

IMAGING EVALUATION IN VERTEBRAL STATIC DISORDERS – SAGITAL PROFILE

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Disclosure statement

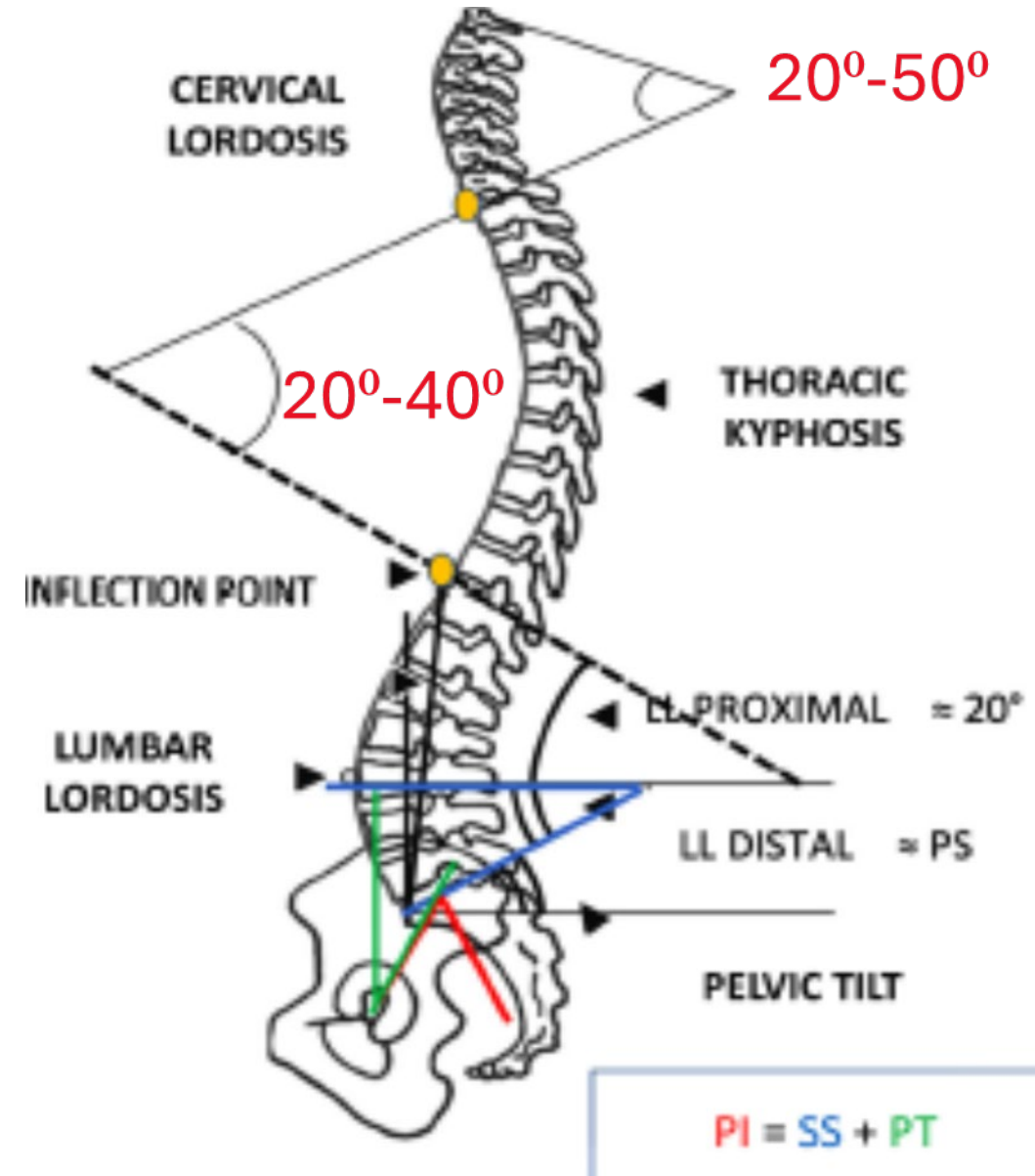
The authors have no actual or potential conflict of interest in relation to this program/presentation.

Homo sapiens developed sagittal alignment along with bipedal position.

Vertical posture was an important point in human evolution and environmental mastery, **at the cost of instability in postural control for the trunk and maintaining the horizontal gaze**. In healthy subjects, close relationships between pelvic morphology and sagittal alignment of the spine are known.

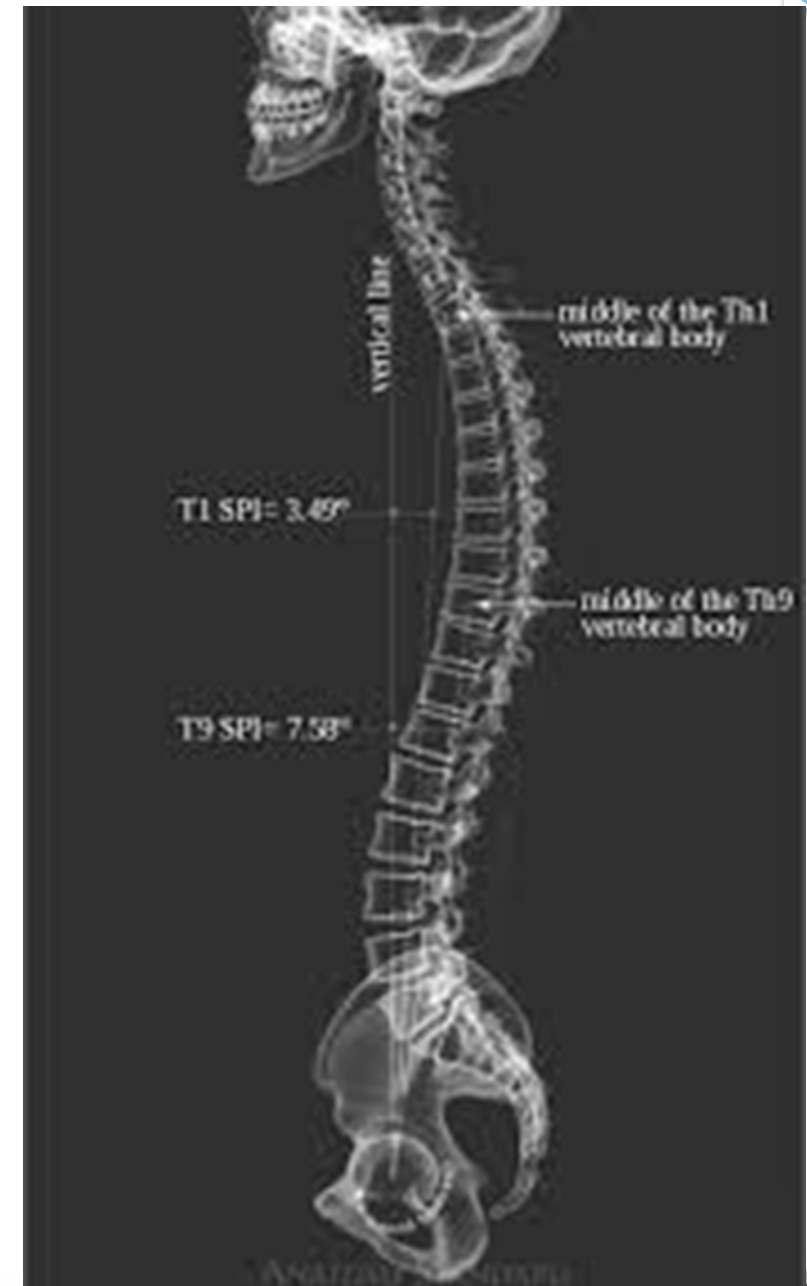
In order to make the vertical position energy-efficient and thus develop mutually supportive sagittal curves, this organization is governed by strict rules under physiological conditions that allow alignment between the center of gravity and the joint centers of the lower limbs.

1. Takakusaki K. **Neurophysiology of gait: from the spinal cord to the frontal lobe**. Mov Disord 2013;28:1483–91



For children and adolescents, morphological changes related to skeletal growth and maturation of the postural control center change the alignment of the spine to improve spinal balance.

