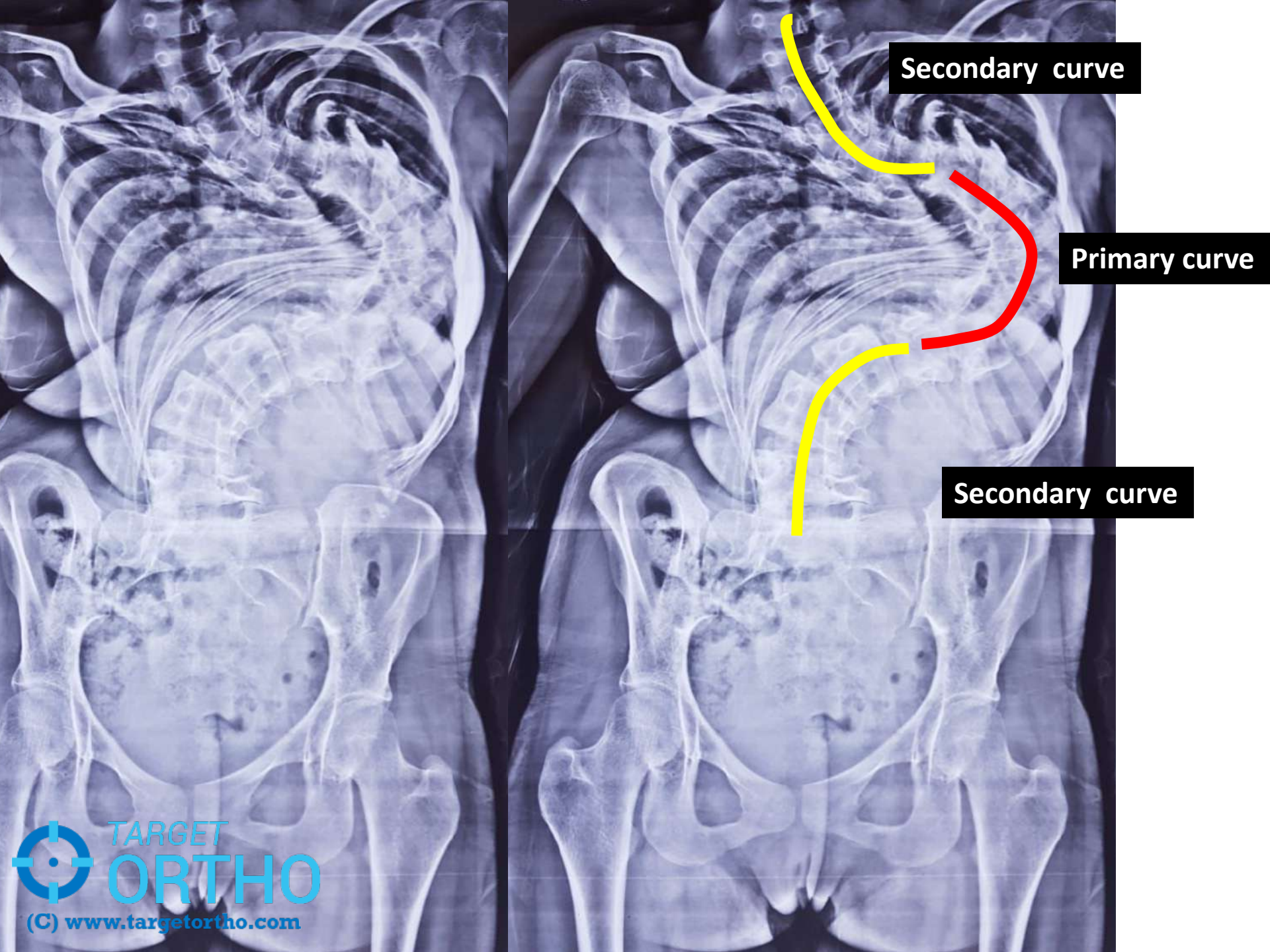
Stable vertebra (S) - is one that is bisected or nearly bisected by the CSVL (dotted line).