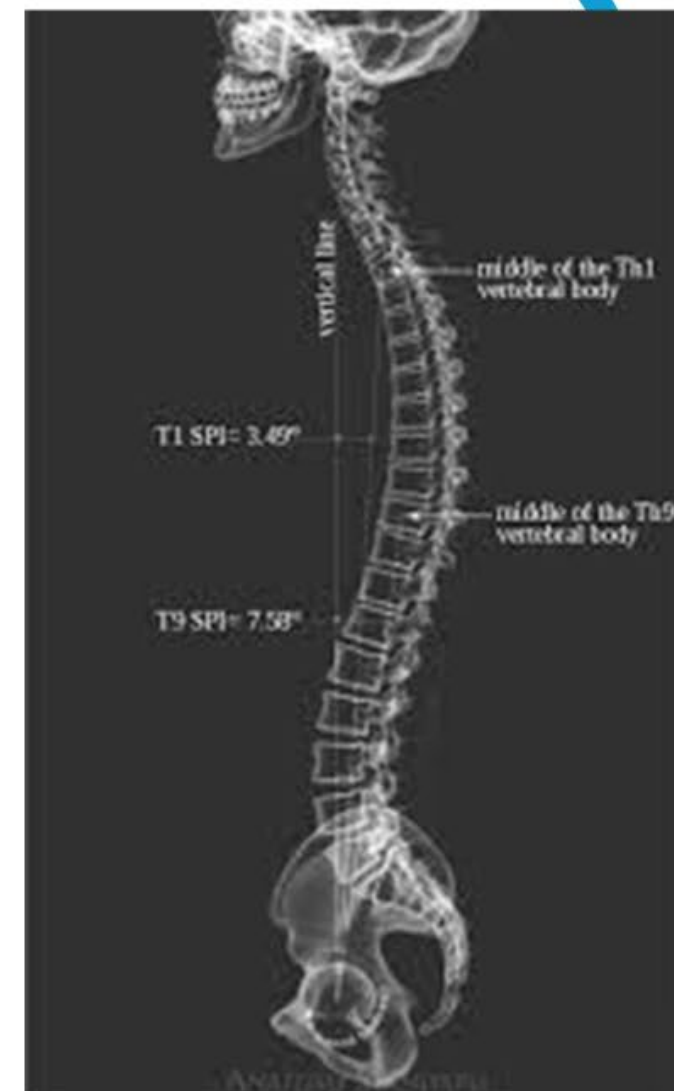
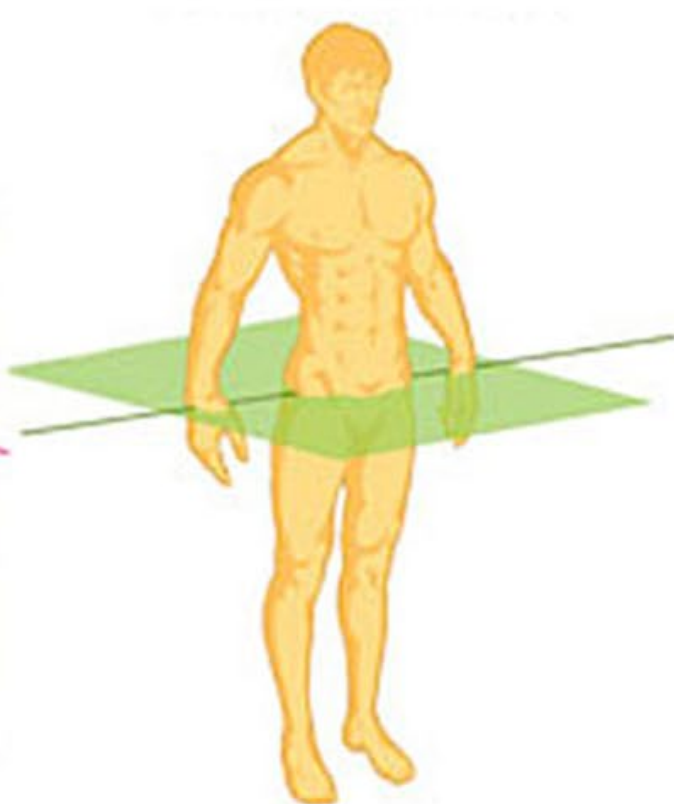
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SAGITAL

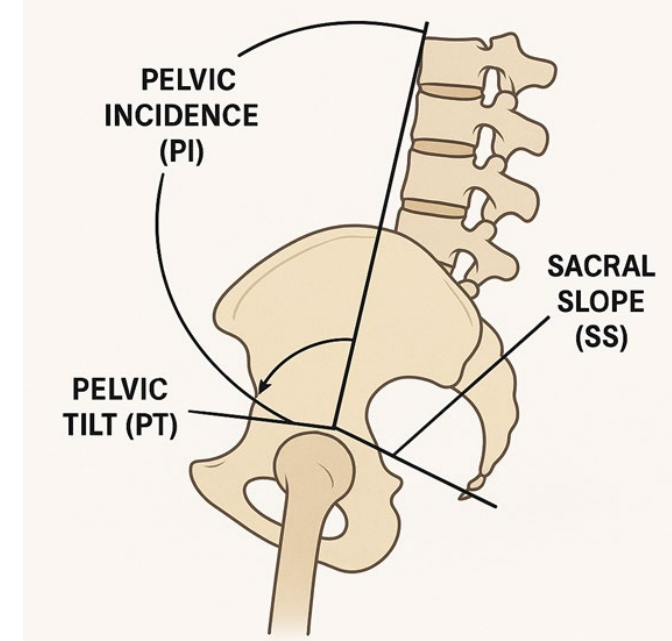
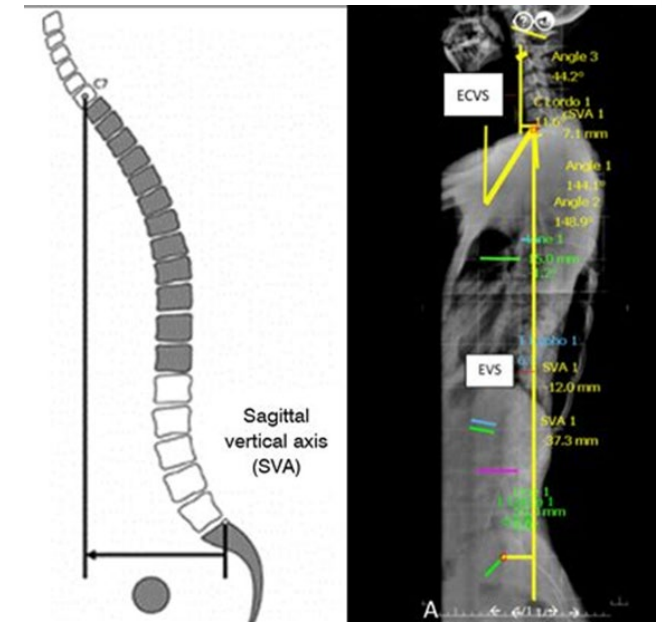
TRANSVERSAL

CORONAL



CONCEPT AND DEFINITIONS

- **Sagittal profile = alignment in the lateral plane (lumbar lordosis, dorsal kyphosis, cervical lordosis, global alignment).** [2,3]
- **Key parameters: SVA, TK, LL, PT, PI, SS.** [3]
- **Clinical correlations: pain, function, quality of life (HRQoL).** [2,3]

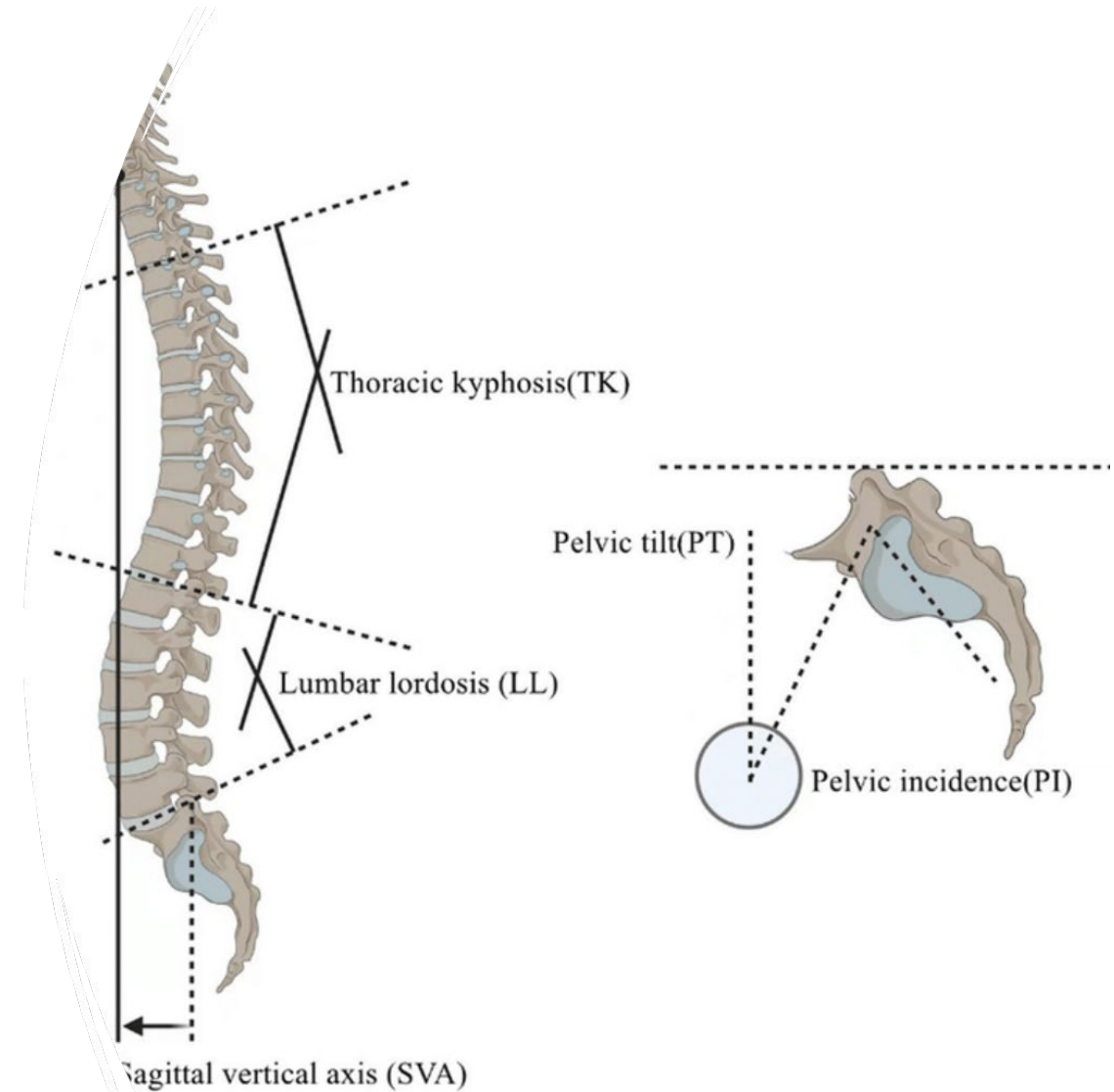


[2] Cheung JPY. The importance of sagittal balance in adult scoliosis surgery. Ann Transl Med. 2020;8(2):32. PMC6995914.

[3] Slattery C, Verma K. SRS–Schwab Classification of Adult Spinal Deformity. Global Spine J. 2018;8(7):703-712. PMC6259802.

KEY PARAMETERS

- SVA – sagittal (spinal) vertical axis,
- TK – thoracic kiphosis,
- LL – lumbar lordosis,
- PT – pelvic tilt,
- PI – pelvic incidence,
- SS – sacral slope. [3]



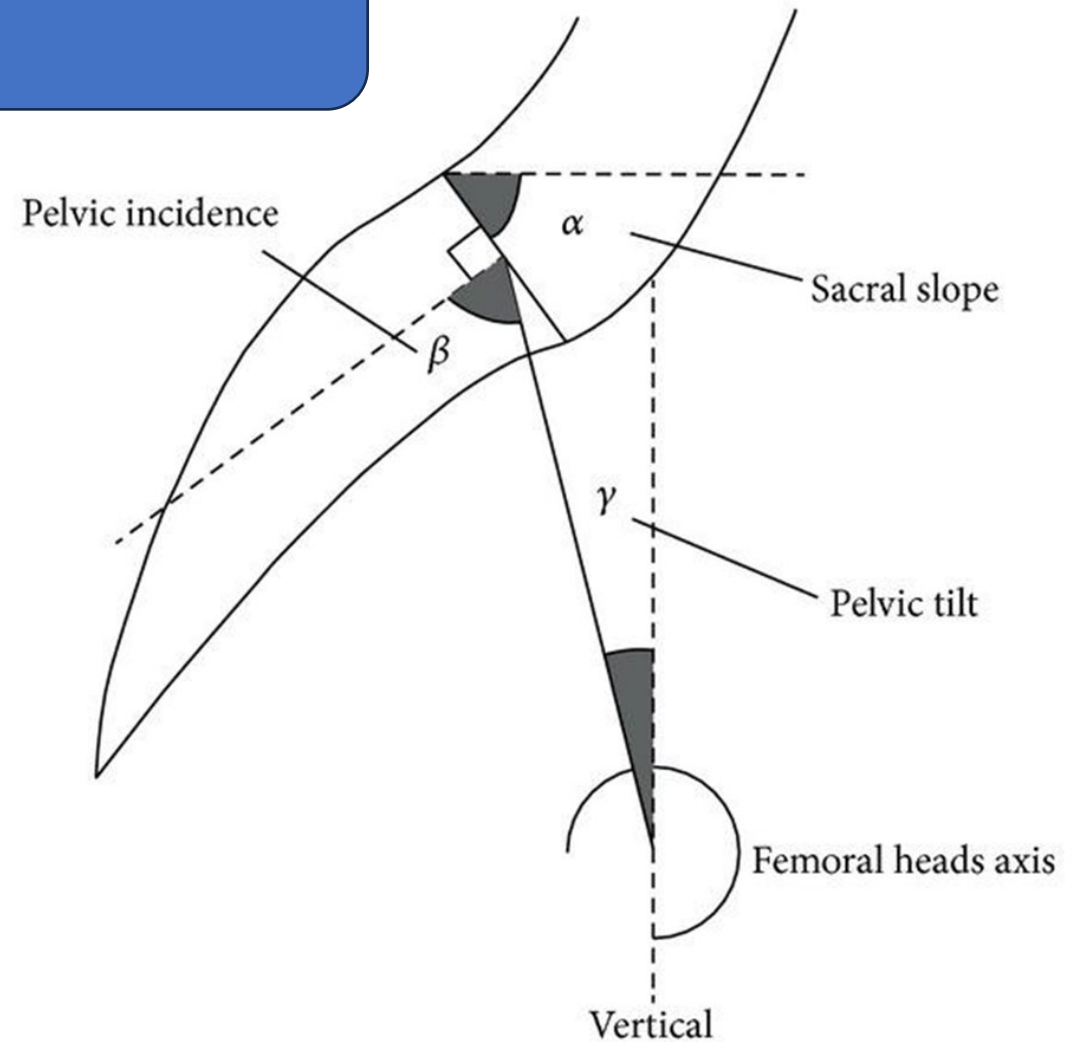
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Parameter (°)	Can it be influenced?	Description
Pelvic incidence (PI=PT+SS)	✗ No	Fixed anatomical parameter determined by pelvic morphology.
Sacral Slope (SS)	✓ Yes	It can vary with posture (lumbar extension/flexion).
Pelvic Tilt (PT)	✓ Yes	May vary with pelvic position (retroversion/antroversion).
Lumbar lordosis (LL)	✓ Yes	It can be altered by posture, surgery or degeneration.
Thoracic Kyphosis (TK)	✓ Yes	It can vary with the posture or deformities of the spine.