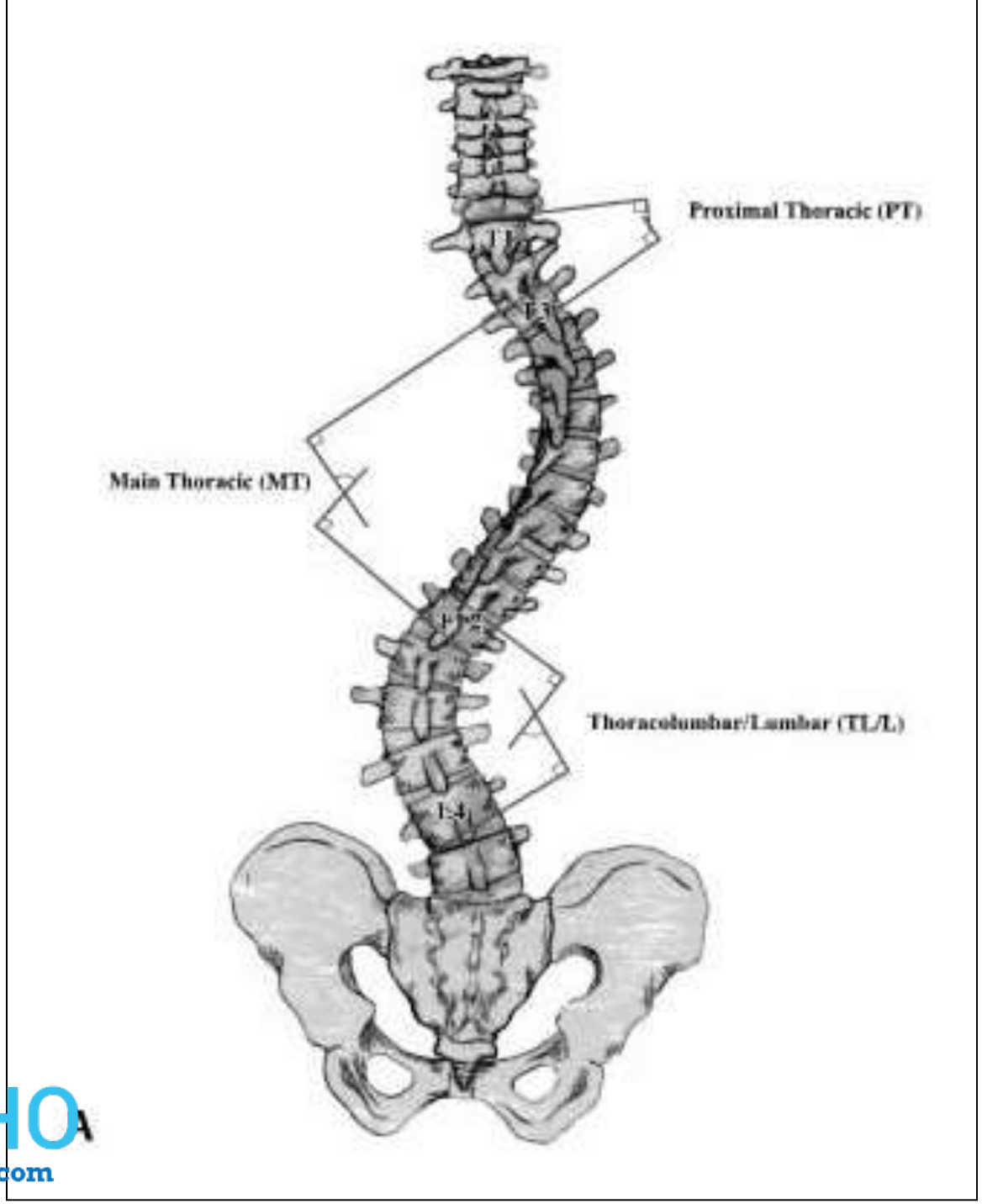
Lenkes system of classification



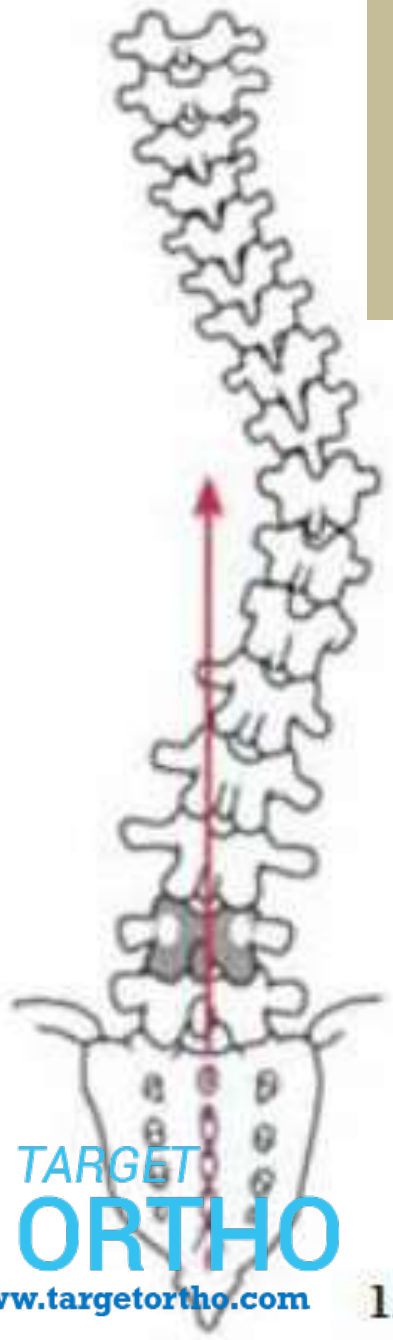






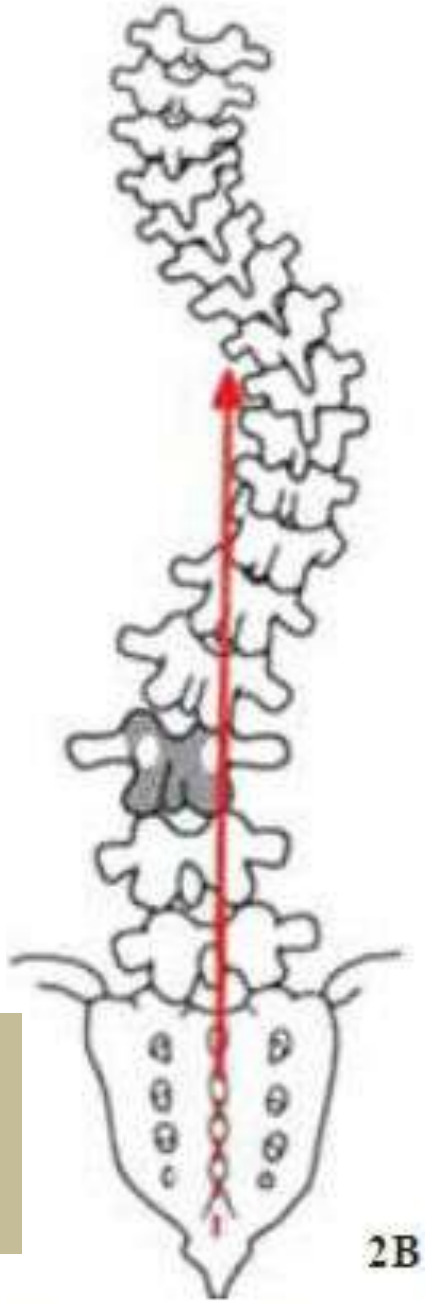


Type 1
Main thoracic curve

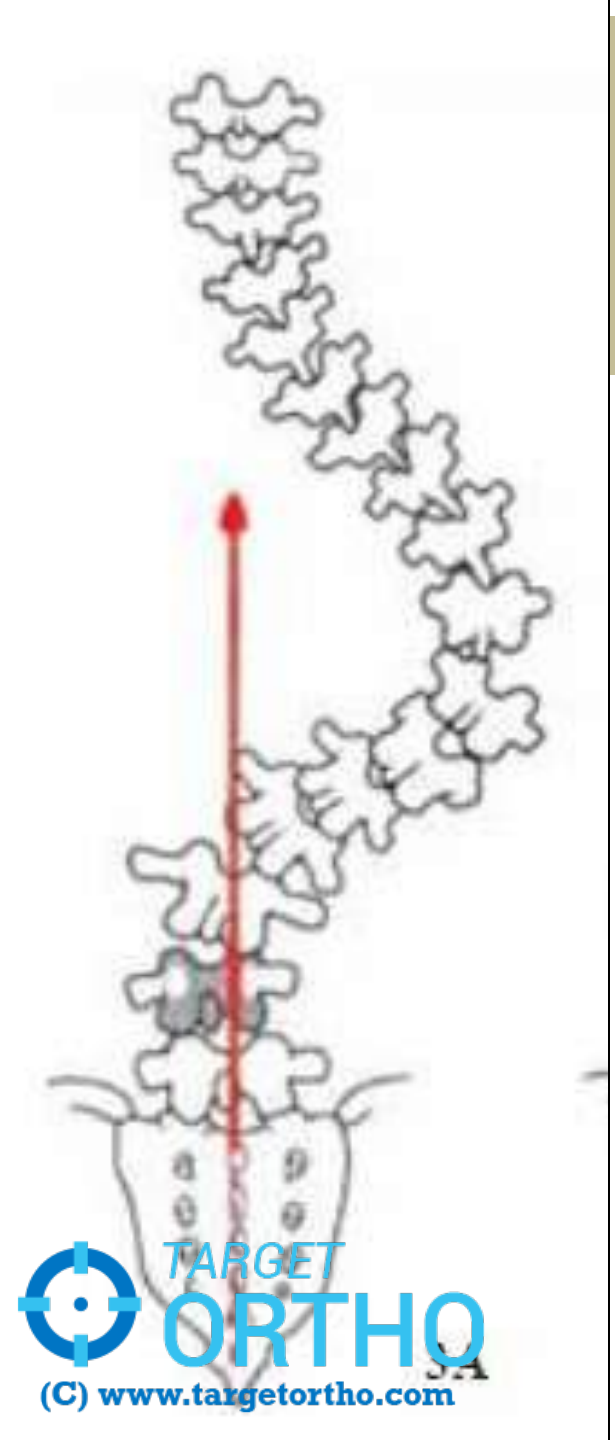


1A

Lenke type-2
Double thoracic curve

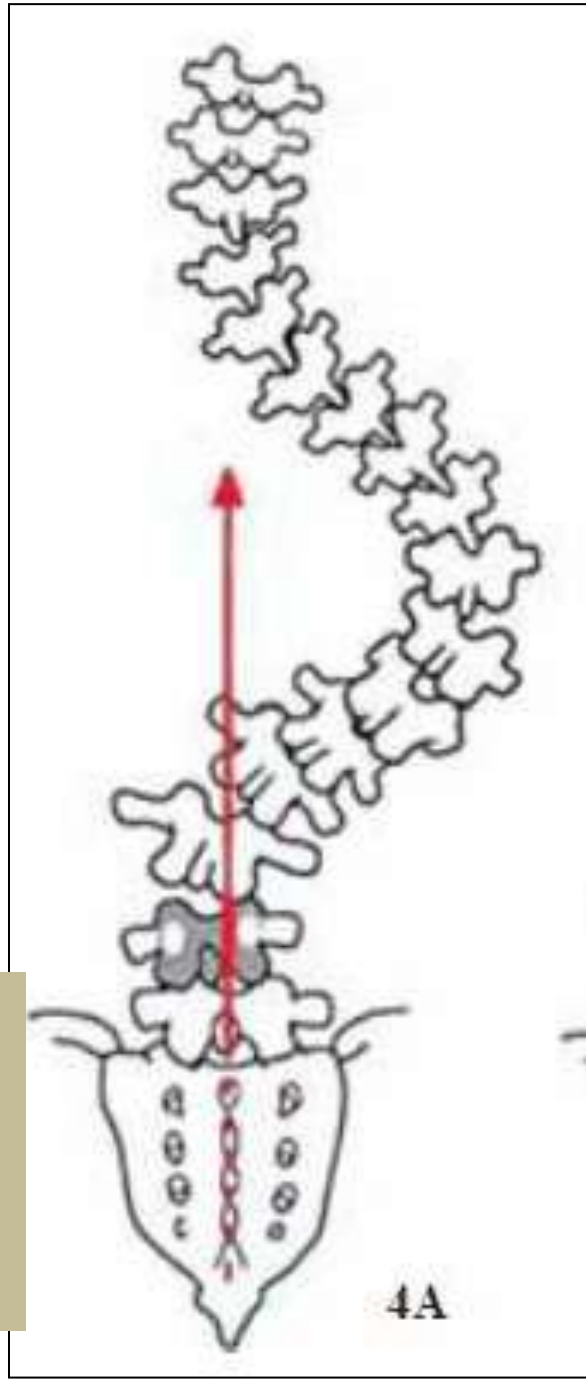


2B

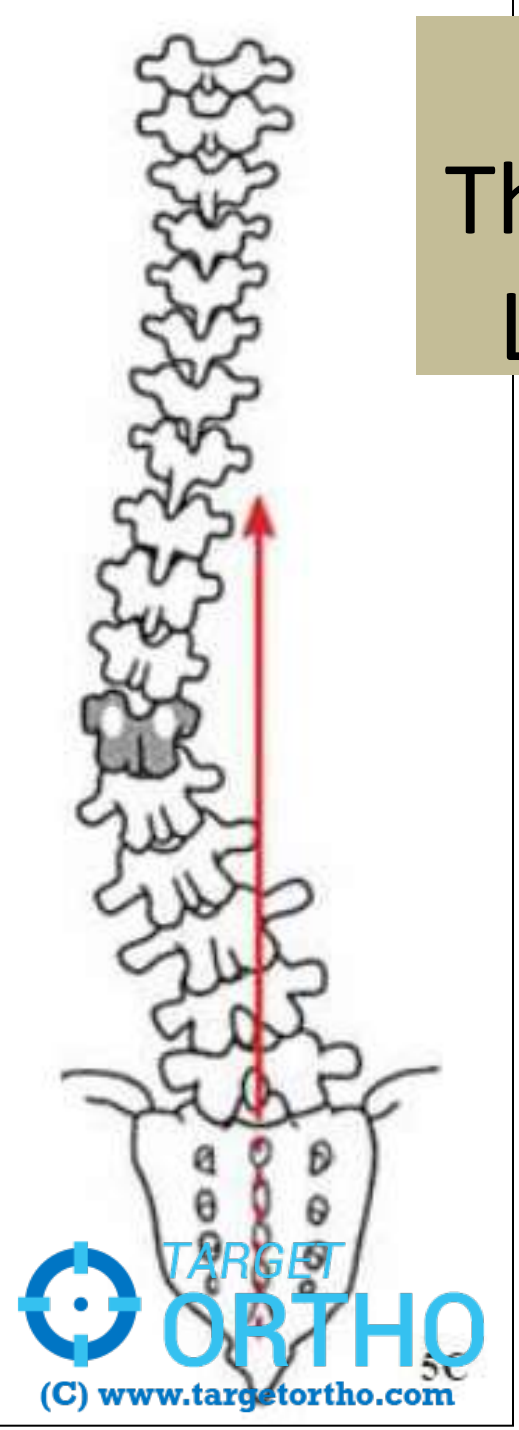


Type 3
Double major

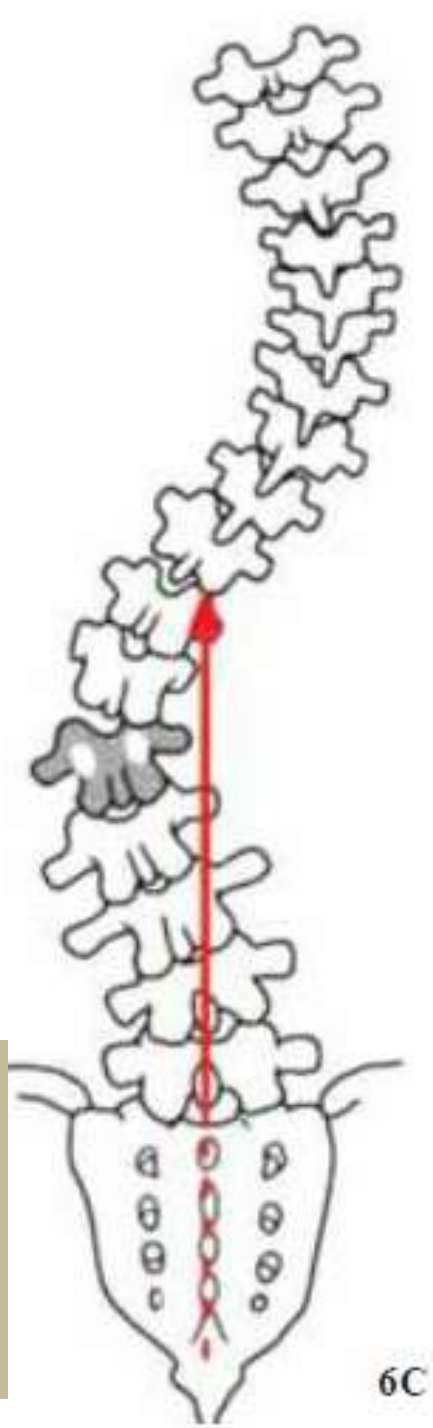
Type 4
Triple major



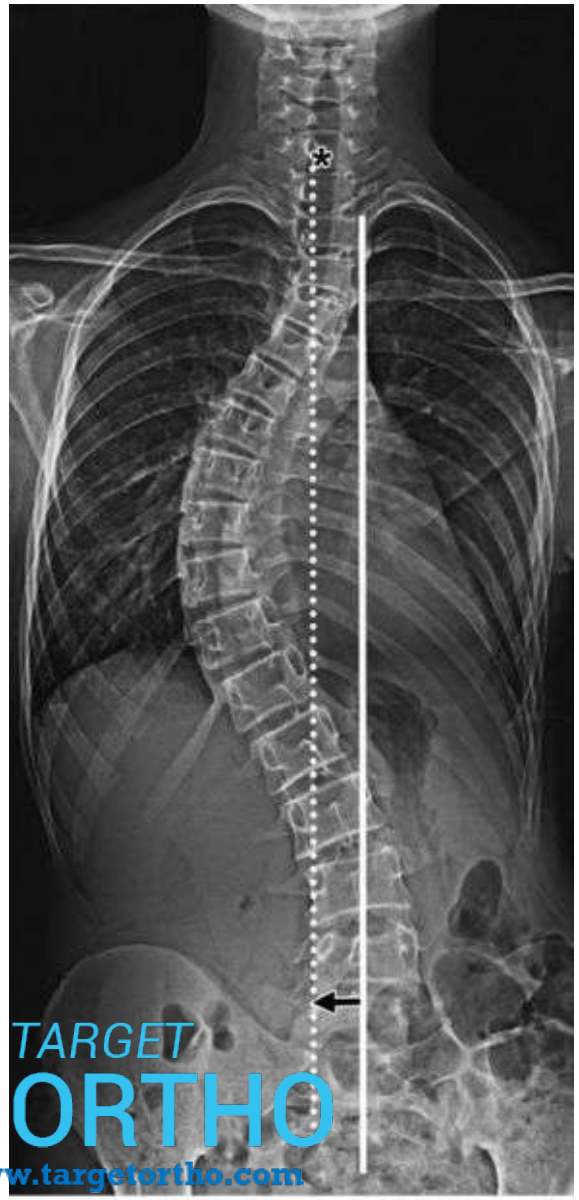
Type 5 Thoracolumbar/ Lumbar curve



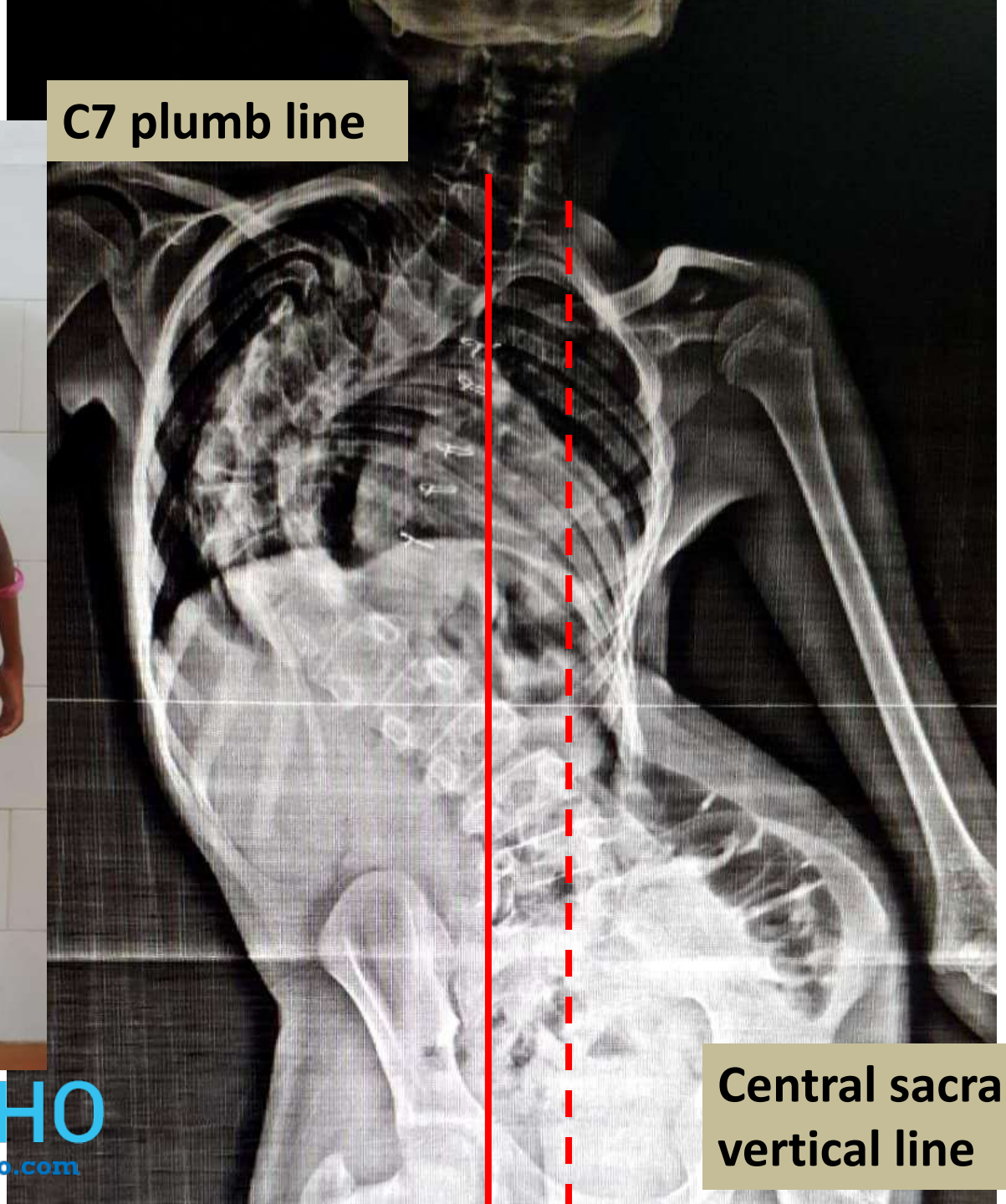
Type 6 Thoracolumbar/ Lumbar curve with Main thoracic curve



Assessment of Vertebral Alignment and Balance



- **The plumb line** is a vertical line drawn downward from the center of the C7 vertebral body
- **Coronal balance** - distance between the CSVL and the plumb line
- Balance is considered abnormal if the distance is greater than 2 cm

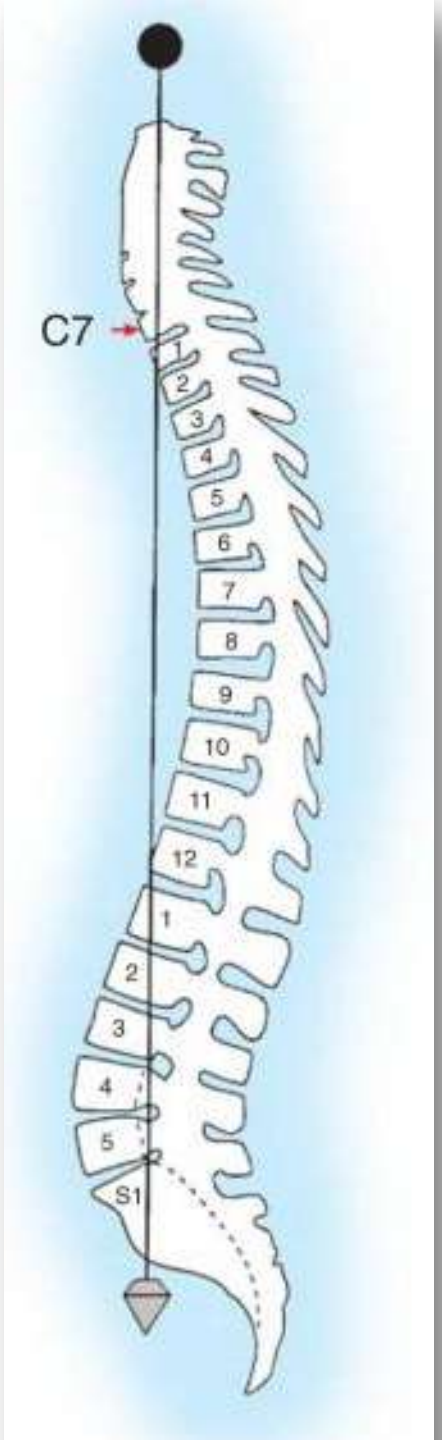


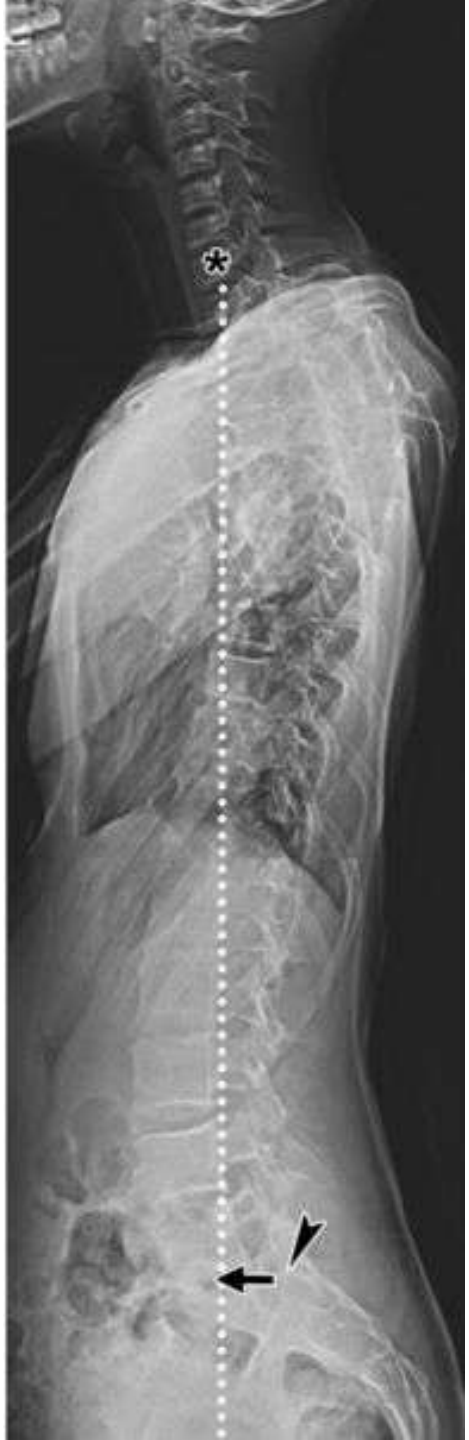
C7 plumb line

Central sacral vertical line

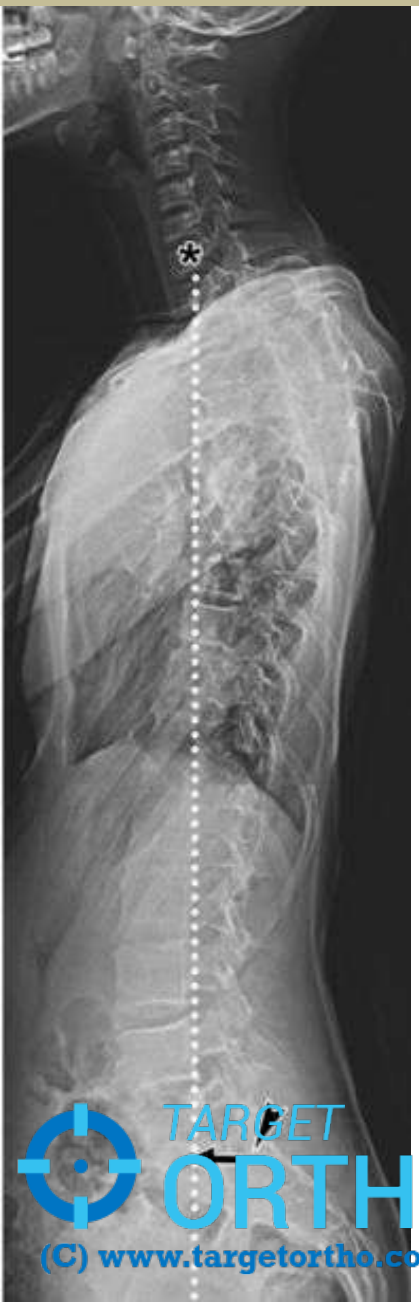
- **Sagittal balance** - distance between the posterosuperior aspect of the S1 vertebral body and the plumb line.