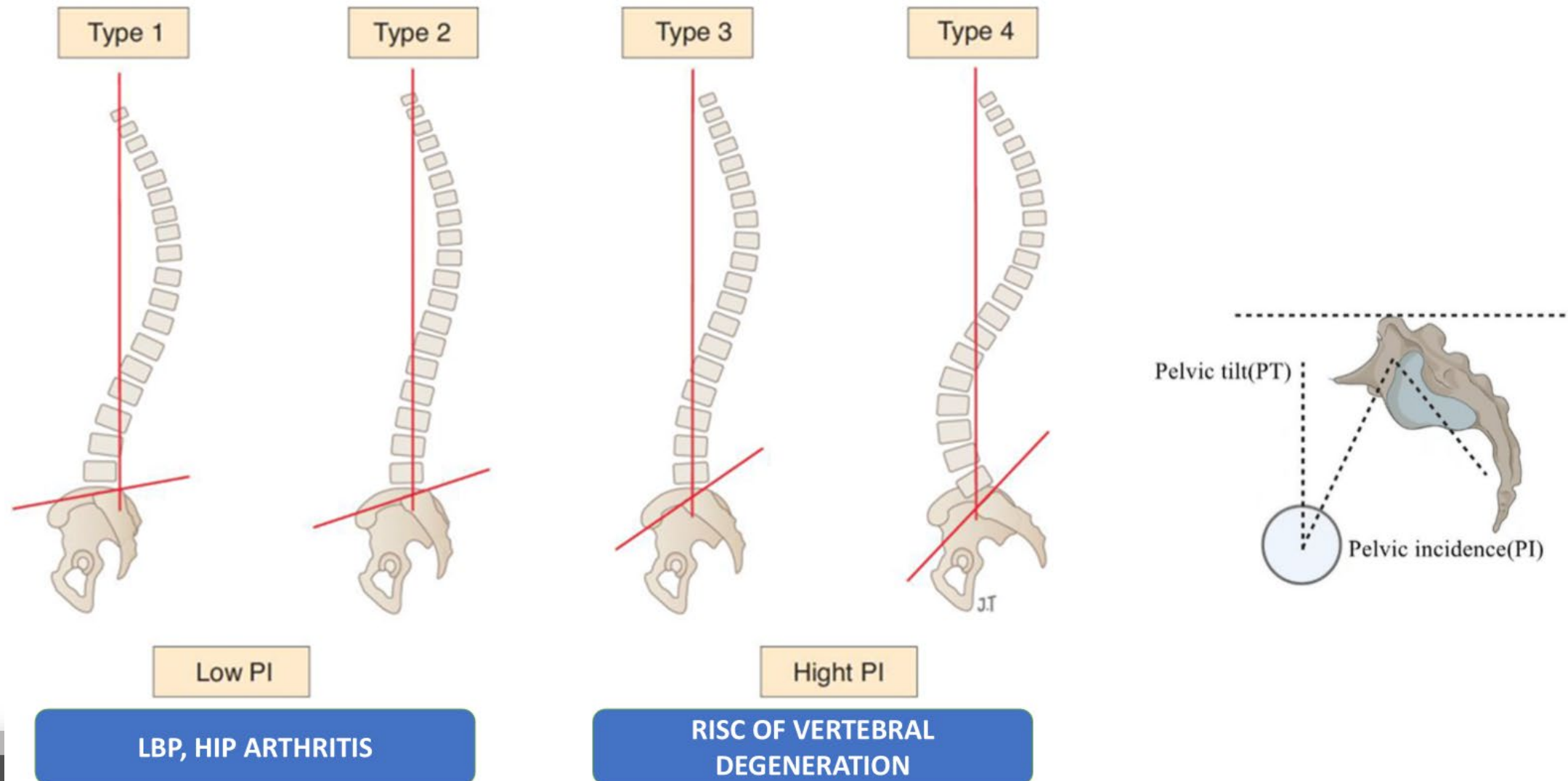
$$PI = PT + SS$$

$$B = \gamma + \alpha$$

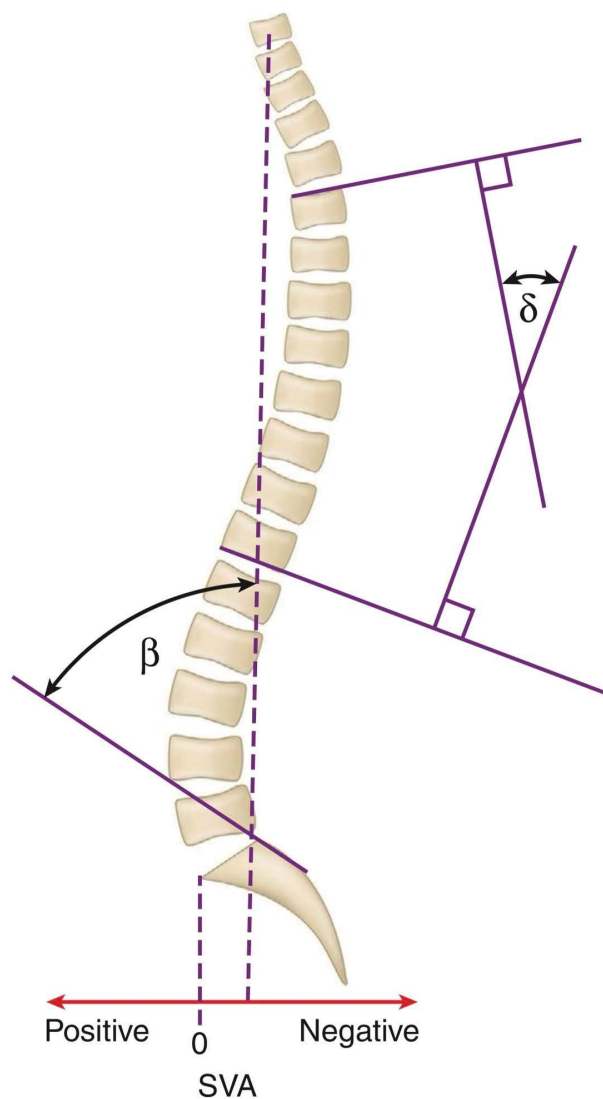


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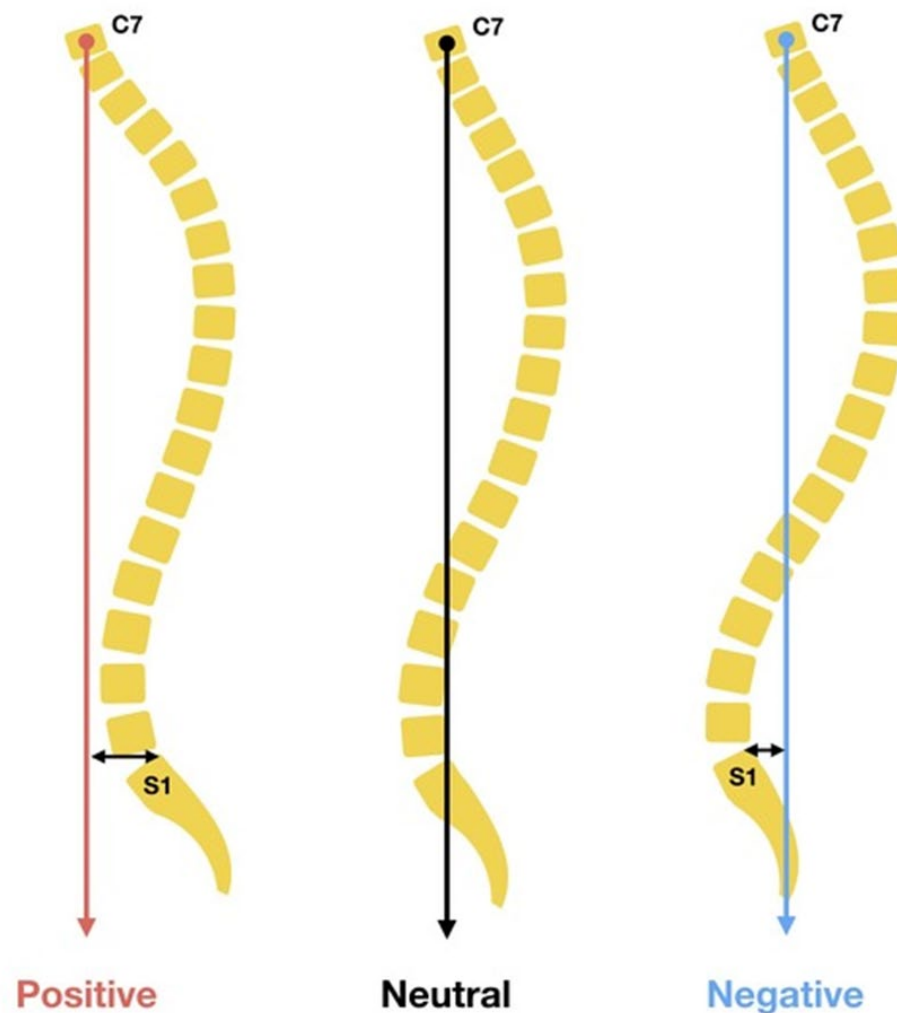
PELVIC INCIDENCE ROUSSOULY CLASSIFICATION



SVA = ECHILIBRUL SAGITAL = SAGITTAL BALANCE

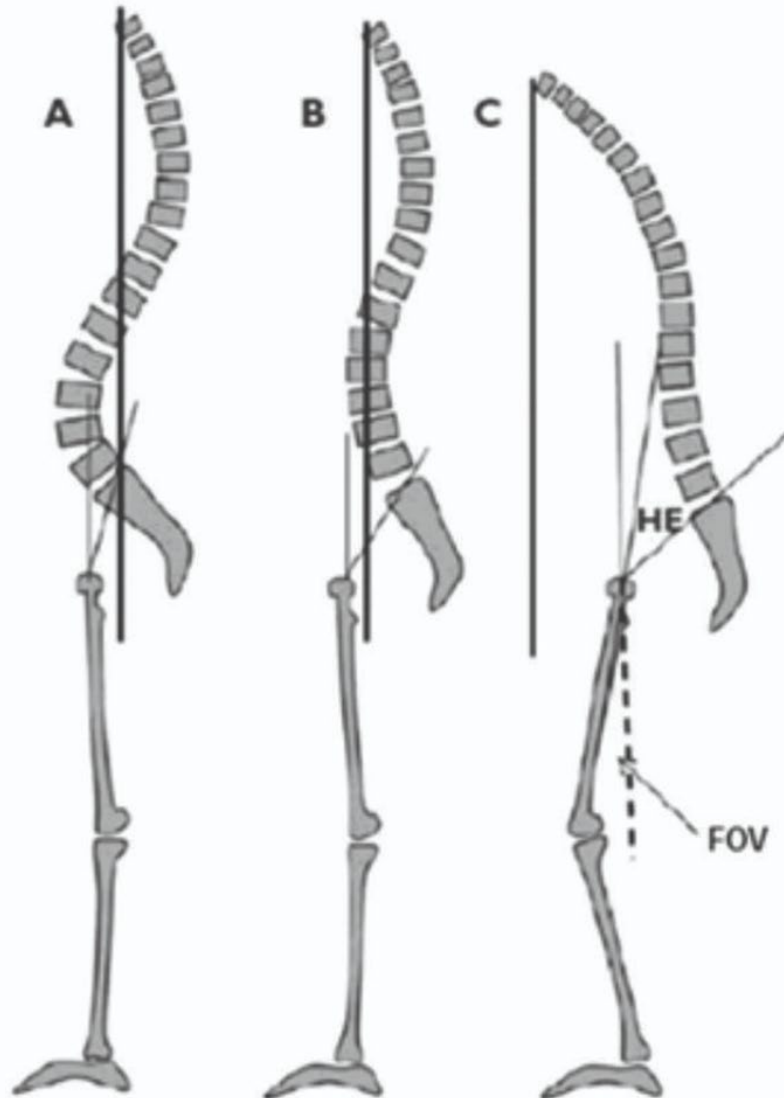
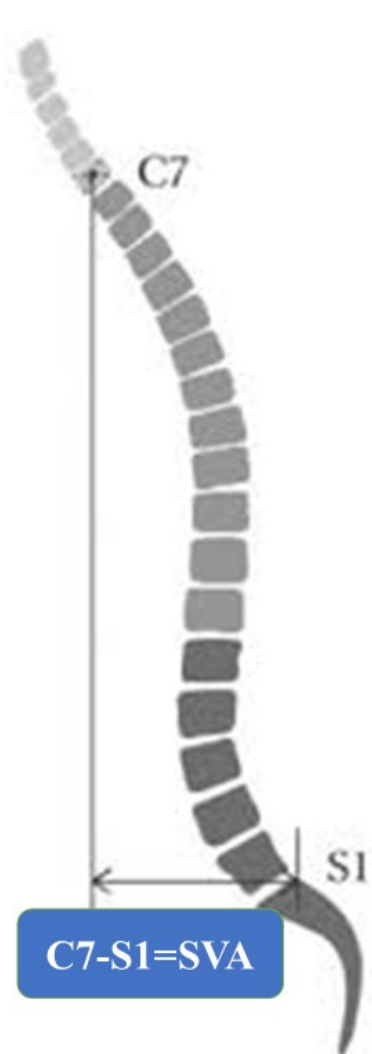


Sagittal balance



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SVA = SAGITTAL VERTICAL AXIS (C7 – S1) = ECHILIBRUL SAGITAL



A. NORMAL
SVA= 0-5 cm

**B, C. ANTERIOR
COLLAPSE**
SVA< 0 cm

**POSTERIOR
COLLAPSE**
SVA>5 cm

EMBRYO-FOETAL DEVELOPMENT

Embryonic flexion → primary global kyphosis

Spinal primary ossification: weeks 8-12 of gestation

Modelling dependent on intrauterine mechanical stress



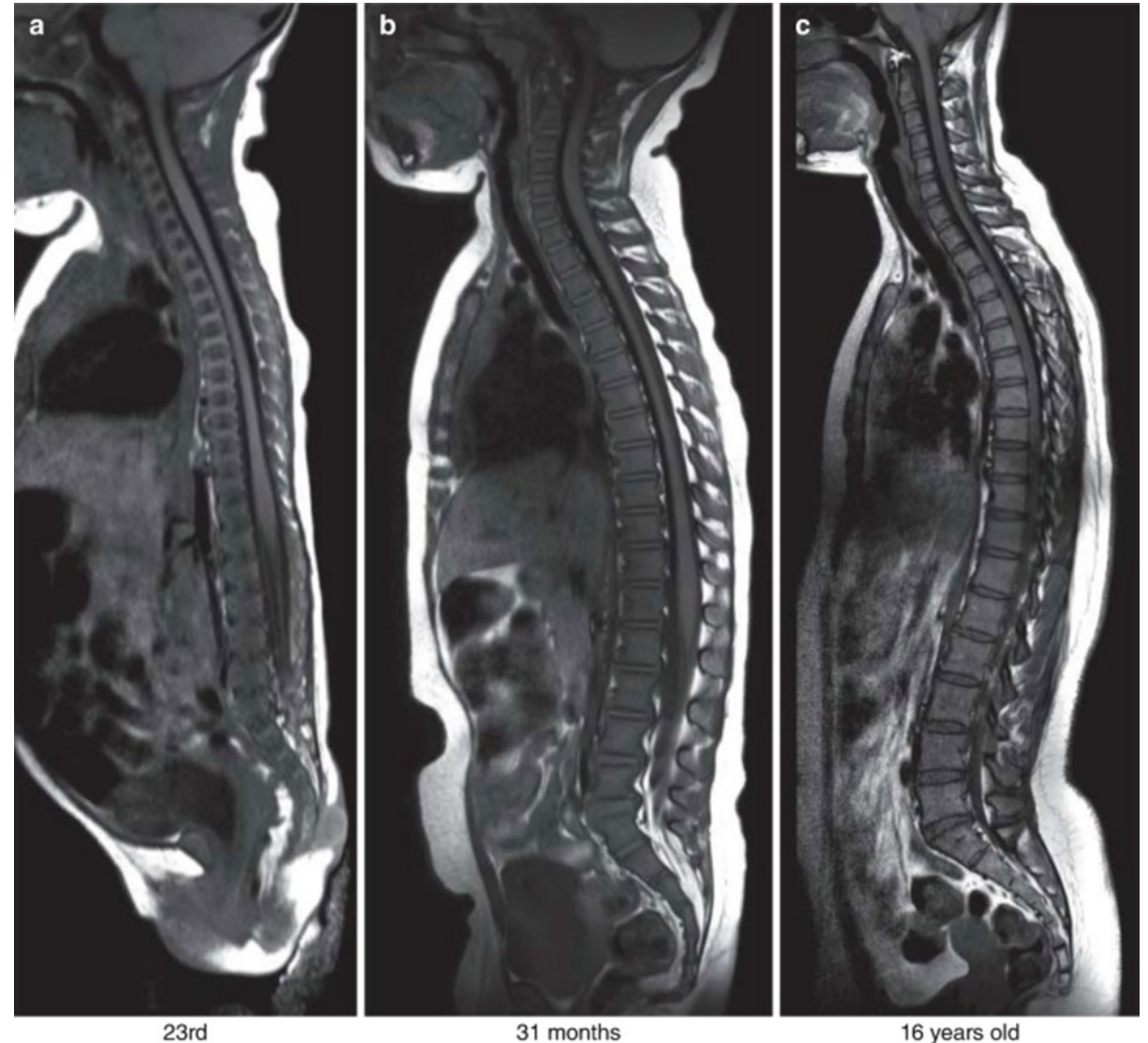
NEWBORN

- predominantly cyphotic column - global kyphosis $\approx 30-40^\circ$ (single curvature).
- lack of secondary lordosis.
- relative muscle hypotonia.
- hyperhydrated discs.
- incomplete neuromuscular control.