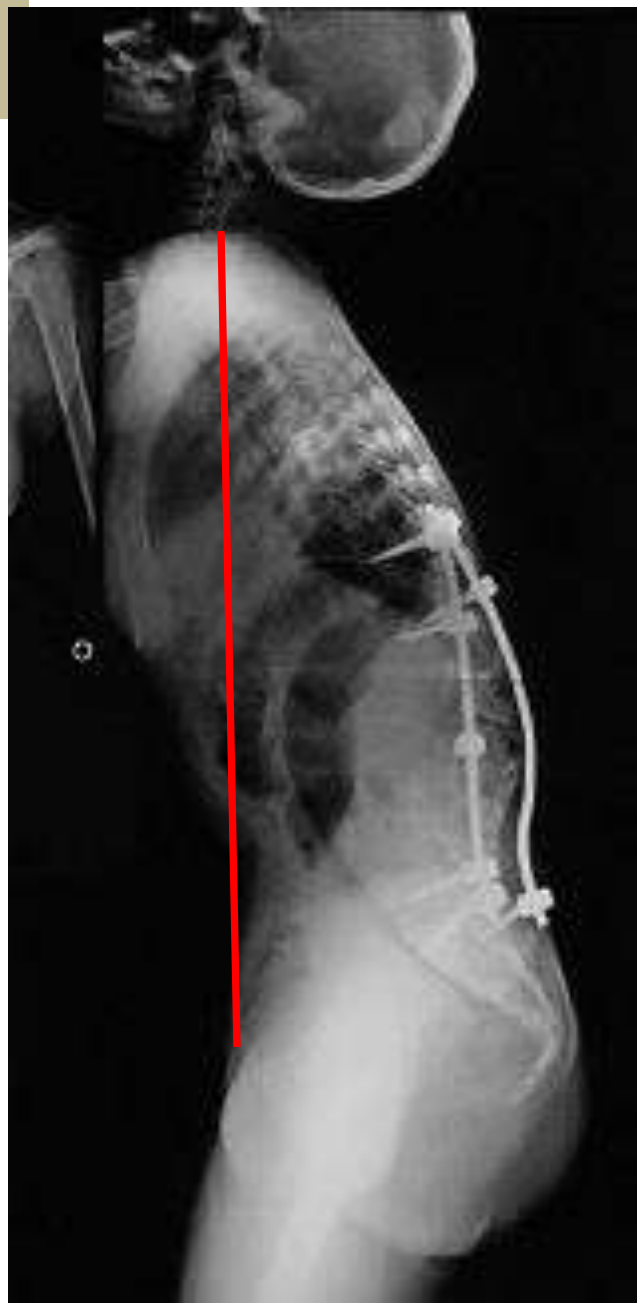
- Imbalance if > 2 cm

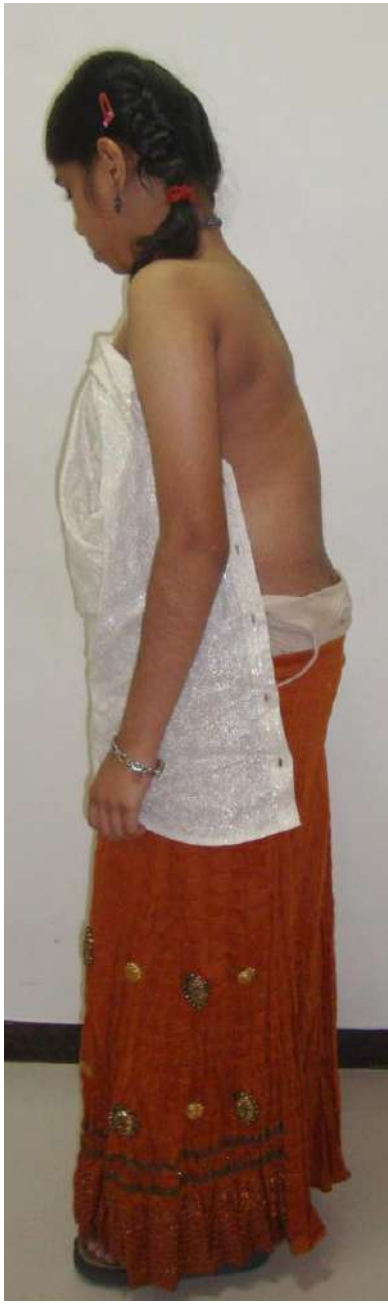




Sagittal balance

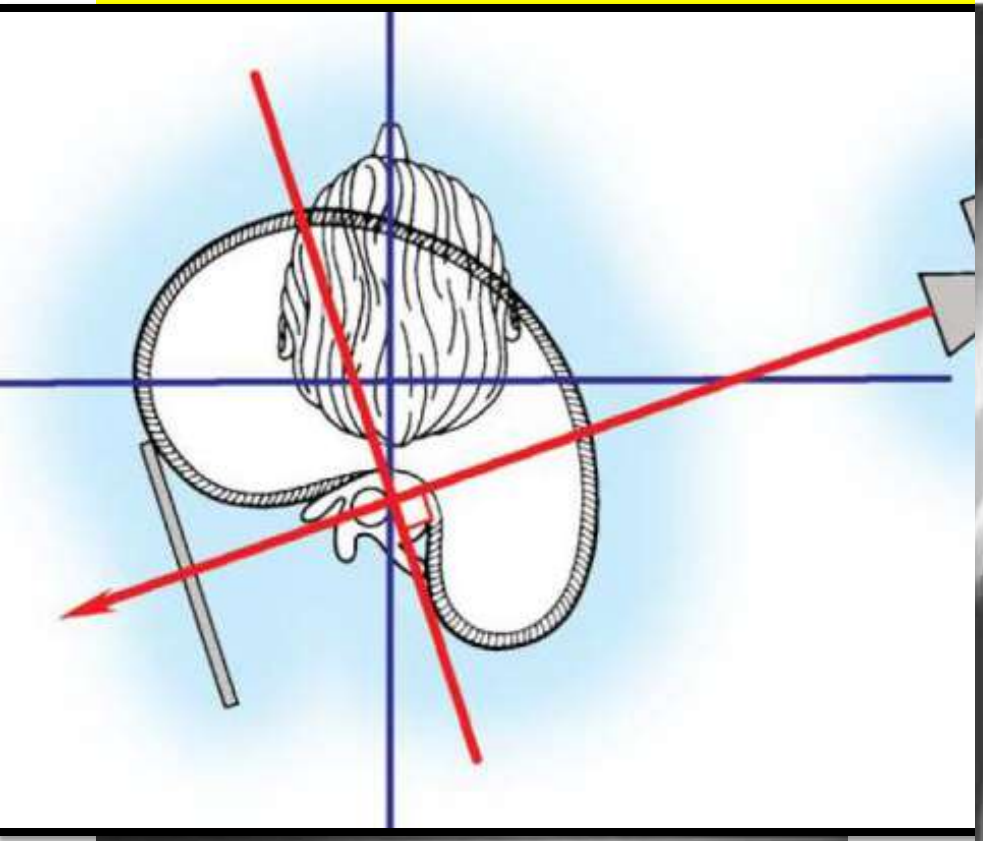


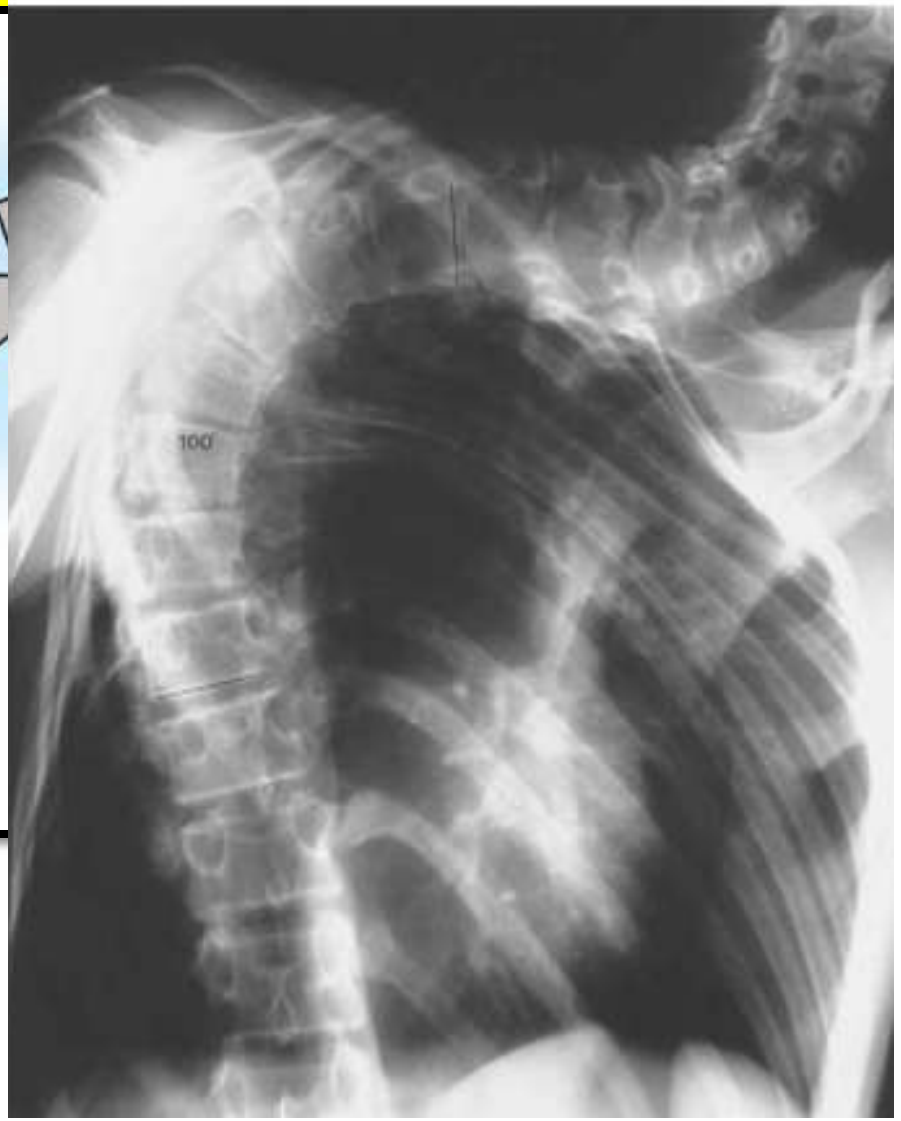




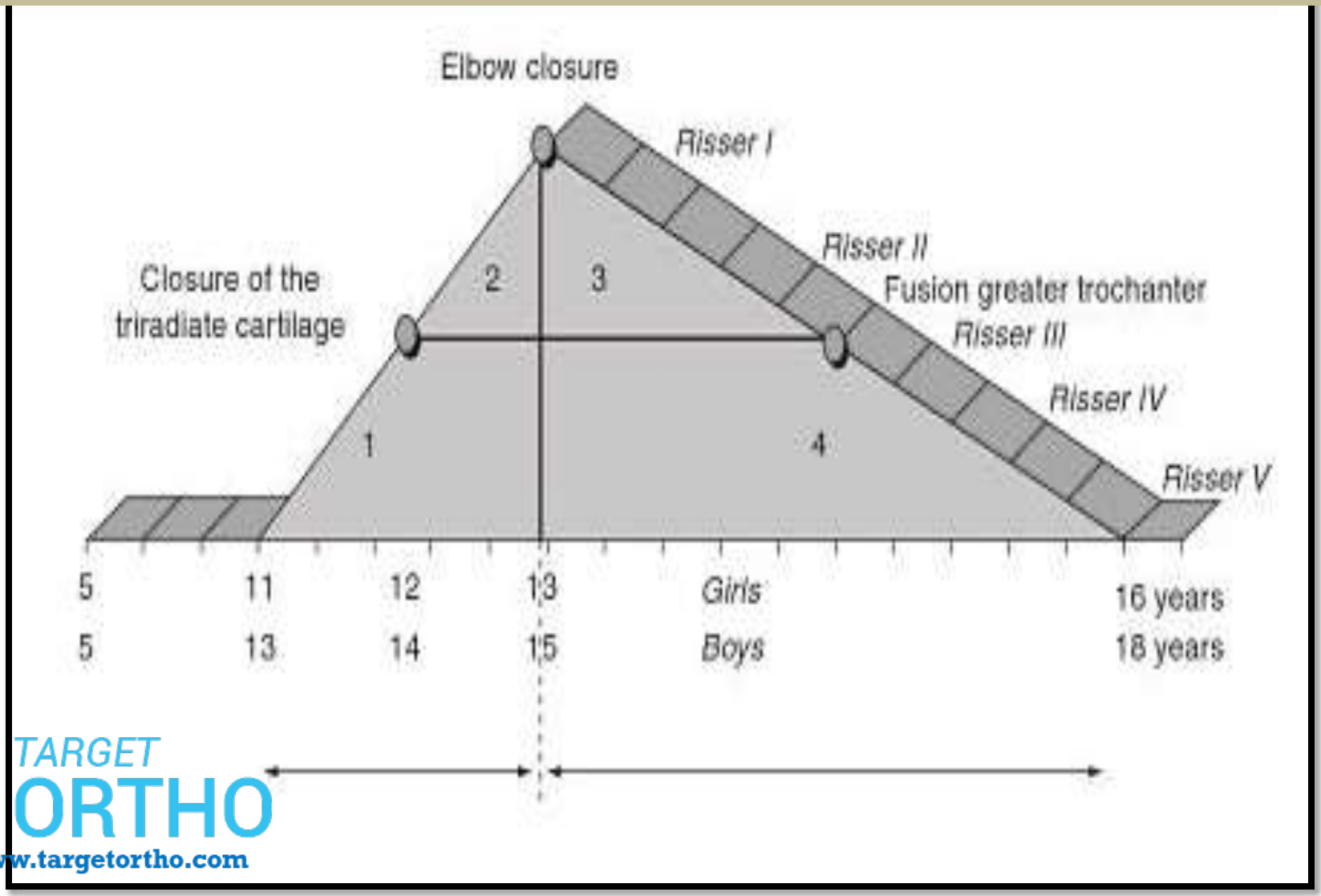
Positive sagittal imbalance

Stagnara view





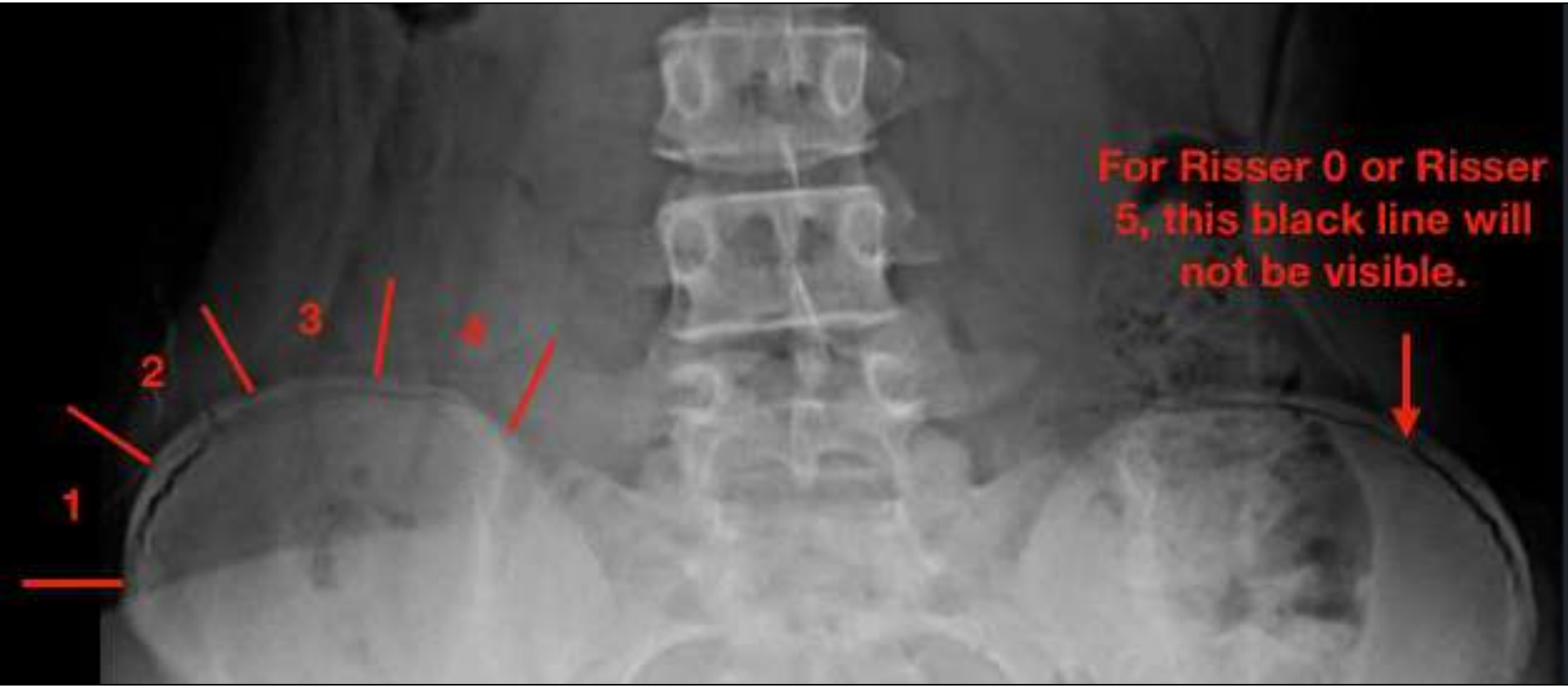
Assessment of progression

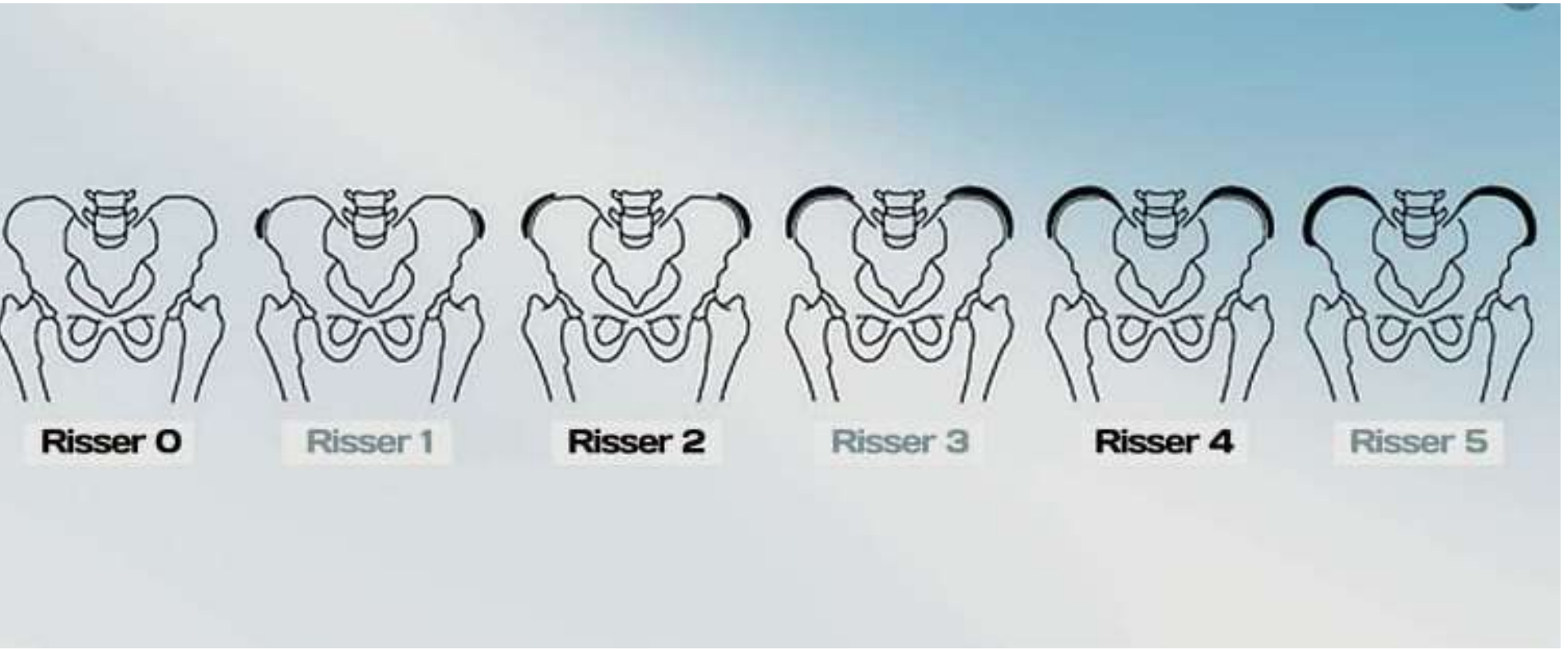


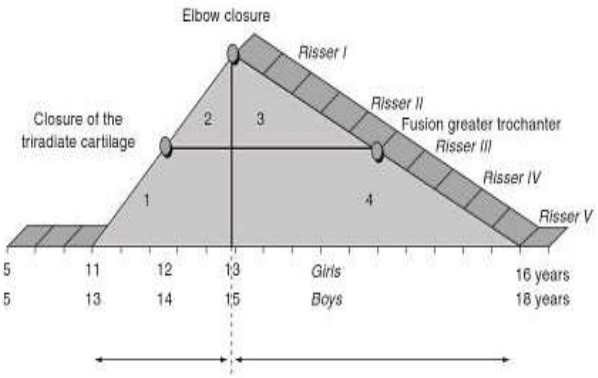
Assessment of progression

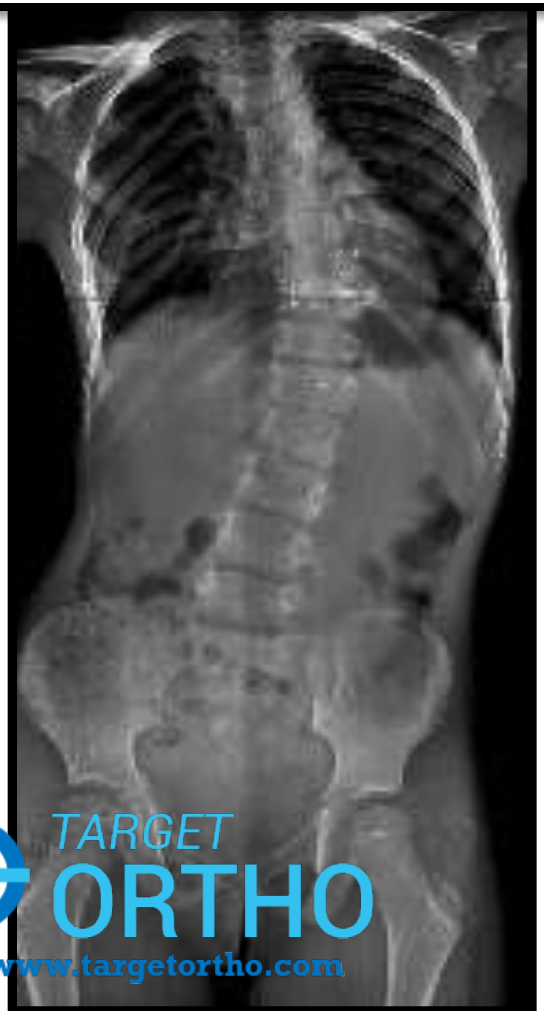
1. Rissers grading

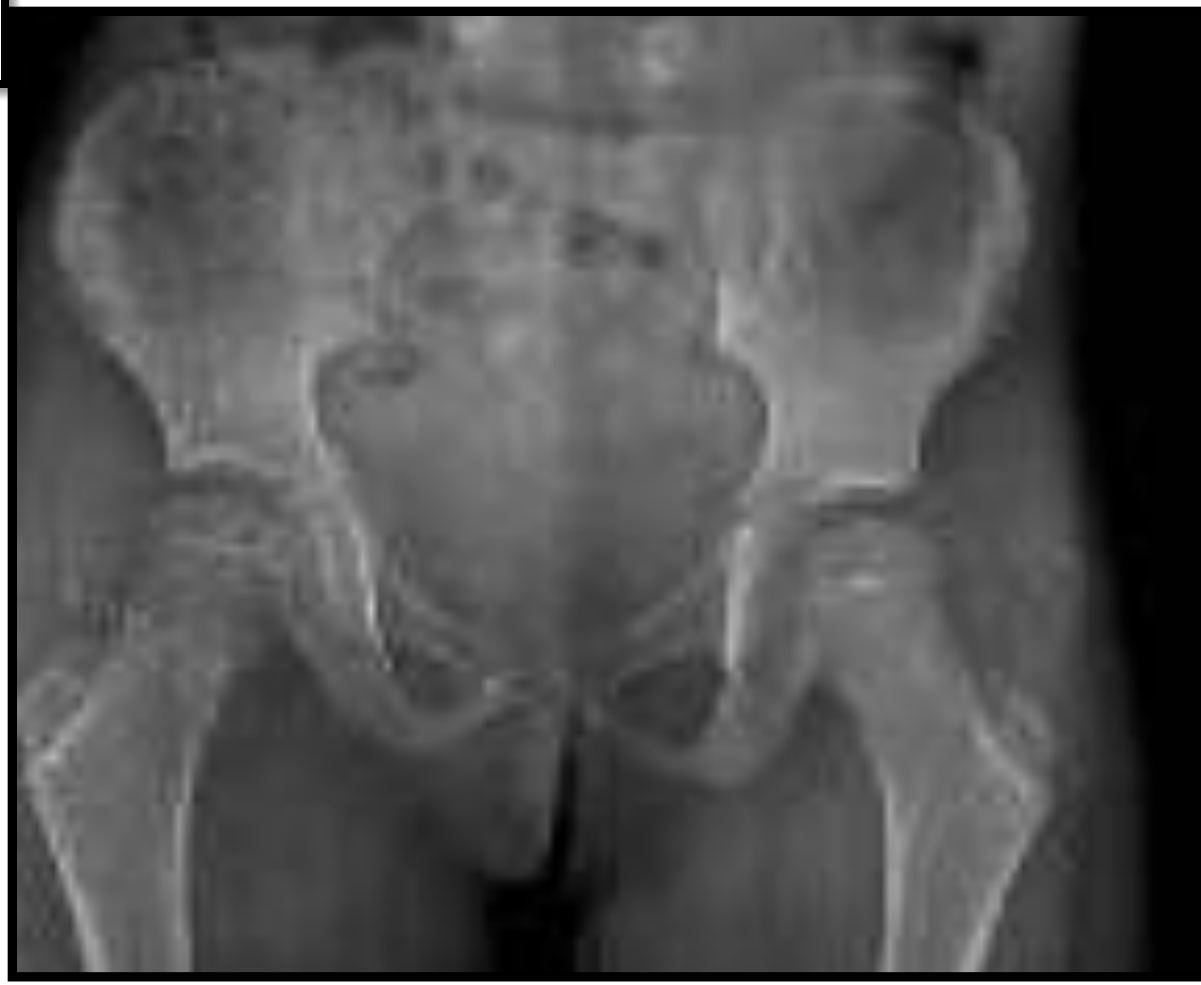
2. Fusion of triradiate cartilage & greater trochanter