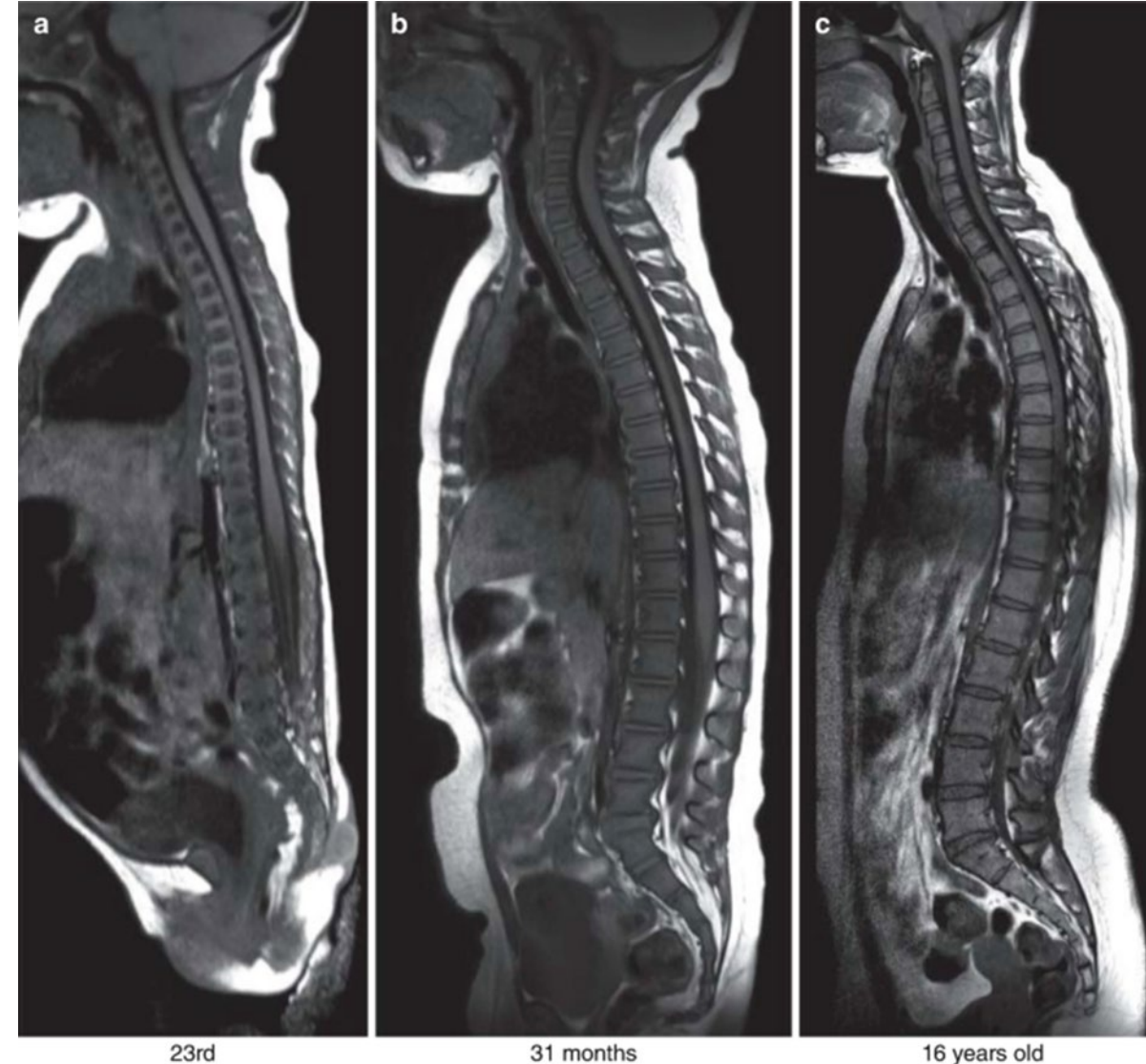
CERVICAL LORDOSIS

- appears around the age of 3-4 months.
- related to head control.
- progressive neuromuscular development.
- complete cephalic control - 3-4 months.
- cervical lordosis 15-25° at 1 year.
- activation cervical extensors.
- adaptation to gravity.



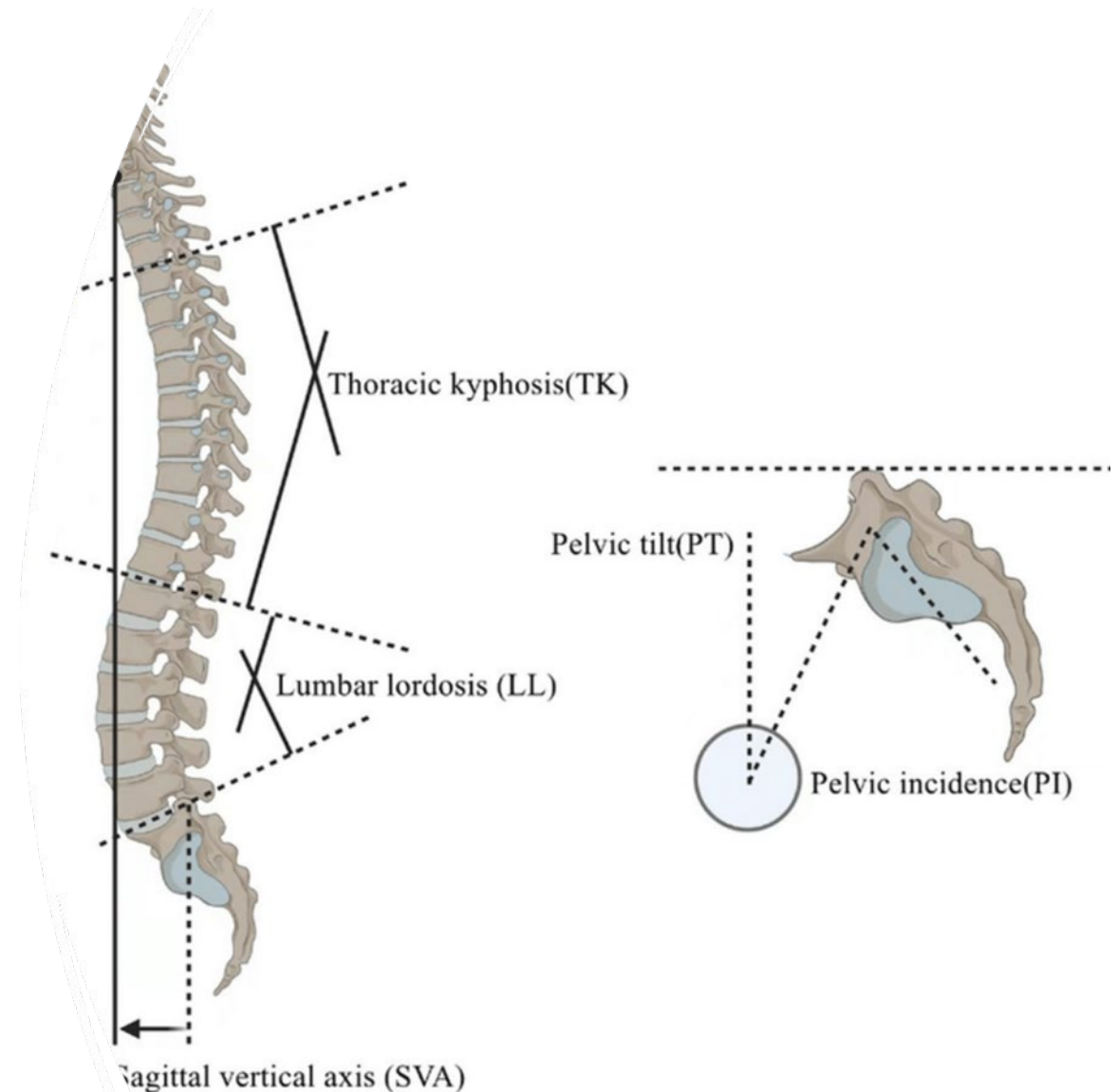
LUMBAR LORDOSIS

- occurs with quadrupedia, orthostatism and independent walking (9-12 months).
- related to independent walking.
- adaptation to axial loading.
- lumbar lordosis 20-30° originally progressive.
- axial loading = adaptive vertebral remodeling.



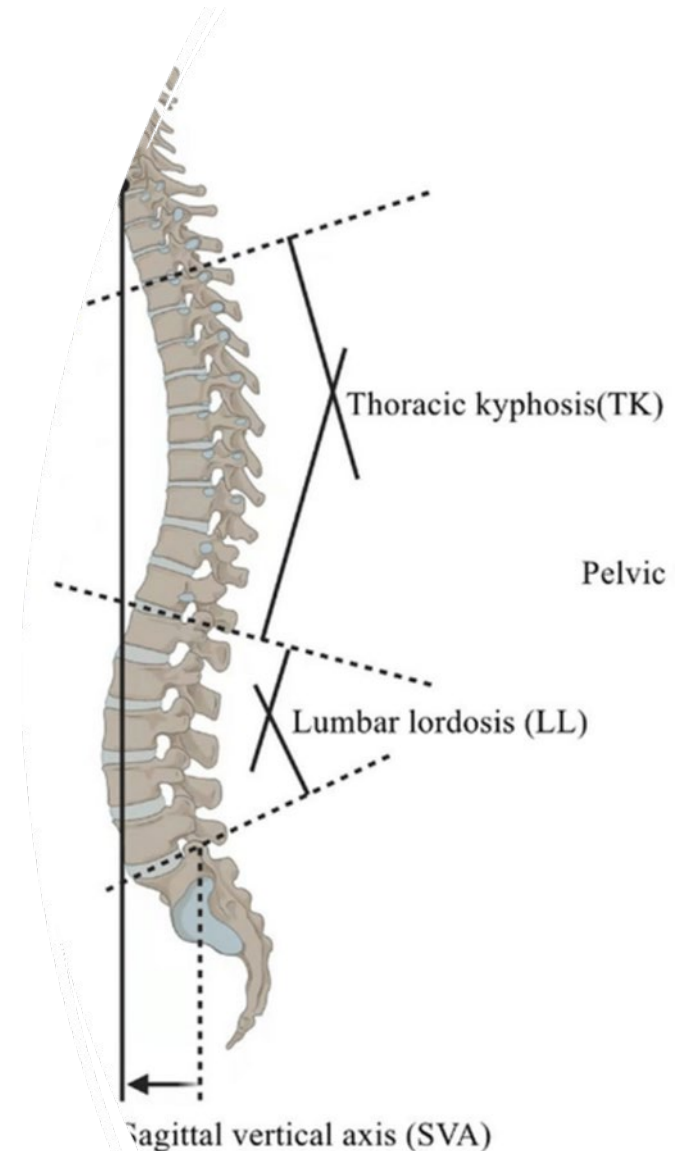
SAGITAL PROFILE 1-5 YEARS

- $LL \approx 35-45^\circ$
- $TK \approx 25-35^\circ$ physiological ligamentous laxity.
- interindividual variability
- hydration 80-90% = high disc height
- contribution to LL
- no degeneration



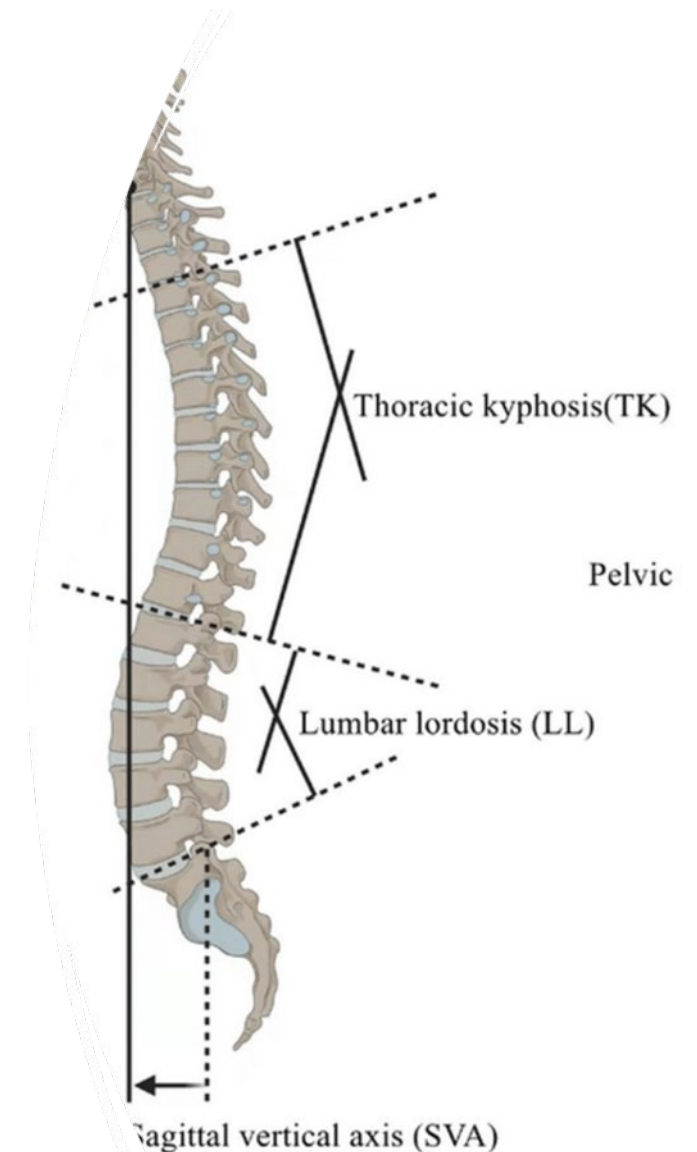
SAGITAL PROFILE 6-10 YEARS OLDS

- longitudinal increment of the vertebra
- $LL \approx 40-50^\circ$
- $TK \approx 30-40^\circ$
- appearance of functional postural deviation



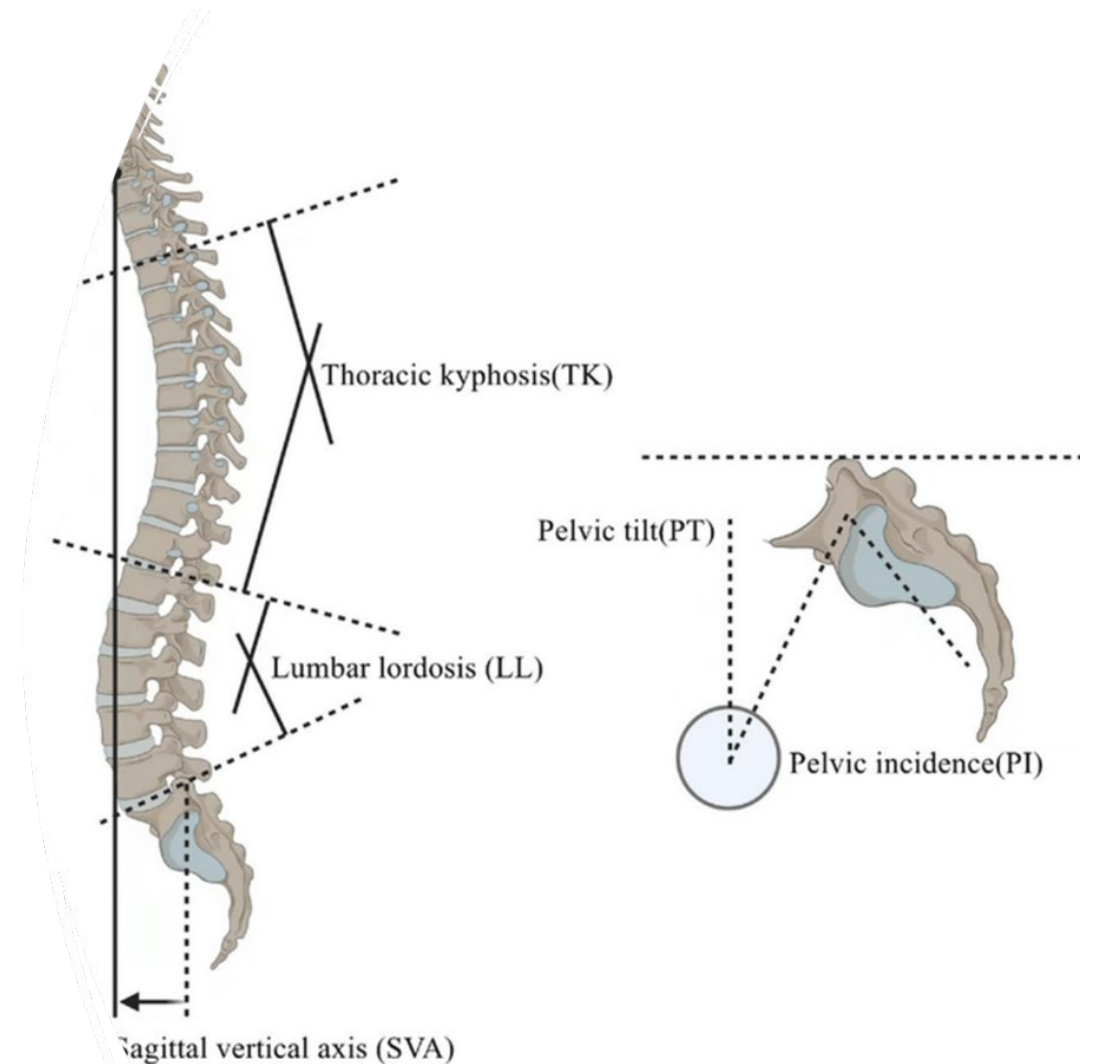
PEAK PUBERTY - F = 10-12, M = 13-14

- Peak Height Velocity (PHV)
- bone-musculature imbalance
- TK can increase to 45°
- transient sagittal instability = highest risk of scoliosis