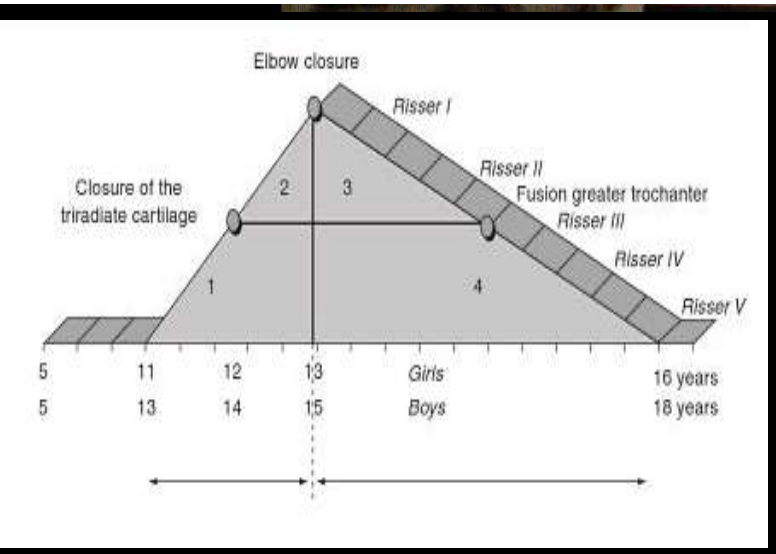


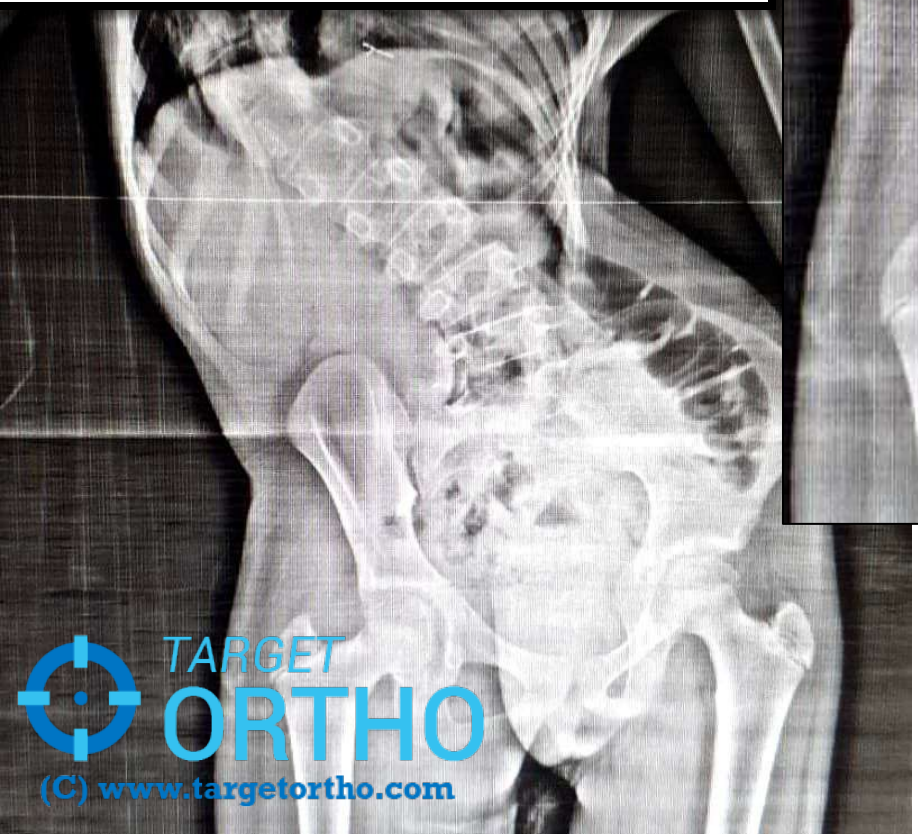


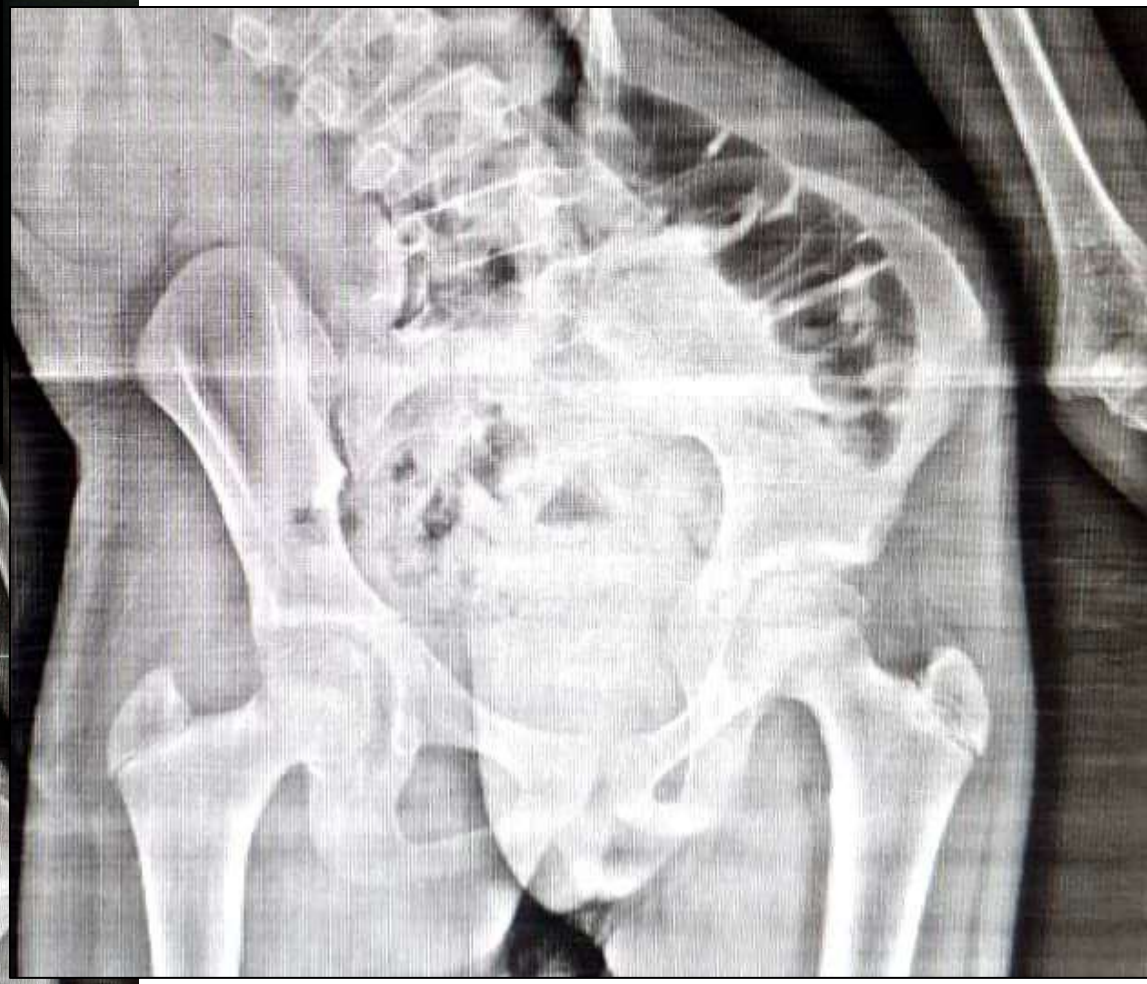


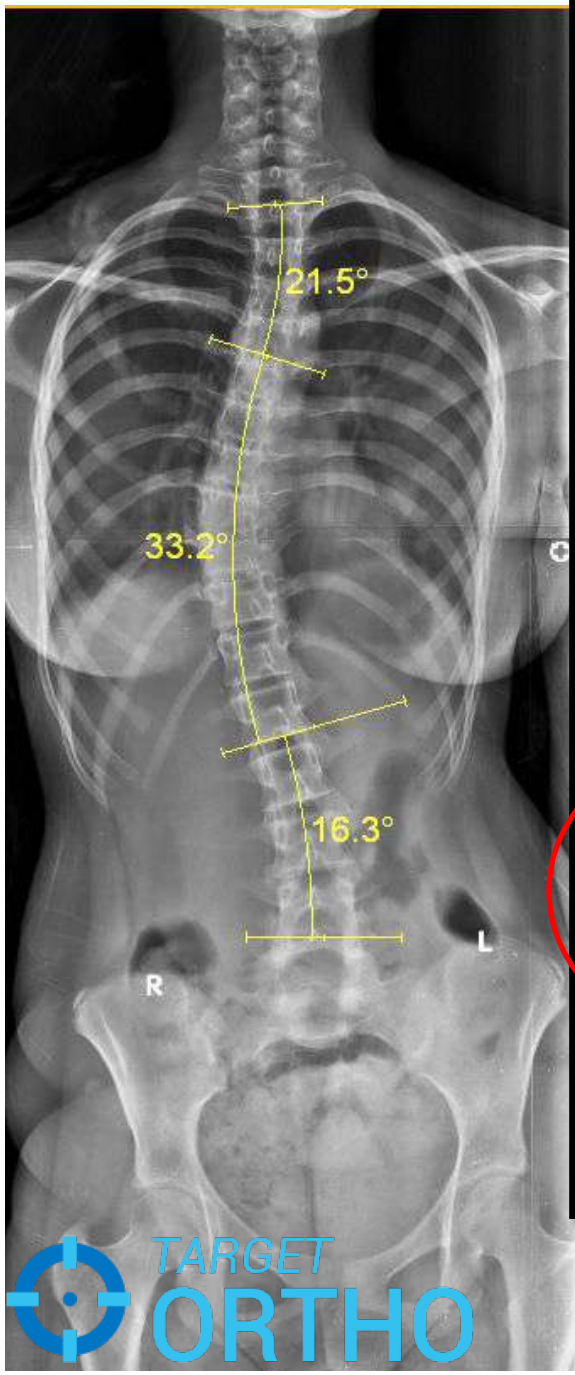


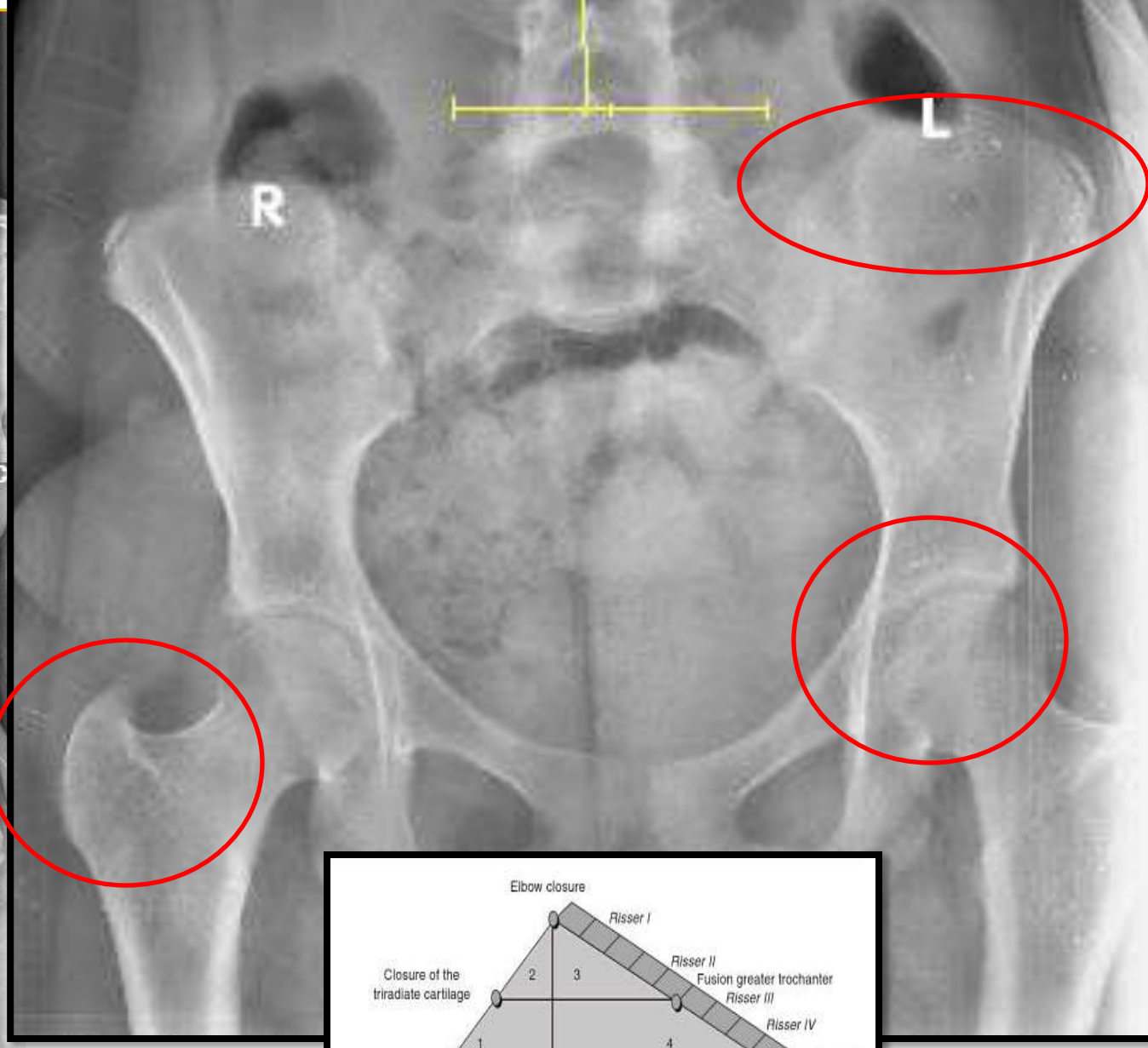


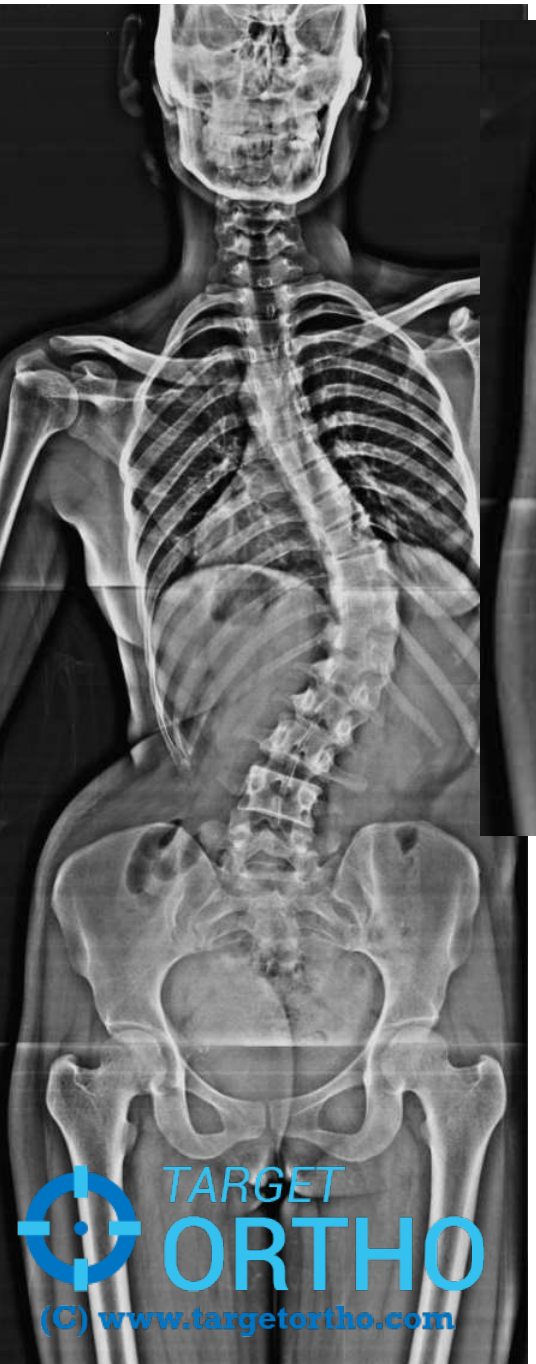


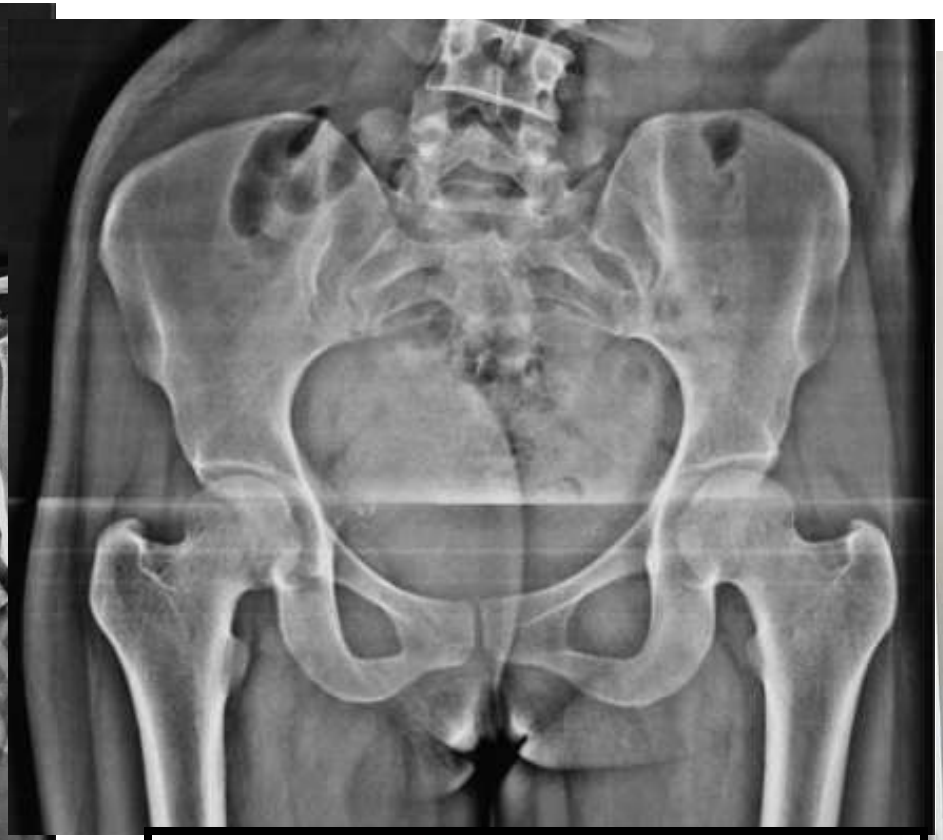


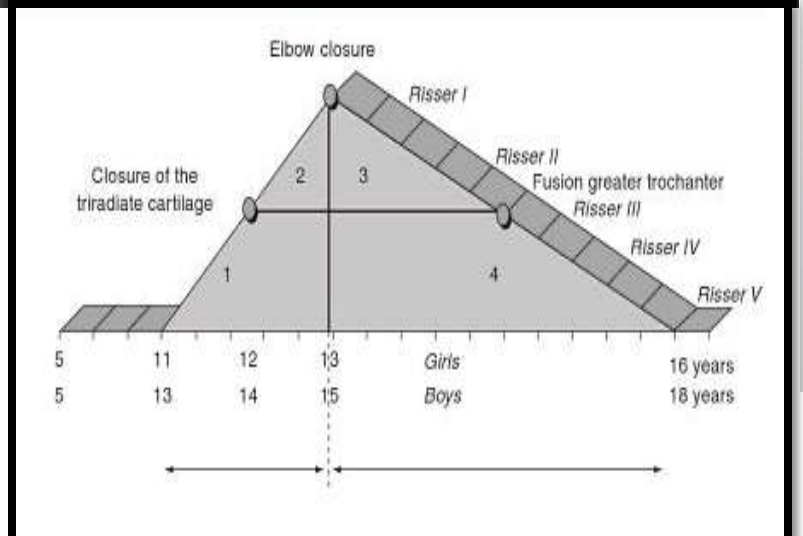








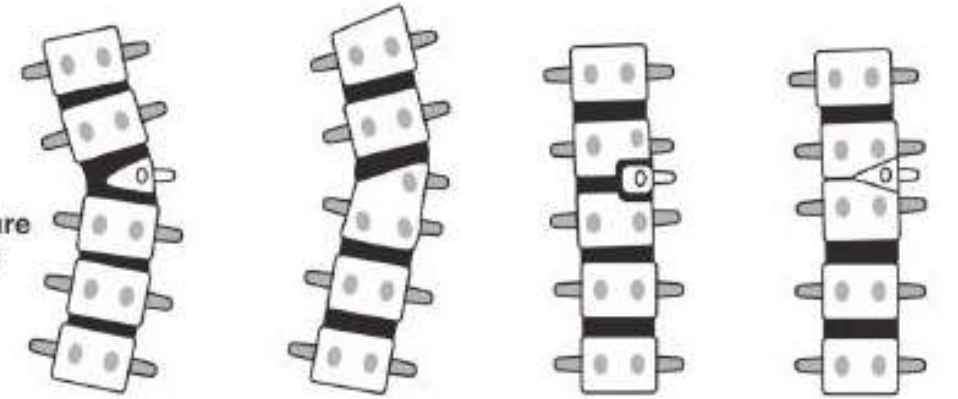




DEFECTS OF FORMATION

Hemivertebra

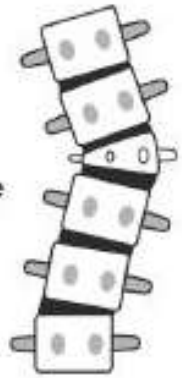
Unilateral complete failure of formation



Fully segmented | Semisegmented | Incarcerated | Nonsegmented

Wedge vertebra

Unilateral partial failure of formation



DEFECTS OF SEGMENTATION

Unilateral Unsegmented Bar

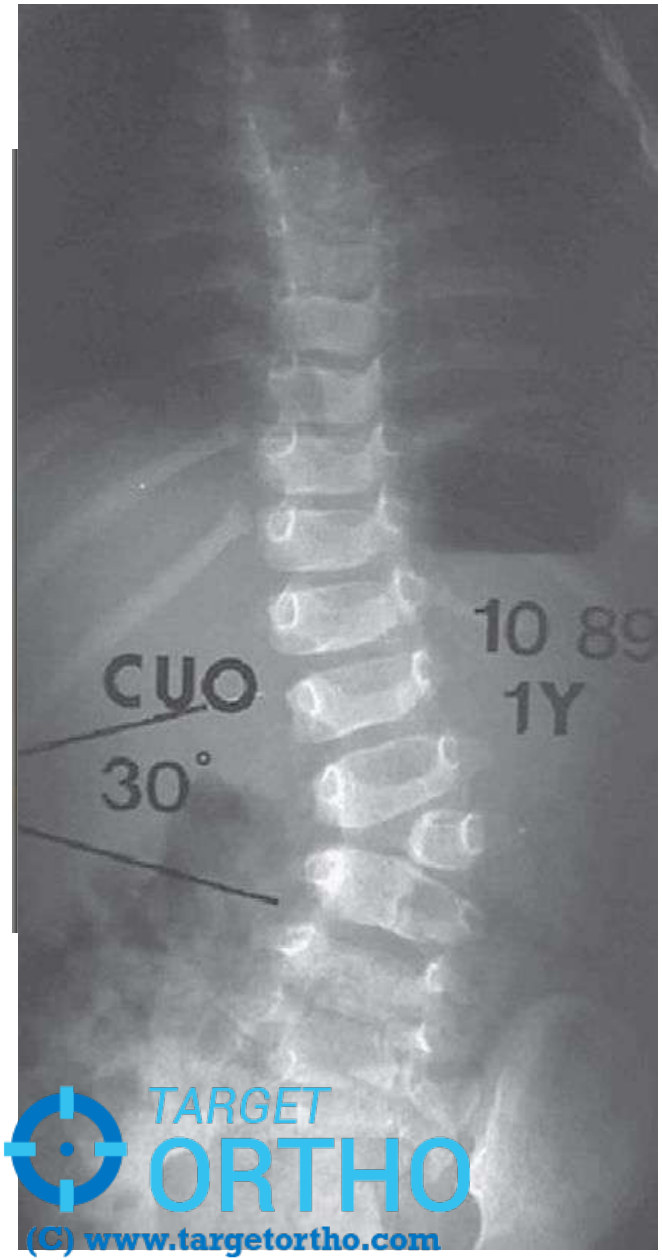
Unilateral Bar and Hemivertebrae

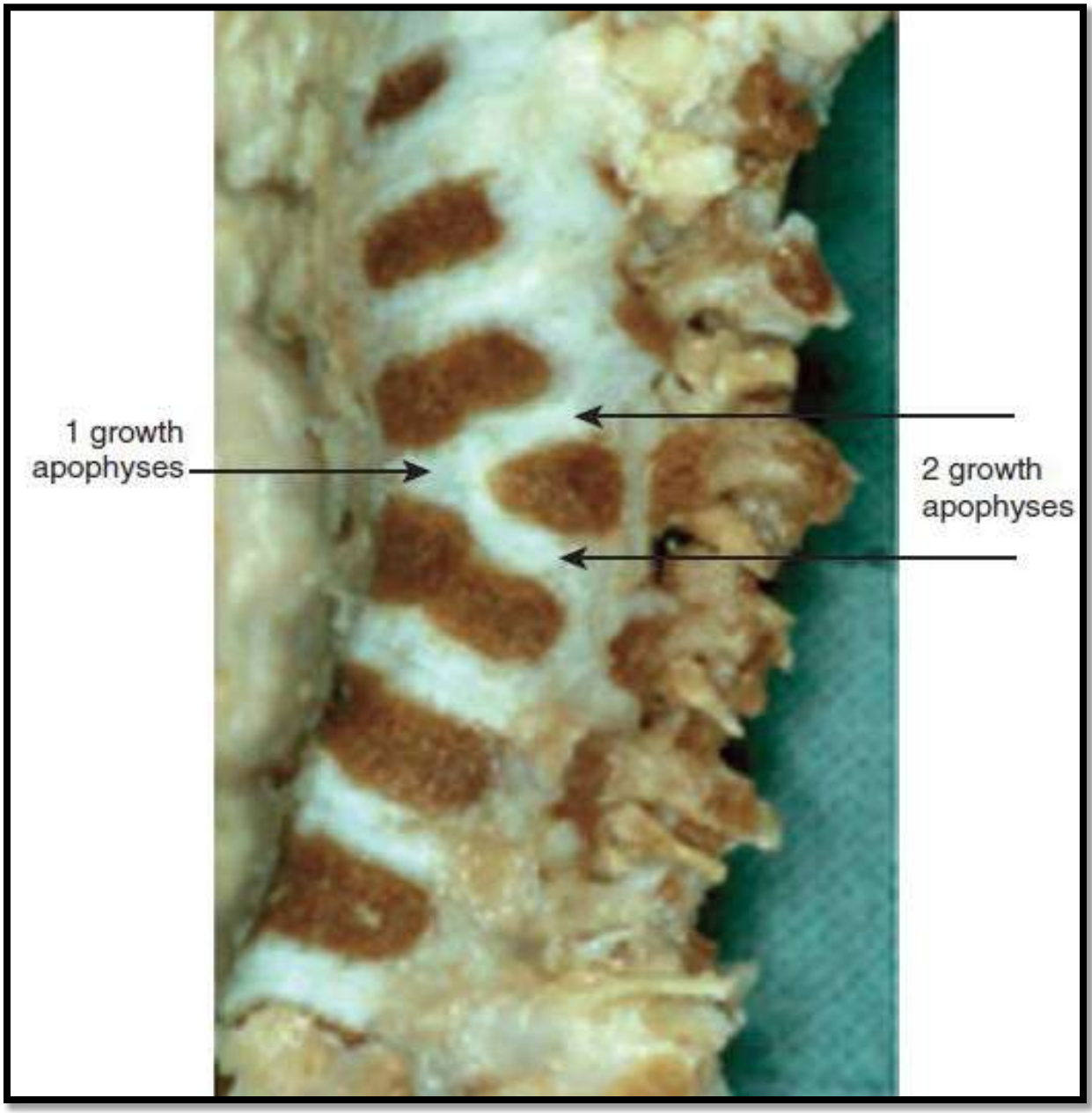
Unilateral failure of segmentation

Block vertebra

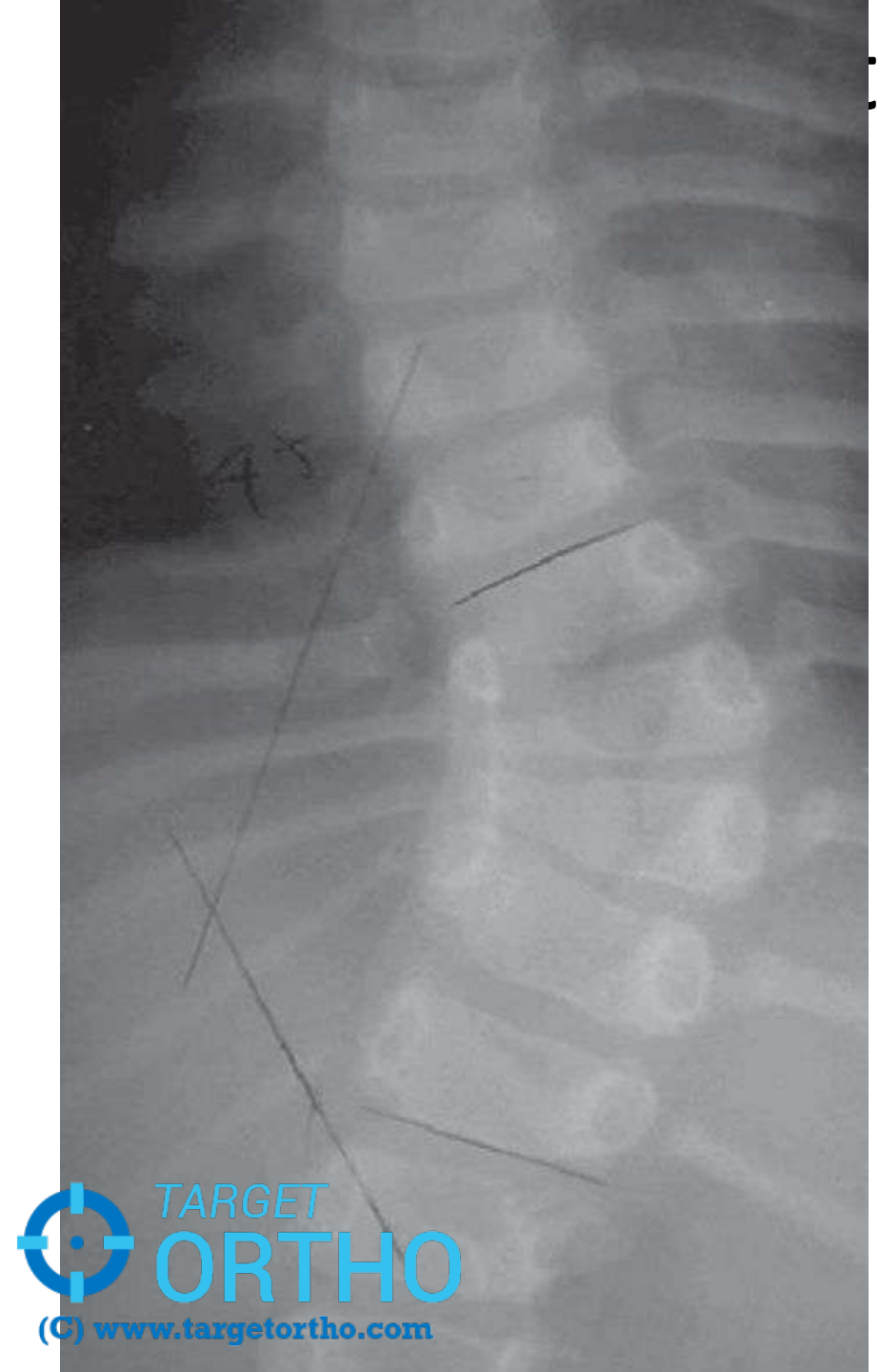
Bilateral failure of segmentation

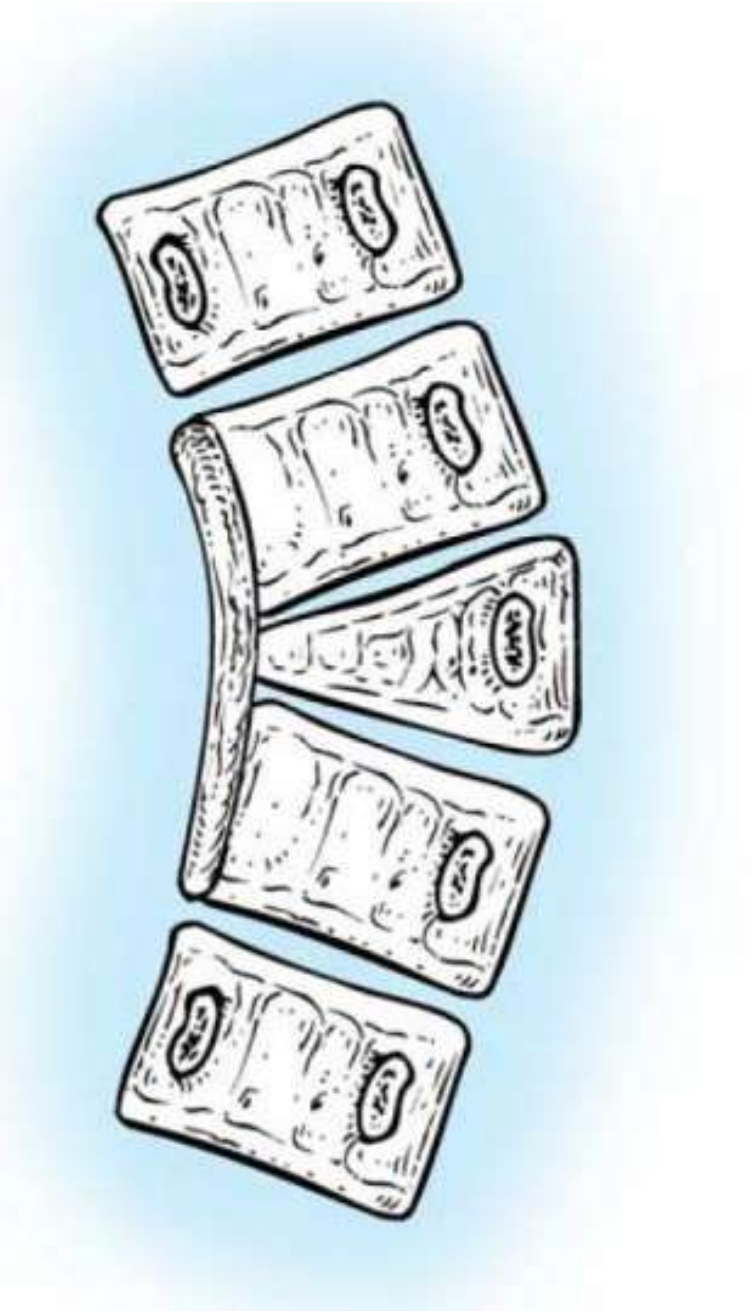
Congenital scoliosis



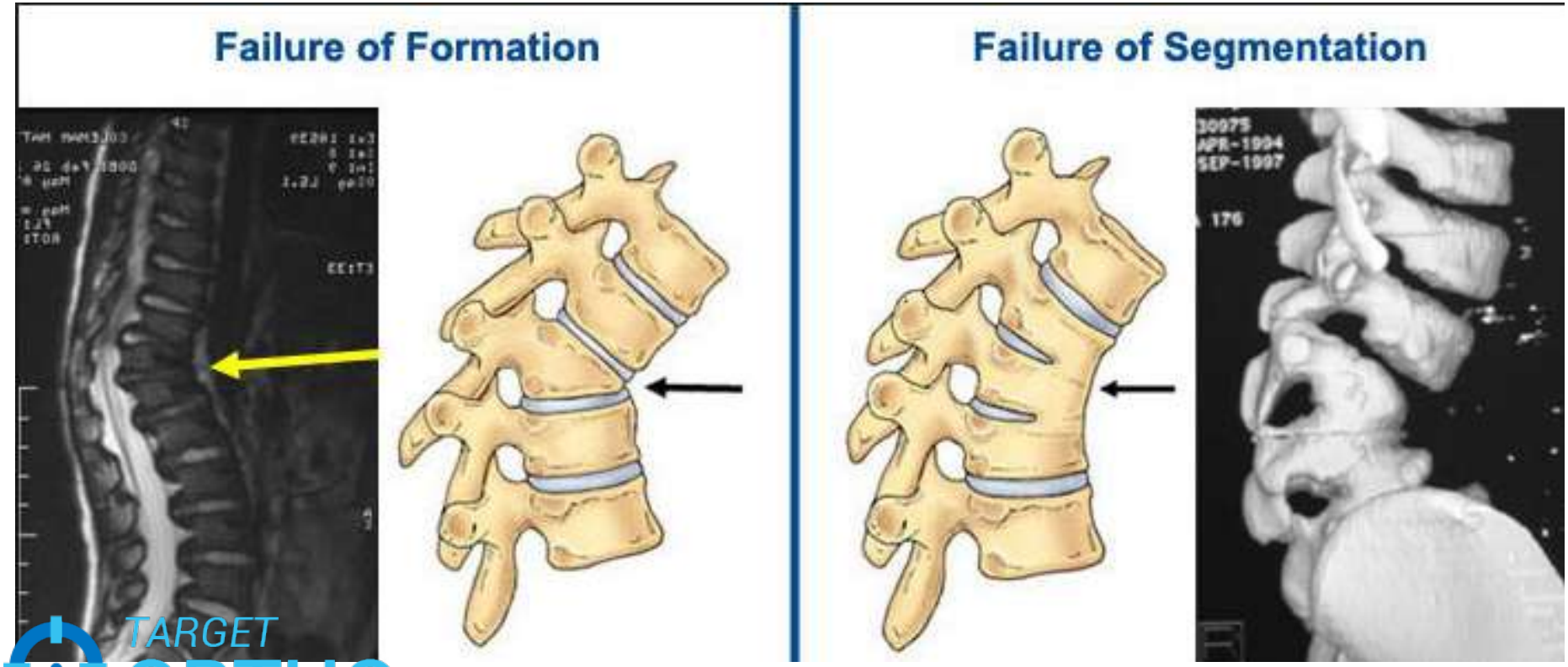


tal scoliosis

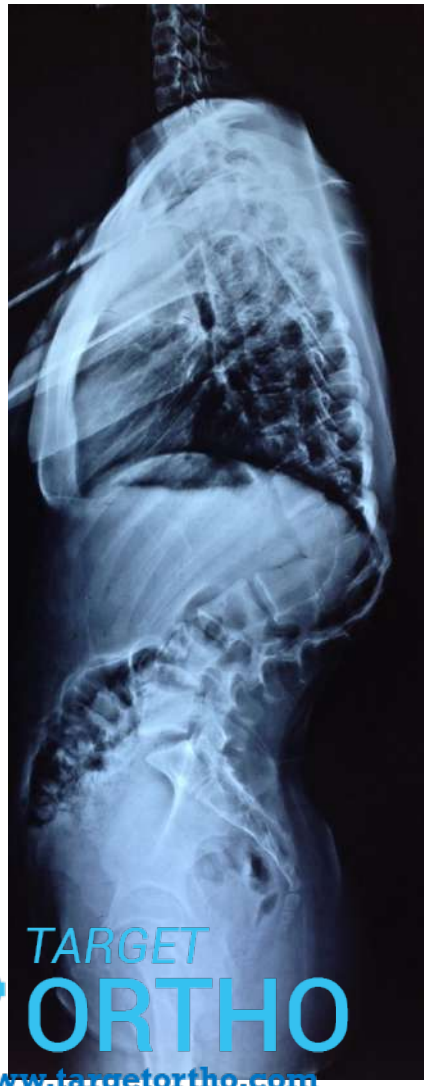


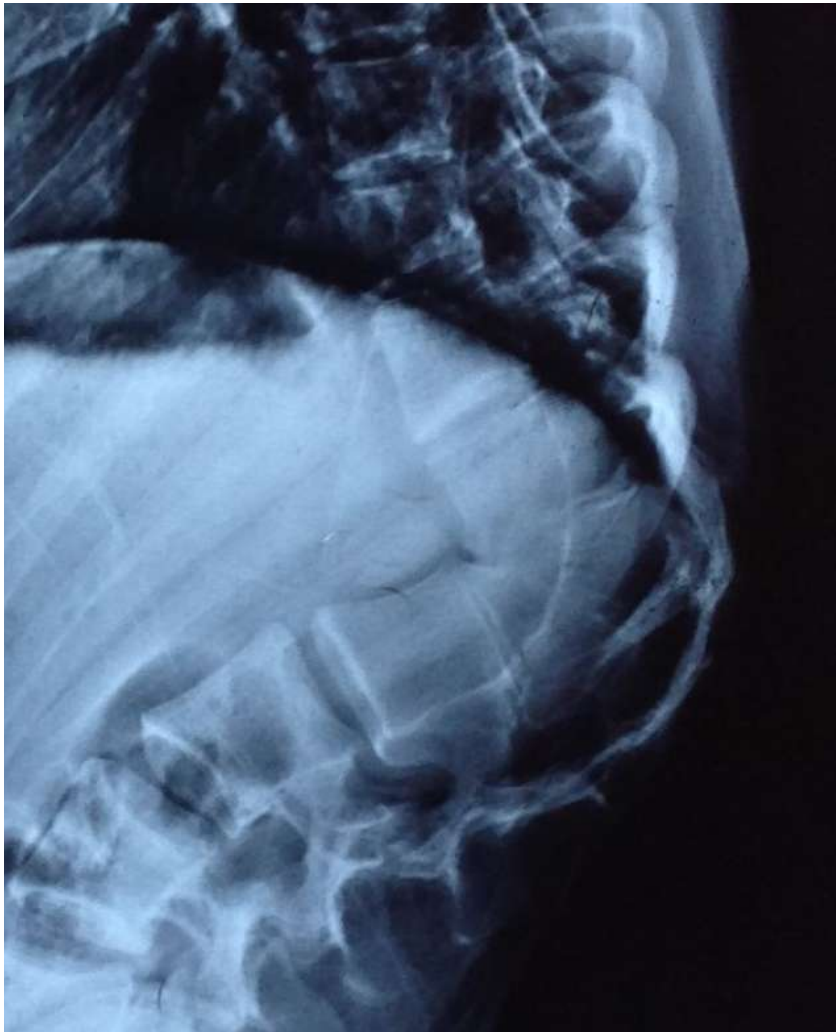


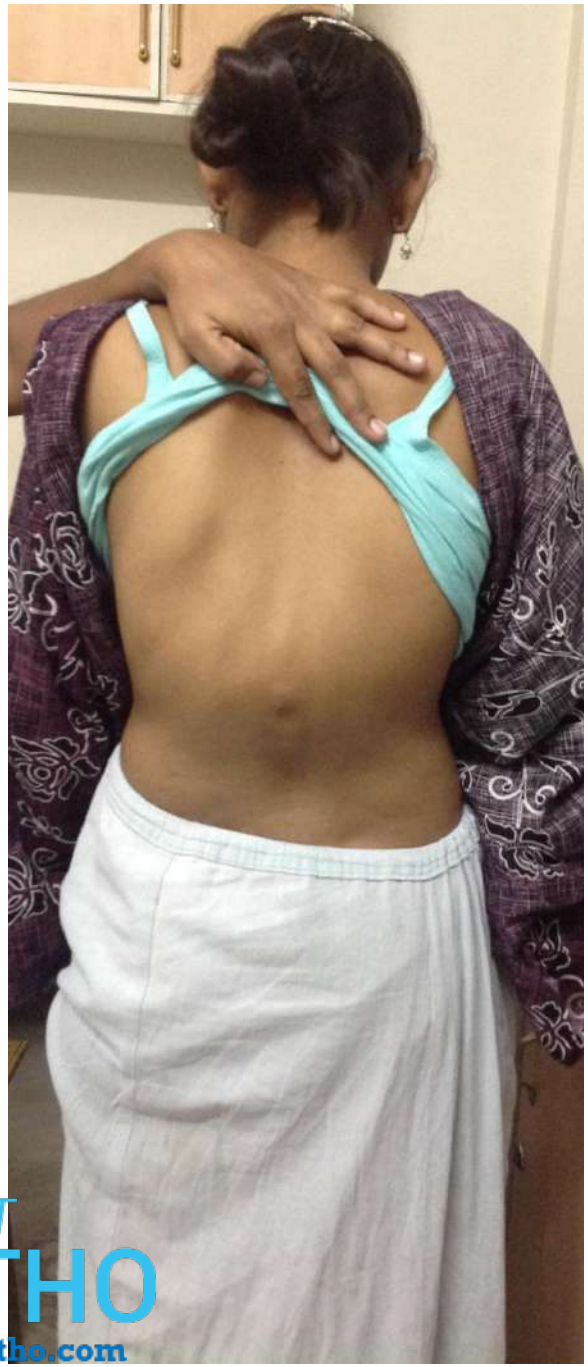
Congenital kyphosis

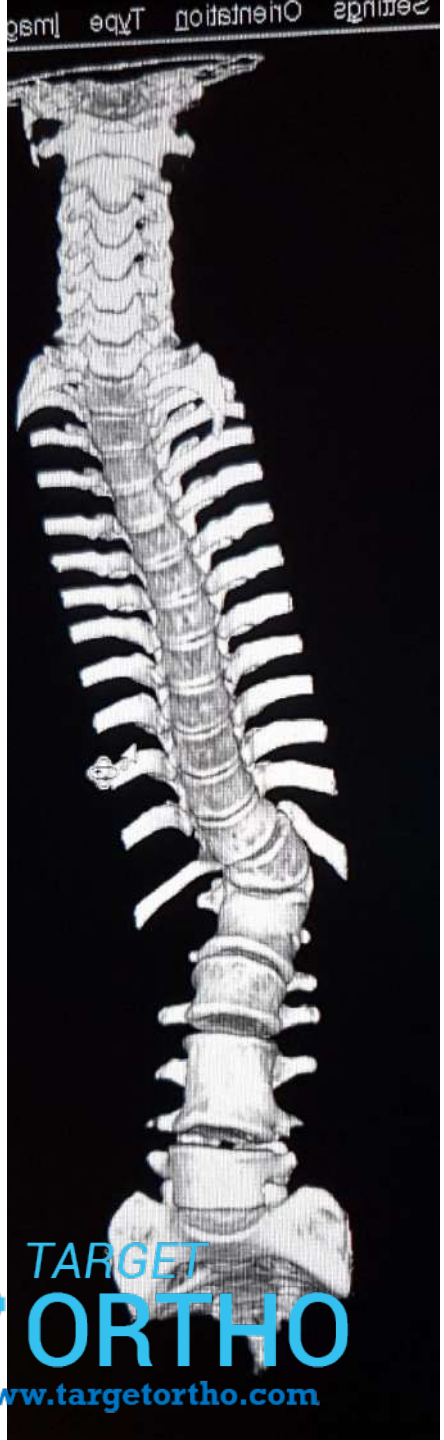


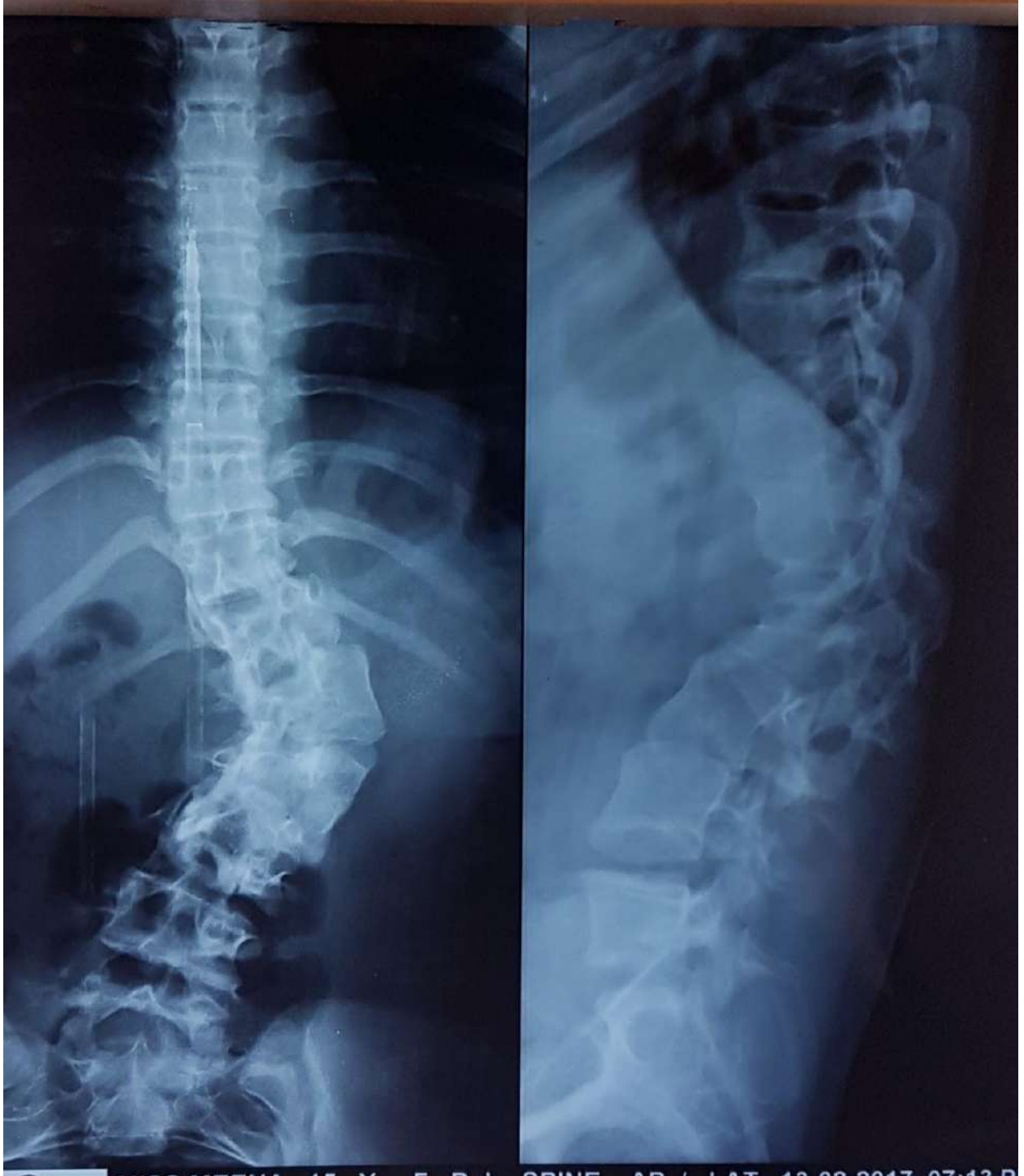
Failure of segmentation



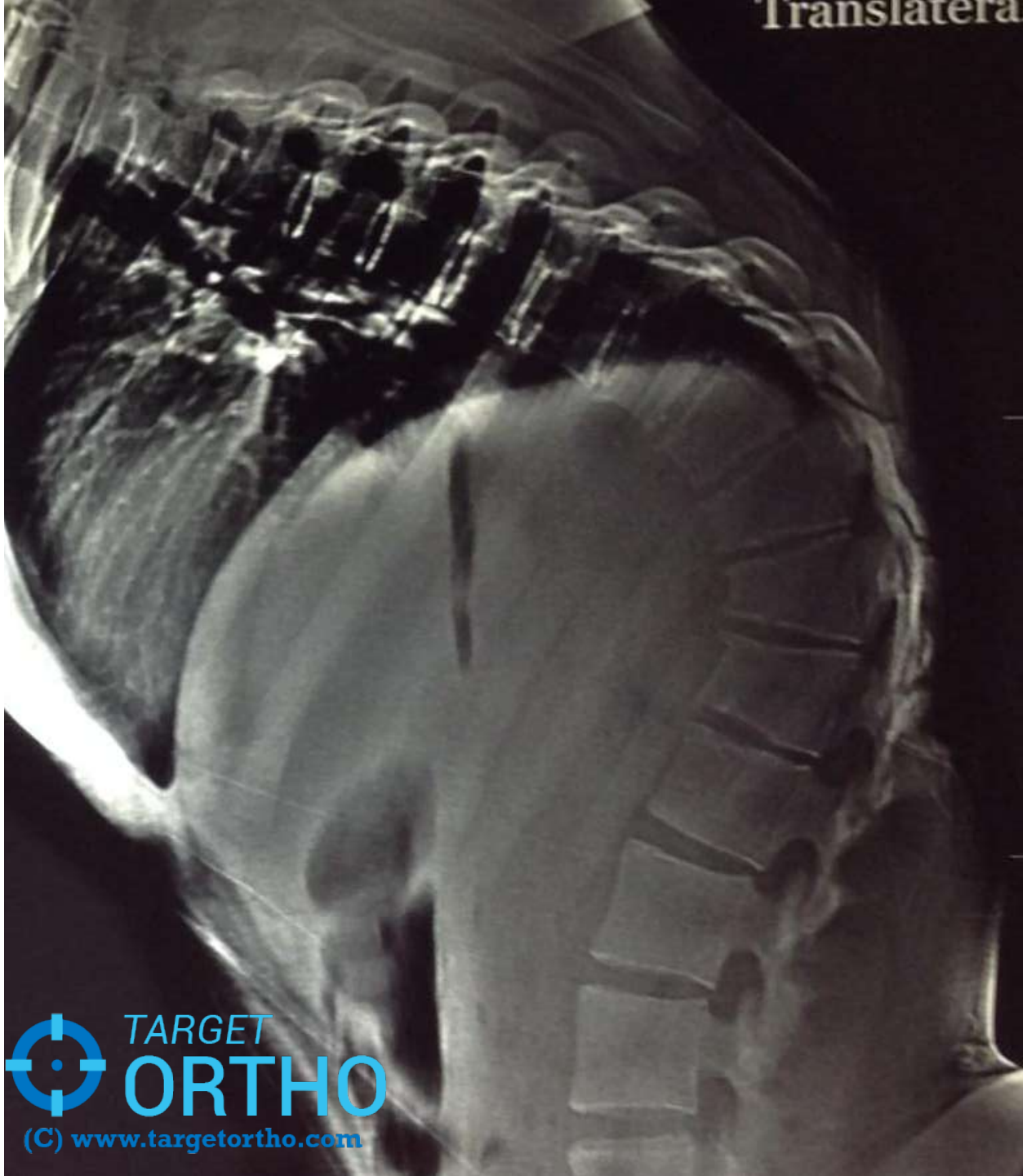


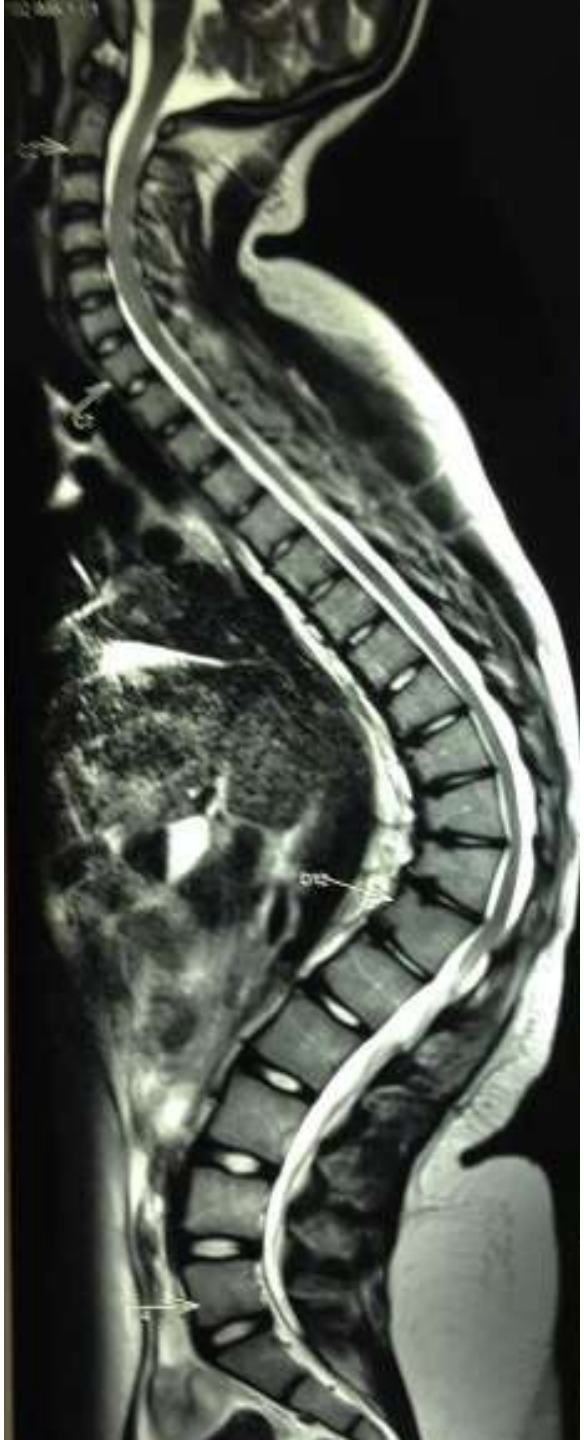






Scheurmanns kyphosis





Cross-sectional Imaging Modalities

- **When to Use CT and MR Imaging**

Table 3
Main Indications for Further Imaging in Patients with Radiographic Findings of Scoliosis

Congenital osseous abnormality (fusion and segmentation anomaly)
Congenital neuropathic abnormality (Arnold-Chiari malformation, tethered cord, dysraphism-related abnormality)