PELVIC PARAMETERS

- **PI remains relatively constant after 8–10 years**
- **PI in children = 40–50°**
- **PI = PT + SS**
- **SS increases progressively**
- **PT depends on postural control**



DEVELOPMENT-SAGITAL IMPACT CORRELATION

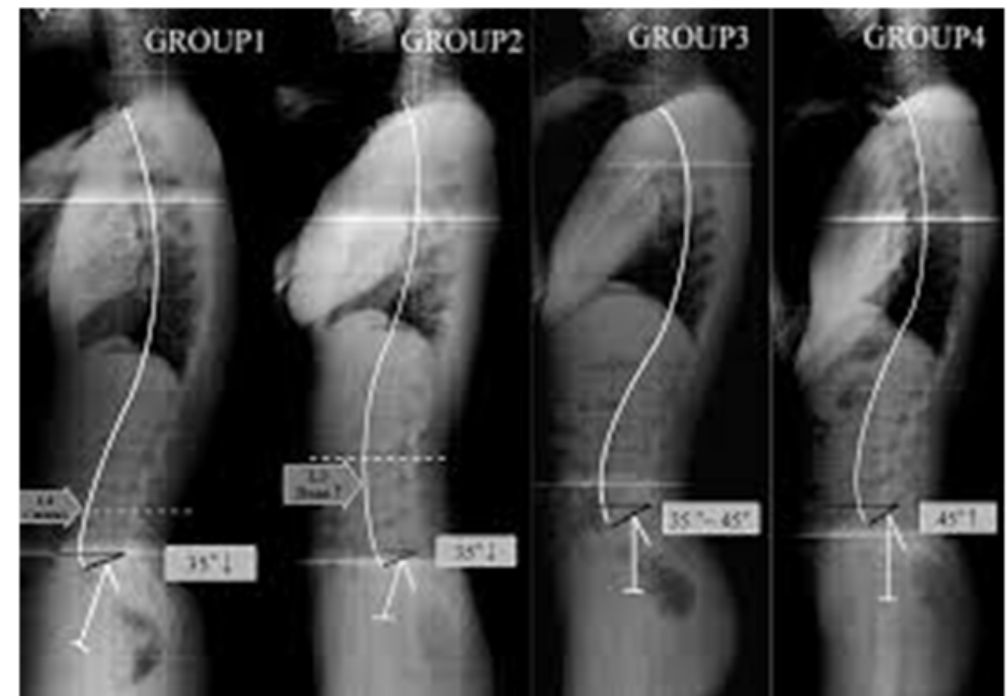
Stage	Key Event	Sagittal Impact	Pathological Risk
0–6 months	Head control	Cervical lordosis (CL) formation	Muscular torticollis
6–12 months	Upright posture (standing)	Lumbar lordosis (LL) formation	Hypolordosis
6–10 years	Linear growth	Curve stabilization	Postural disorders
Puberty	Peak height velocity (PHV)	Increase in thoracic kyphosis (TK)	Scheuermann disease

Comparative evolution of sagittal parameters

Parameter	Newborn	Child (6–10 years)	Adolescent
TK (°)	Global kyphosis	30–40°	35–45°
LL (°)	Absent	40–50°	45–60°
PI (°)	Functionally undefined	40–50°	Morphologically stable
SVA	N/A	±2 cm	<2 cm

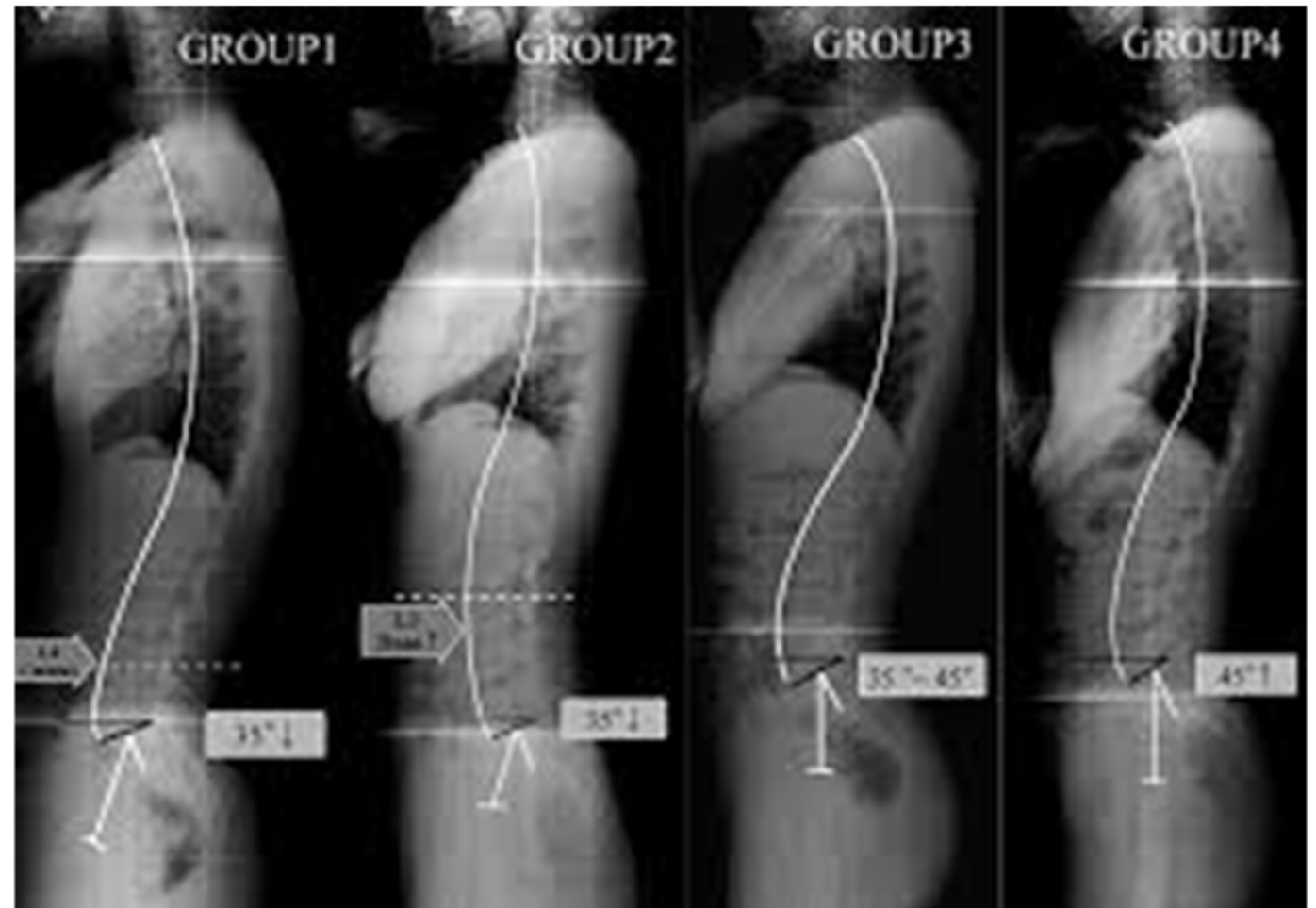
PHYSIOLOGICAL CRITERIA vs PATHOLOGICAL

- $TK < 45^\circ$ adolescent = physiological
- $TK \geq 50^\circ$ + wedge vertebra $> 5^\circ$ = Scheuermann
- LL disproportionate to PI ($LL = PI \pm 9^\circ$)
- $SVA > 5$ cm = major vertebral disbalance



SEVERITY INDICATORS

- PI–LL mismatch $>20^\circ$
- SVA >5 cm
- PT $>25^\circ$
- $>5^\circ/\text{year}$ progression at PVH



CLINICAL-RADIOLOGICAL EVALUATION ALGORITHM

1. Detailed medical history
2. Complete clinical examination
3. Postero-anterior and **latero-lateral standing full-spine X-ray**
4. Radiological measurement: Cobb, Nash-Moe, Risser, TK, LL, PI, PT, SS, SVA
5. Calculation of **PI–LL mismatch**
6. Identification of compensatory mechanisms
7. Monitoring vs treatment



Thank You!



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