Dysplasia (neurofibromatosis, osteogenesis imperfecta, Marfan syndrome)
Pain suggestive of bone tumor, infection, or intervertebral disk herniation
Neurologic deterioration with abnormality at electroneurography or evoked electromyography
Preoperative evaluation of osseous abnormality
Presumed postoperative complication
Idiopathic curvature of spine with specific clinical or radiographic features listed in Table 4

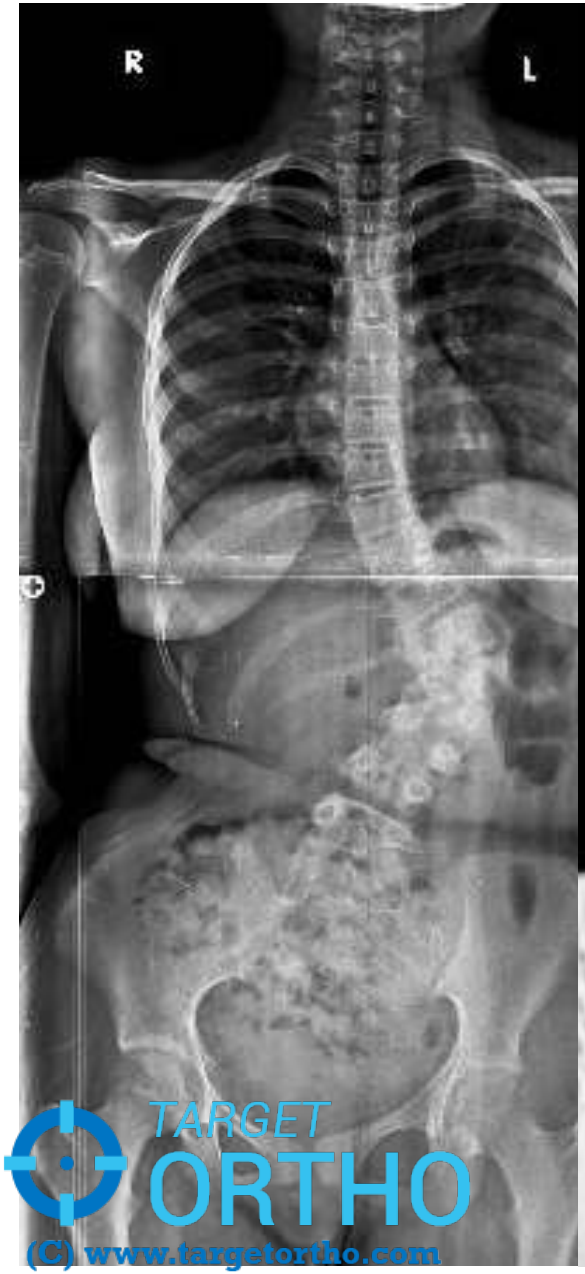
Table 4
Indications for MR Imaging in a Patient with Presumed Idiopathic Scoliosis

Clinical features
Age <10 years
Signs of neurologic deterioration
Rapid progression
Foot deformity
Back pain, neck pain, headache
Radiographic features
Curve type commonly associated with neuropathy (left thoracic, double thoracic, triple major, short-segment, or long right thoracic curve; severe curvature after skeletal maturity)
Wide spinal canal, thin pedicle, wide neural foramina, or other features suggestive of a nonosseous lesion

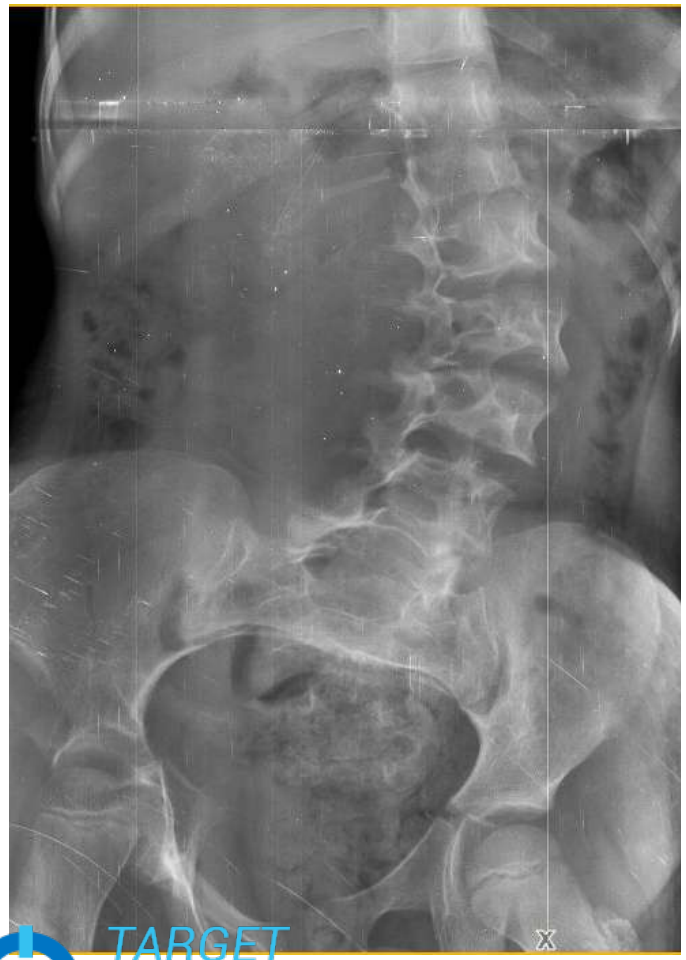
Computed tomography

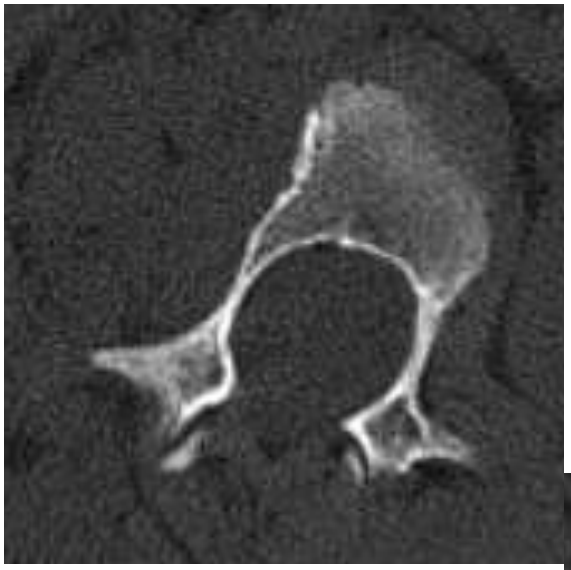
- Better visualisation of complex anomaly
- Assessment of Pedicle size
- Bony bar in diastometomyelia

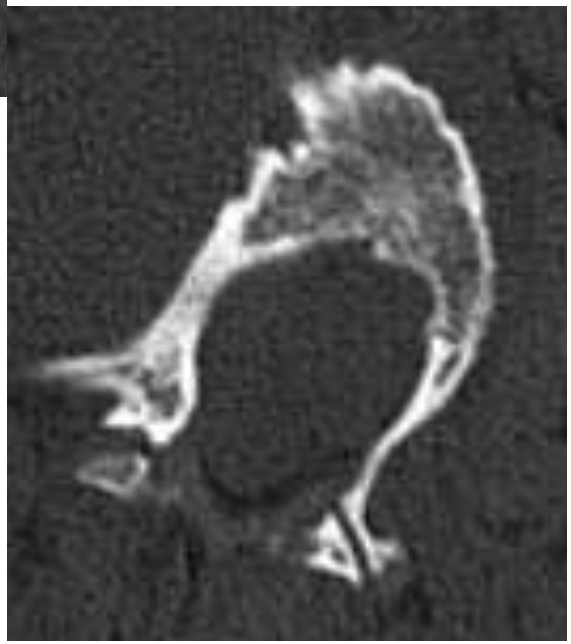
CT- Better visualisation of complex anomaly

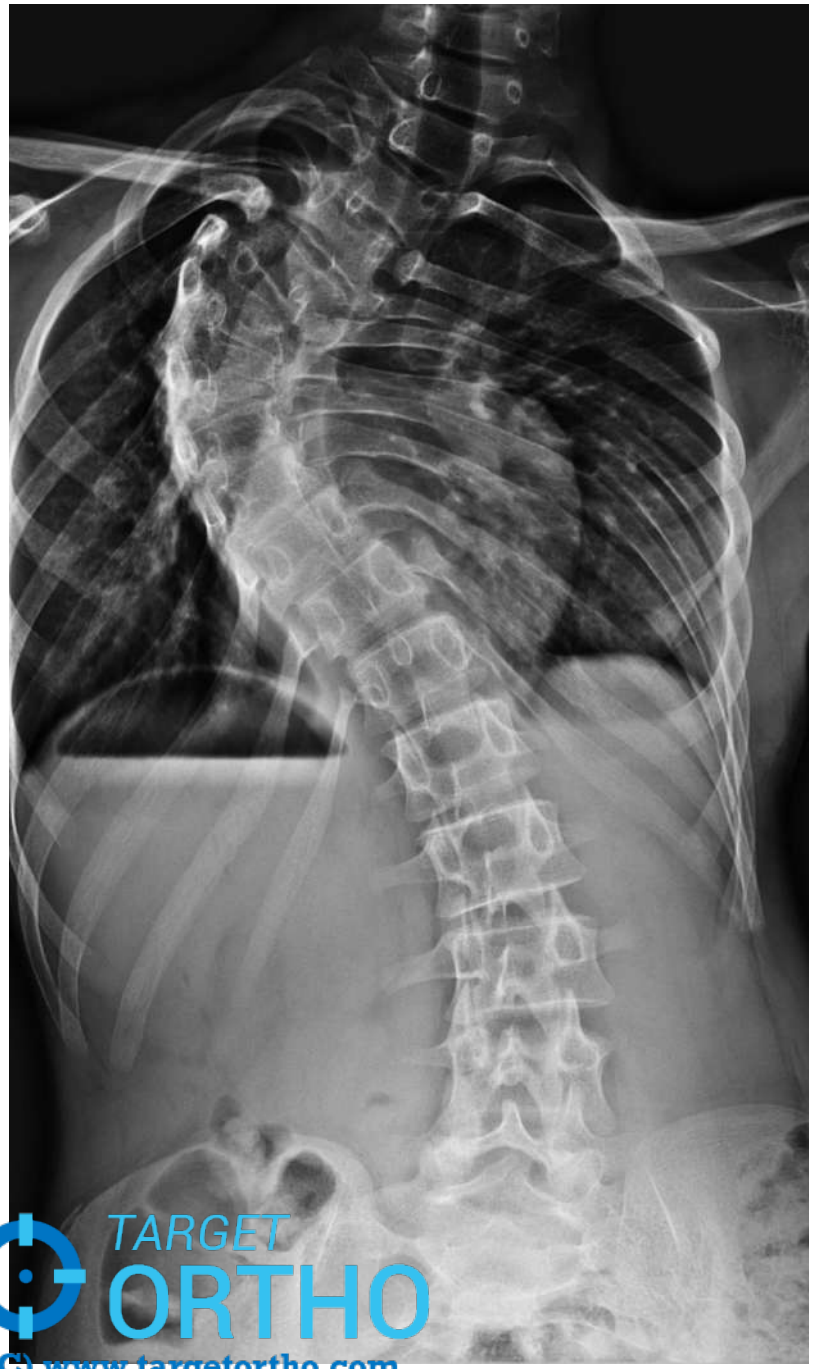


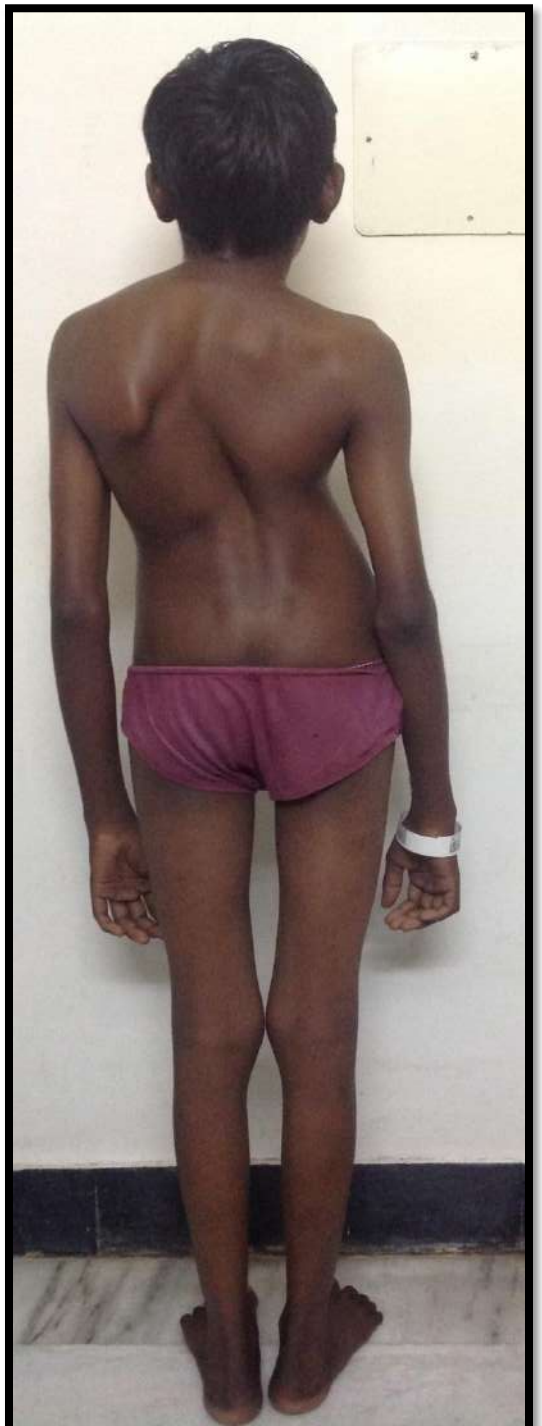
CT- Assessment of Pedicle size

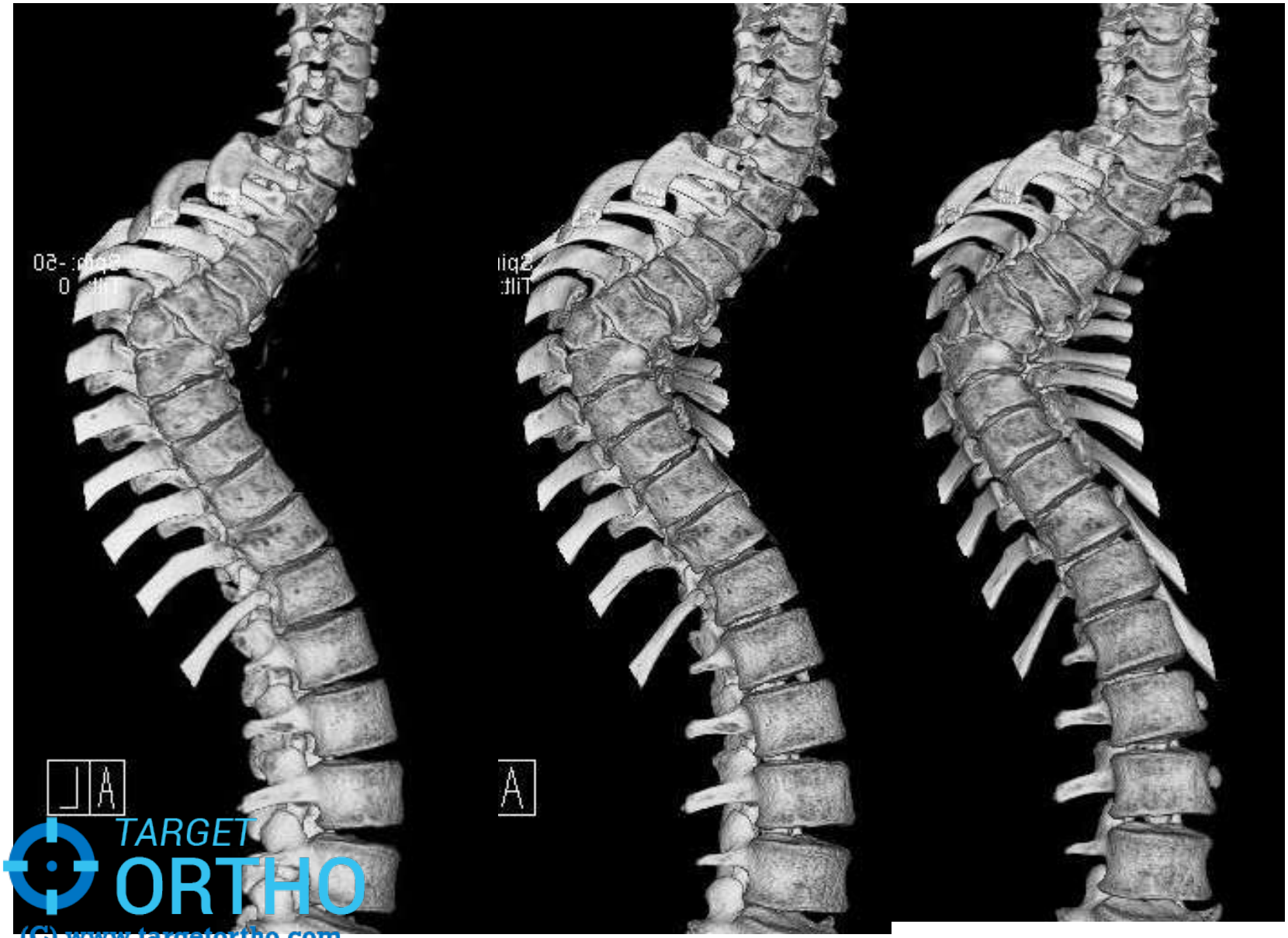


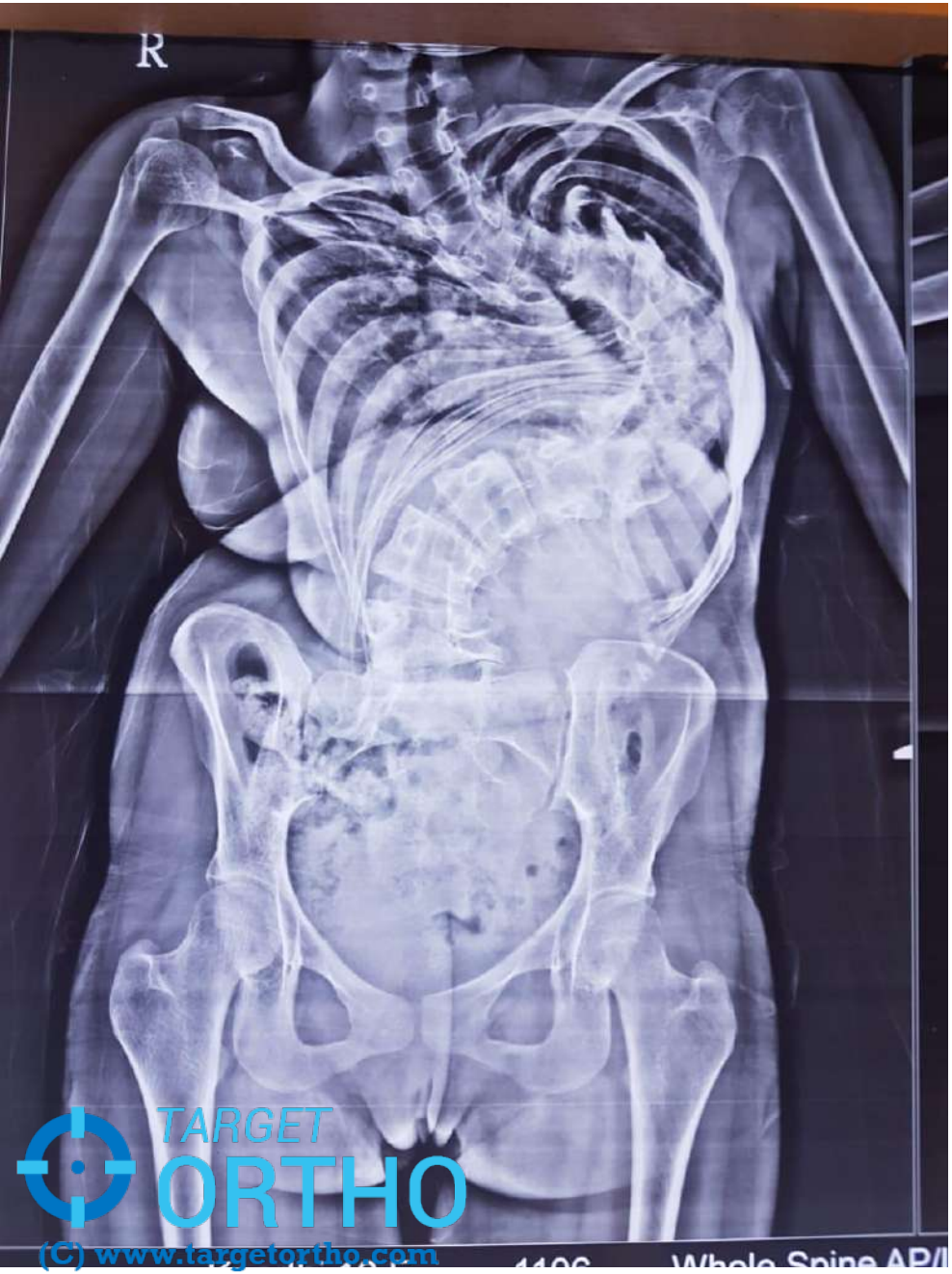








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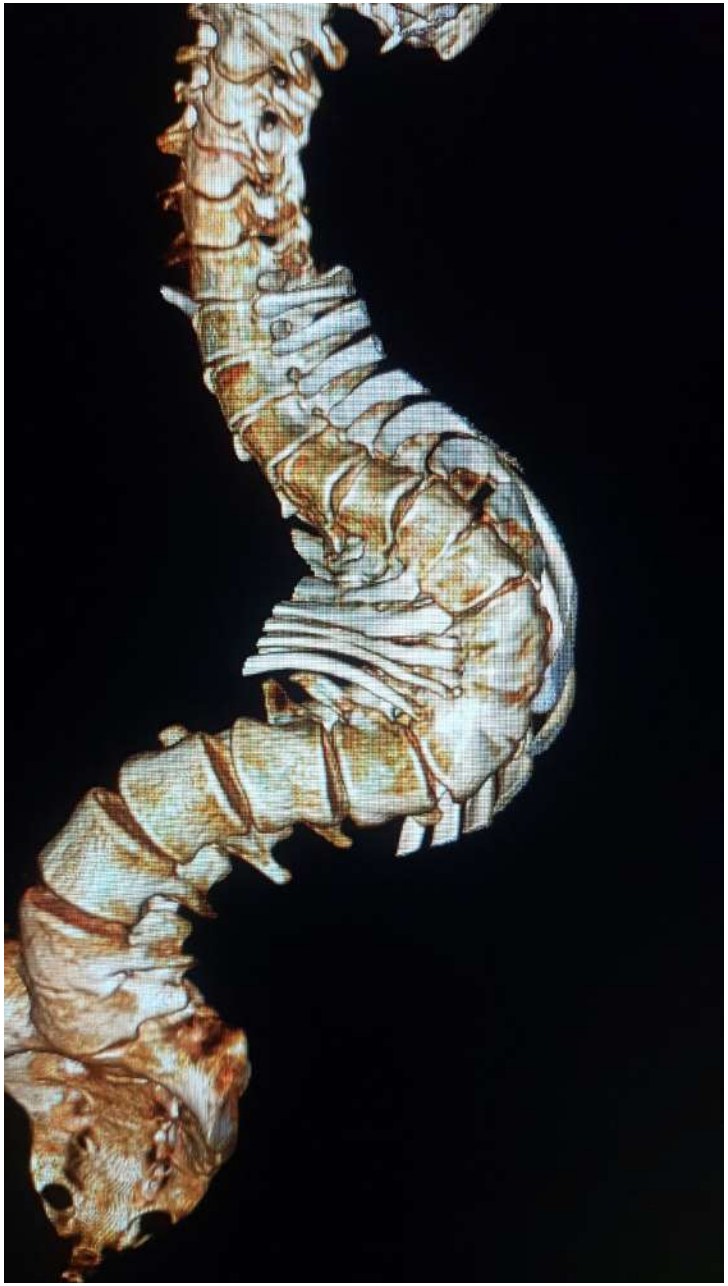
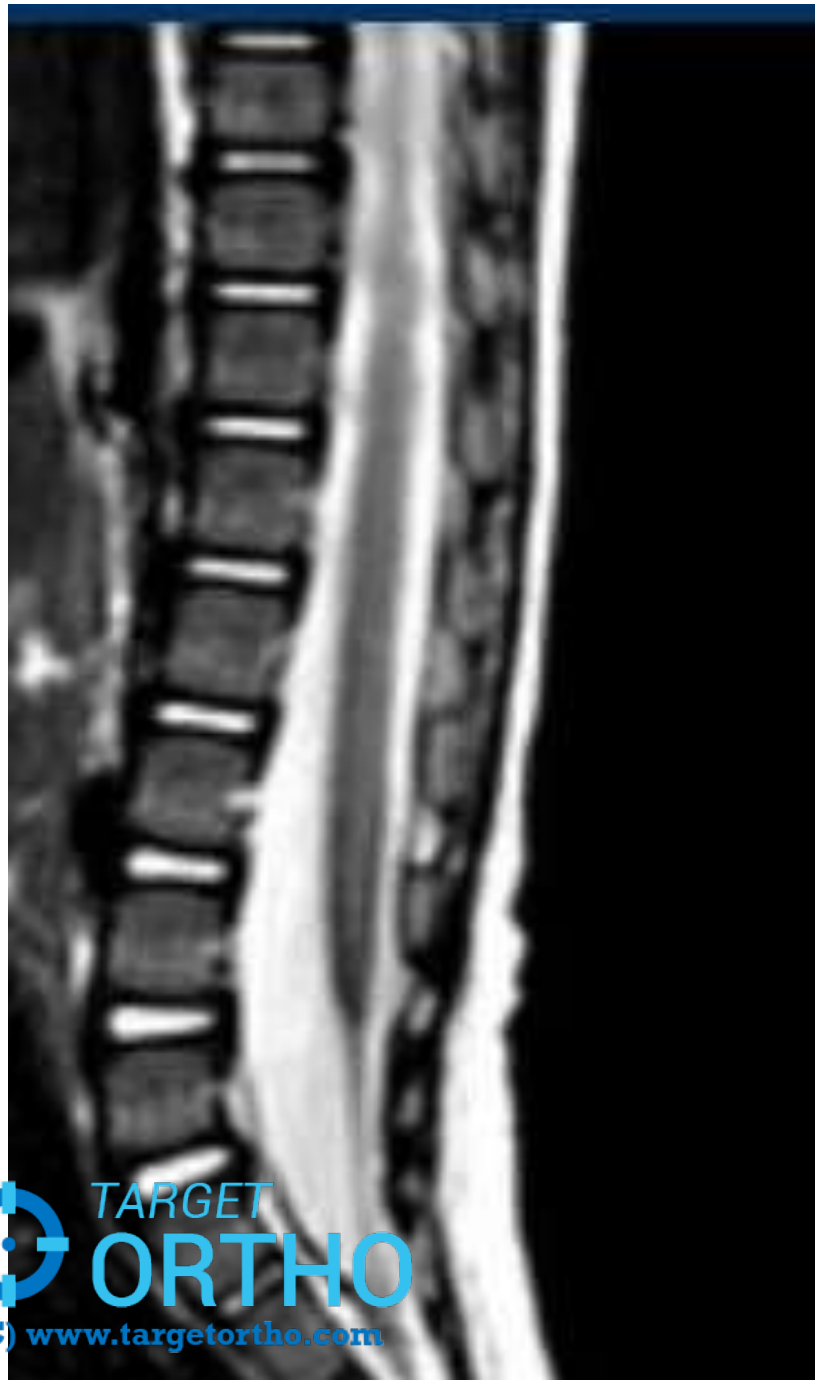
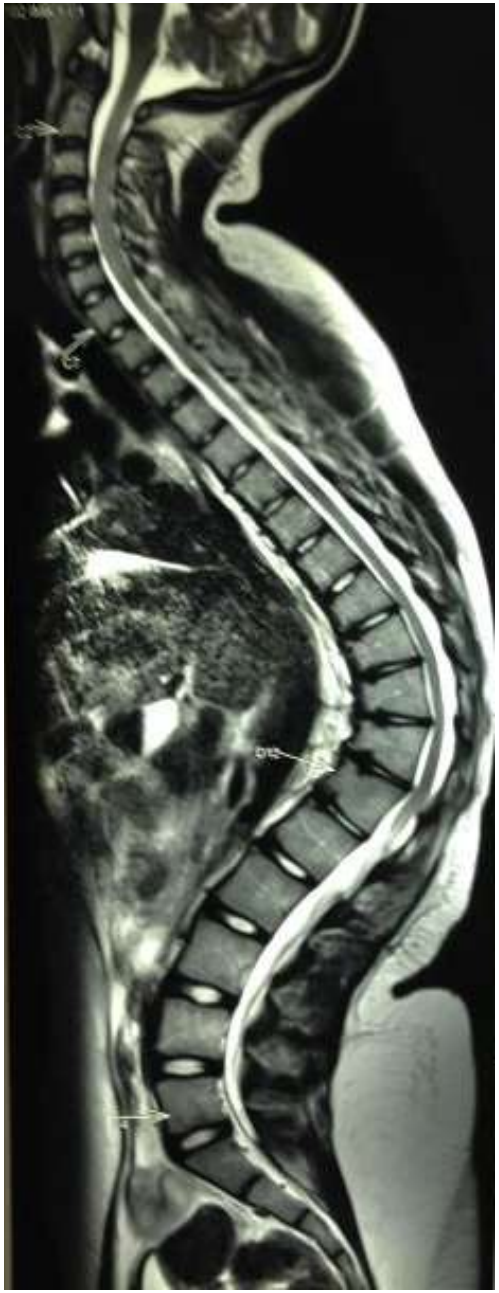


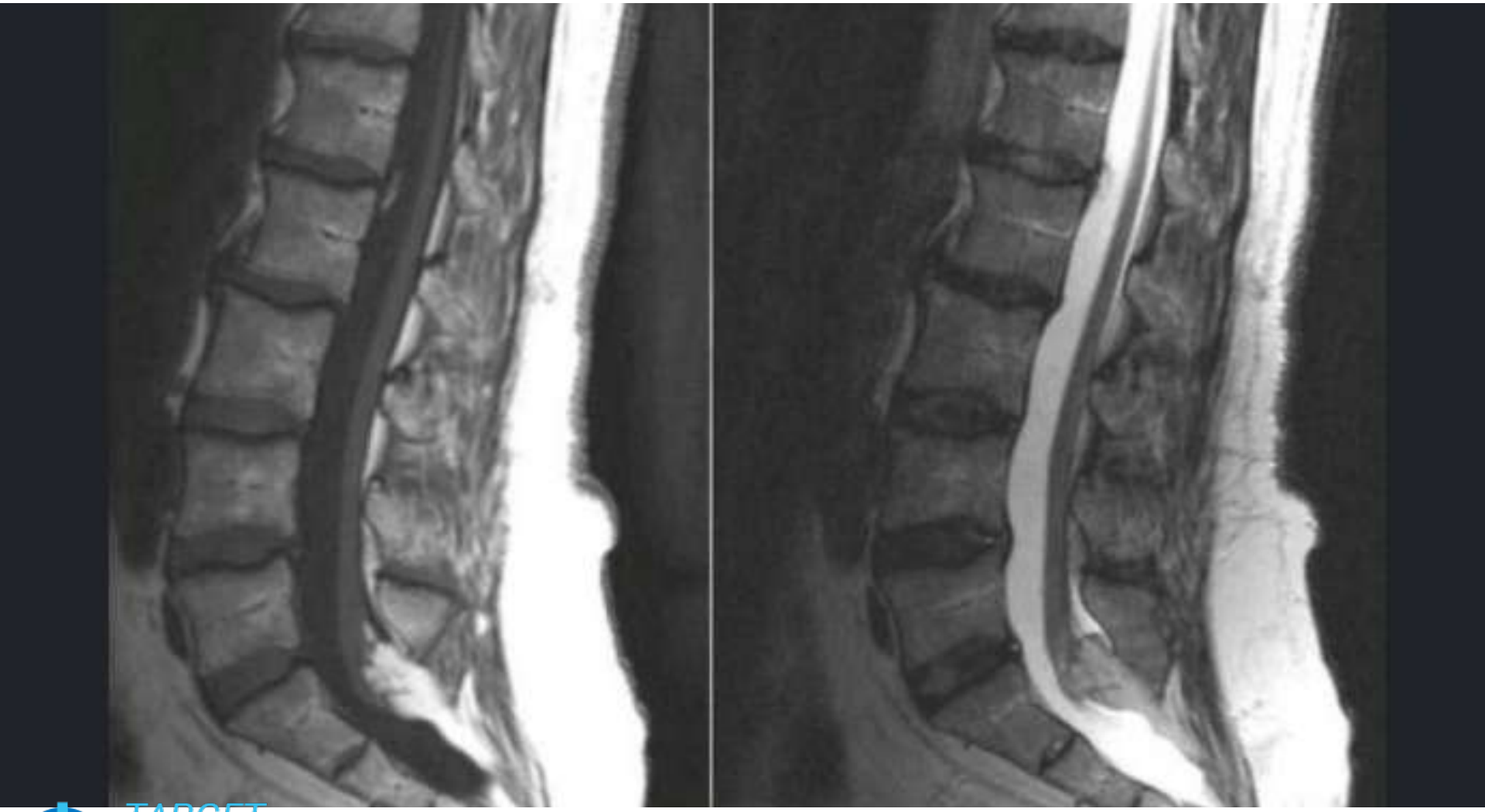
MRI

Status of cord

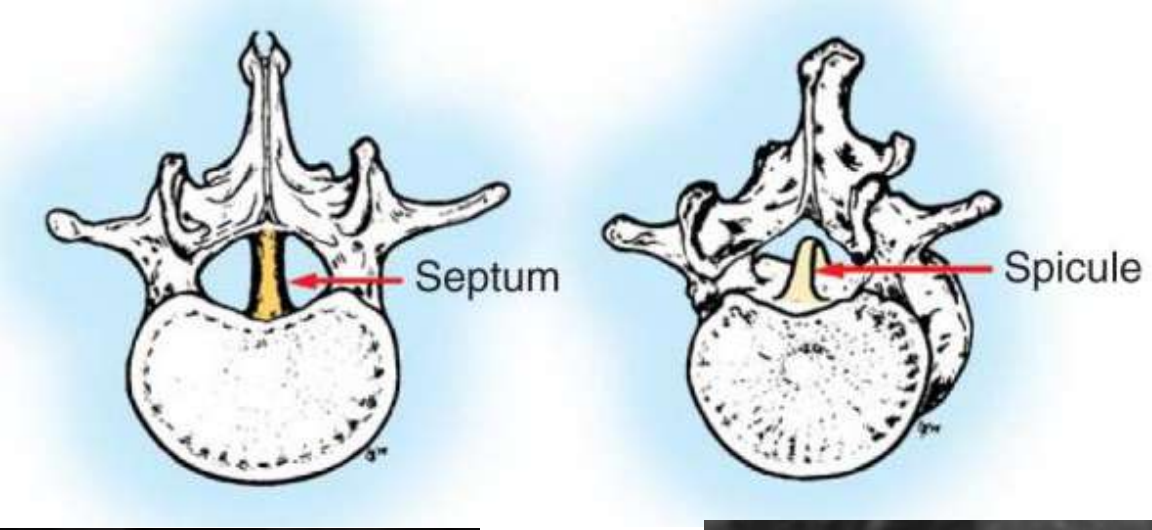
- Neurological defecit
- Absence of reflexes
- Neurocutaneous markers
- Before surgery
- Rapid progression
- Pain – severe

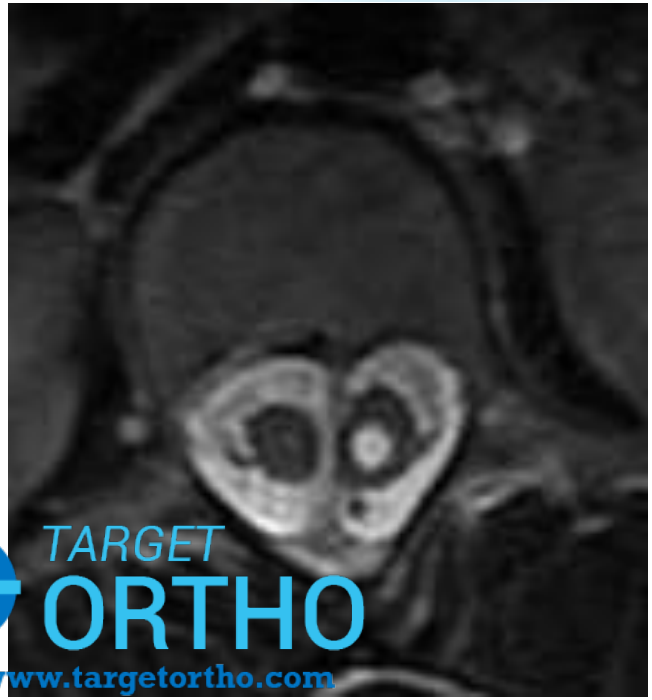


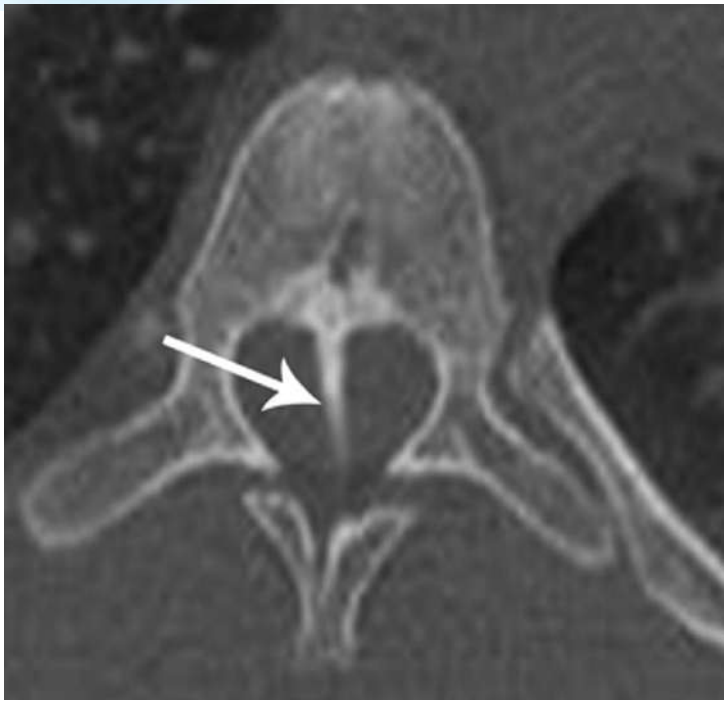




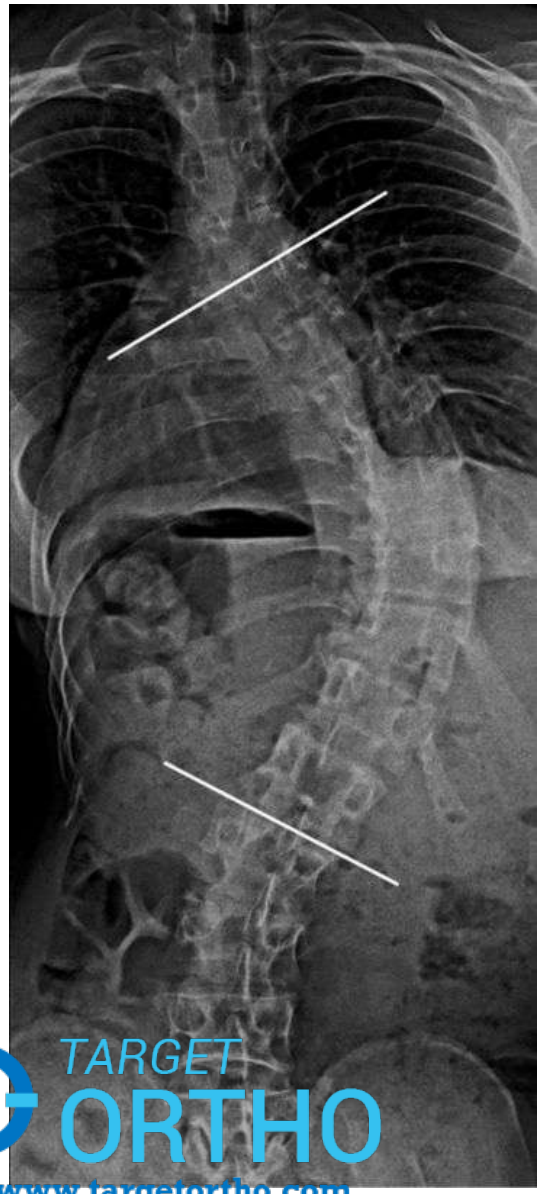
CT-Bony bar in diastometomyelia

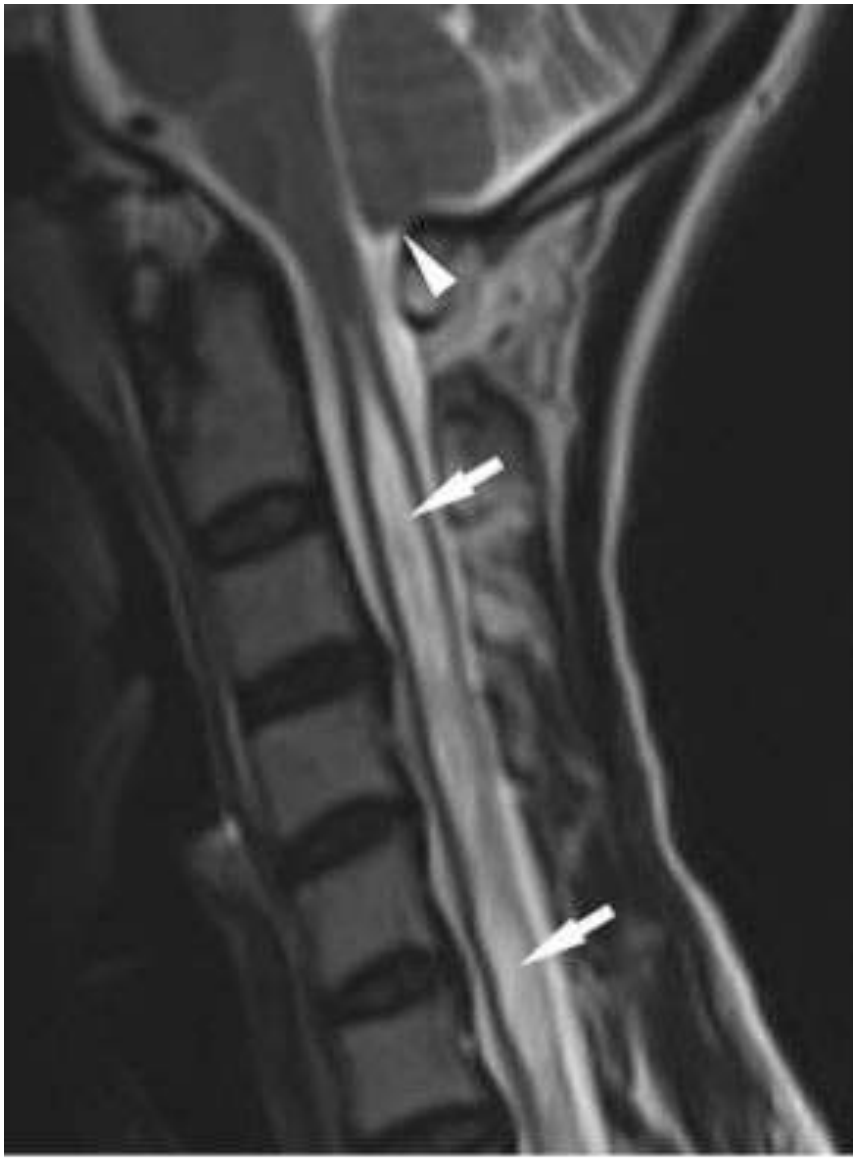




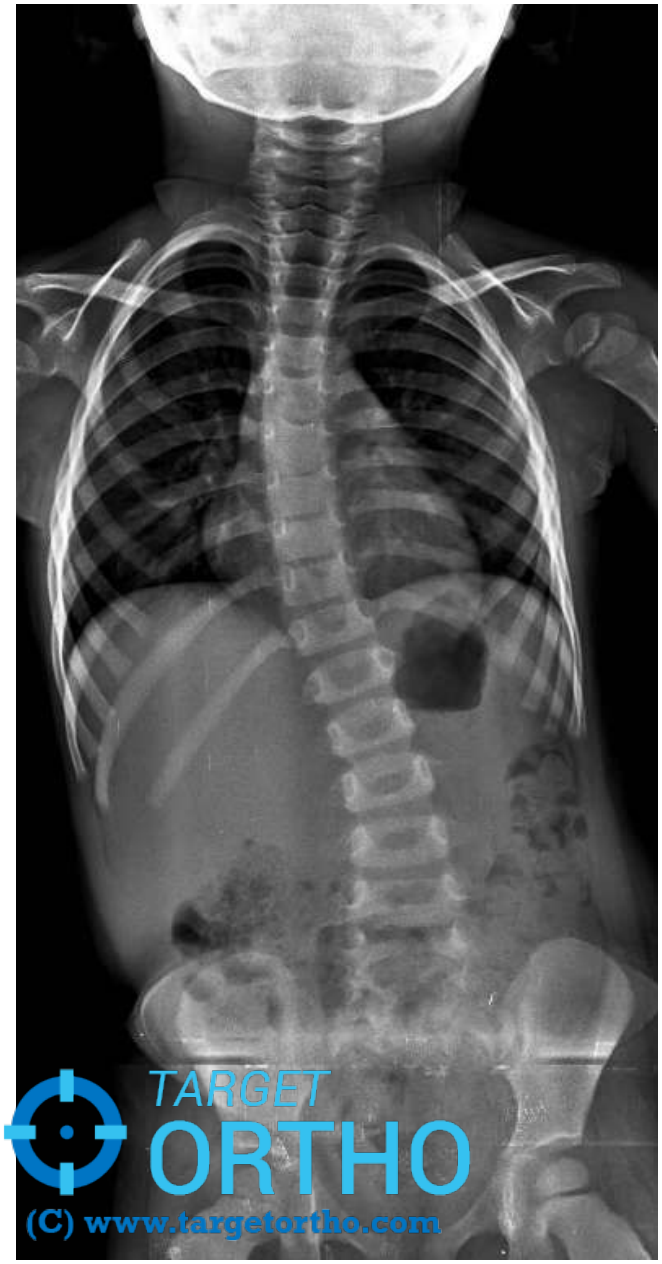


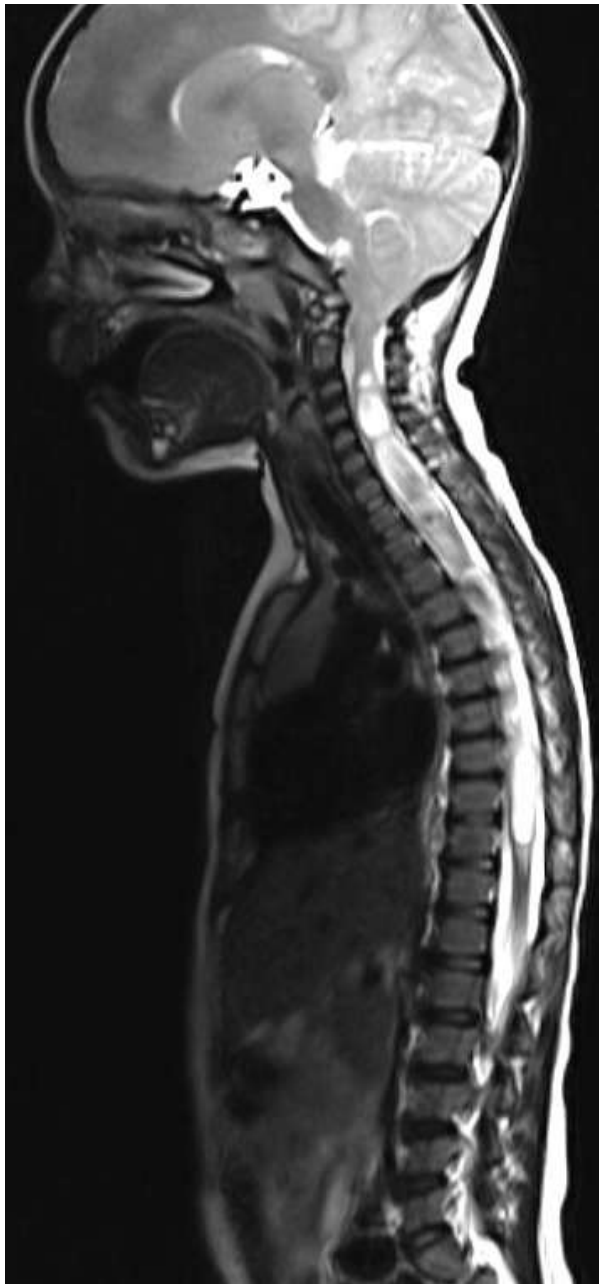
MRI- Arnold Chiari malformation

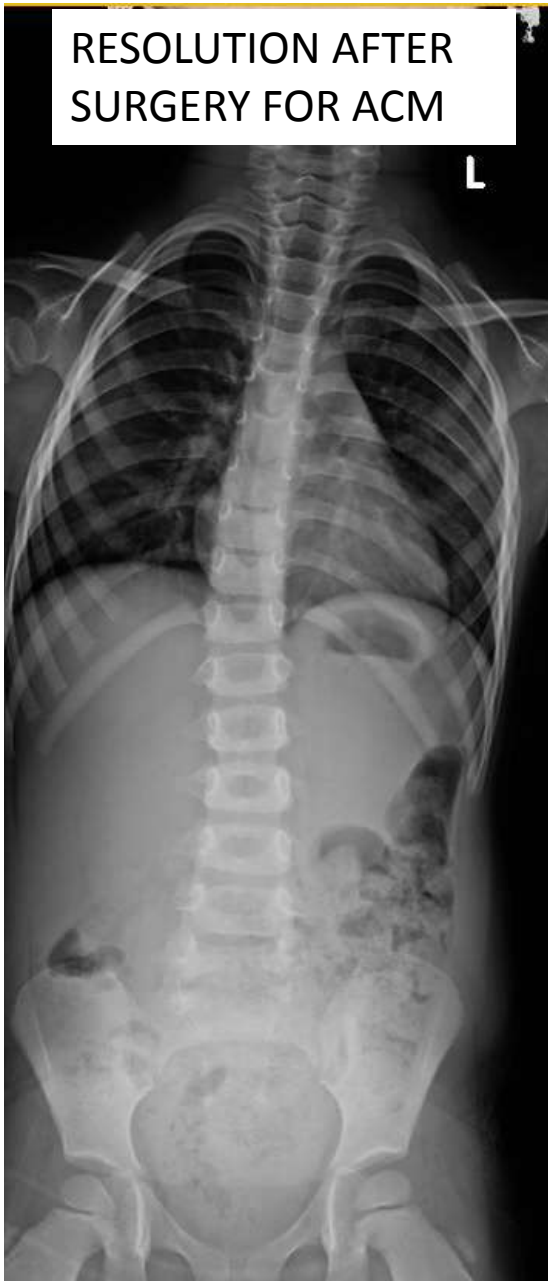




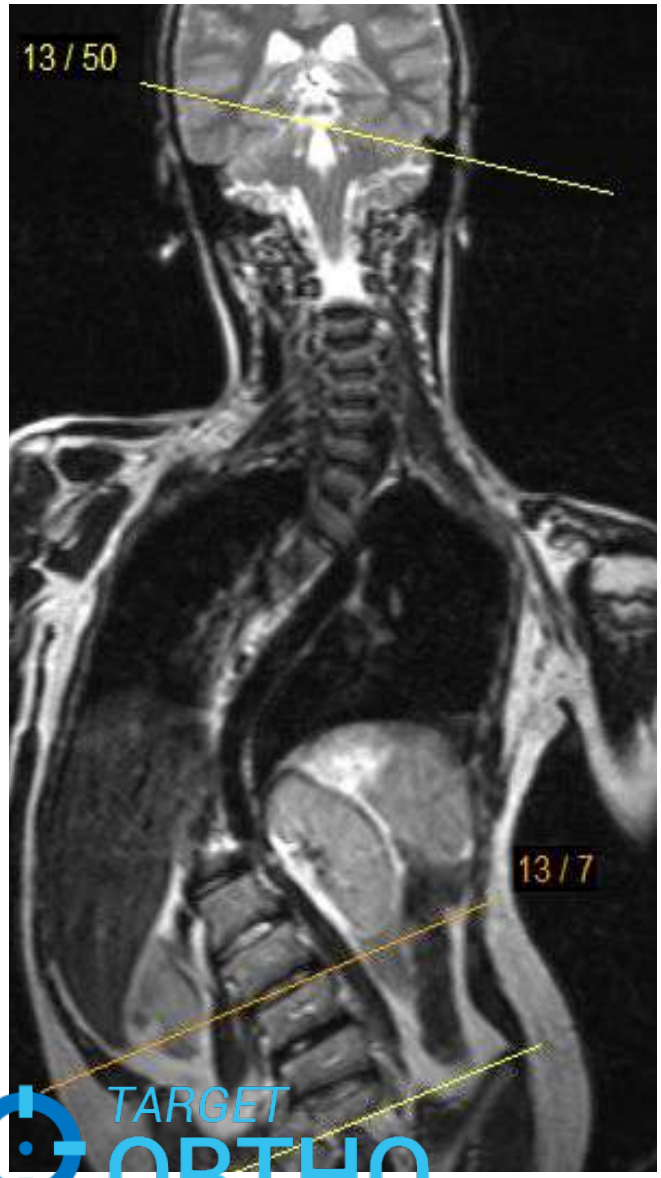
Scoliosis with ACM

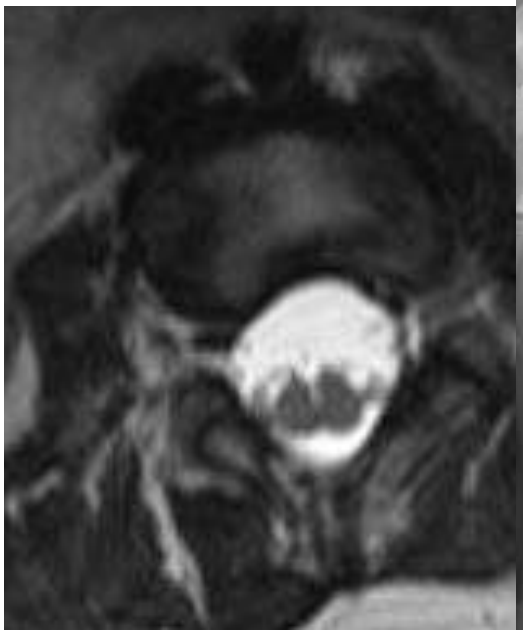


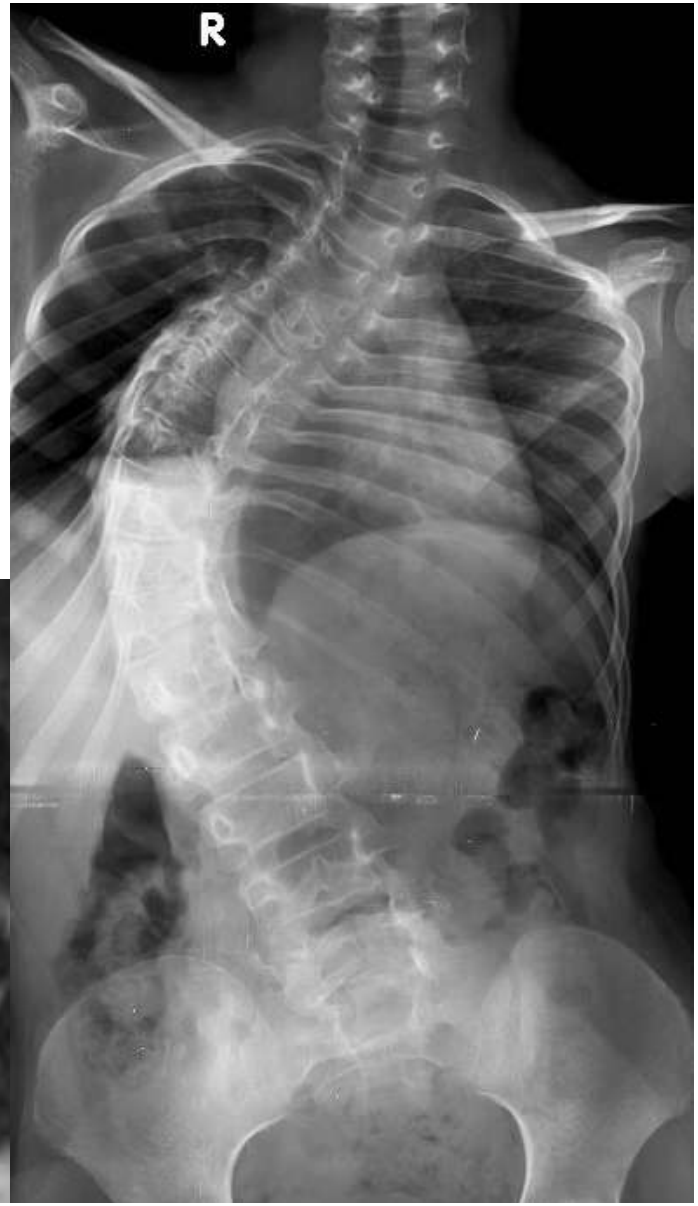




MRI- Tethered cord







Neurofibromatosis