

# The evolution of sagittal segmental alignment of the spine during growth

Muharrem Yazici, MD

Hacettepe University, Ankara, Turkey



# Background

- ❑ Planning of the 3D reconstruction of the spine
  - ❑ Normative data about the sagittal plane
- ❑ Segmental sagittal plane analysis
  - ❑ Many studies for adults
  - ❑ Inadequate data on children

# Questions

- ❑ Whether the pediatric spine is a miniature of adults' in terms of sagittal plane alignment?
- ❑ If not, do segmental alignment of the vertebrae change with growth?

# Objective

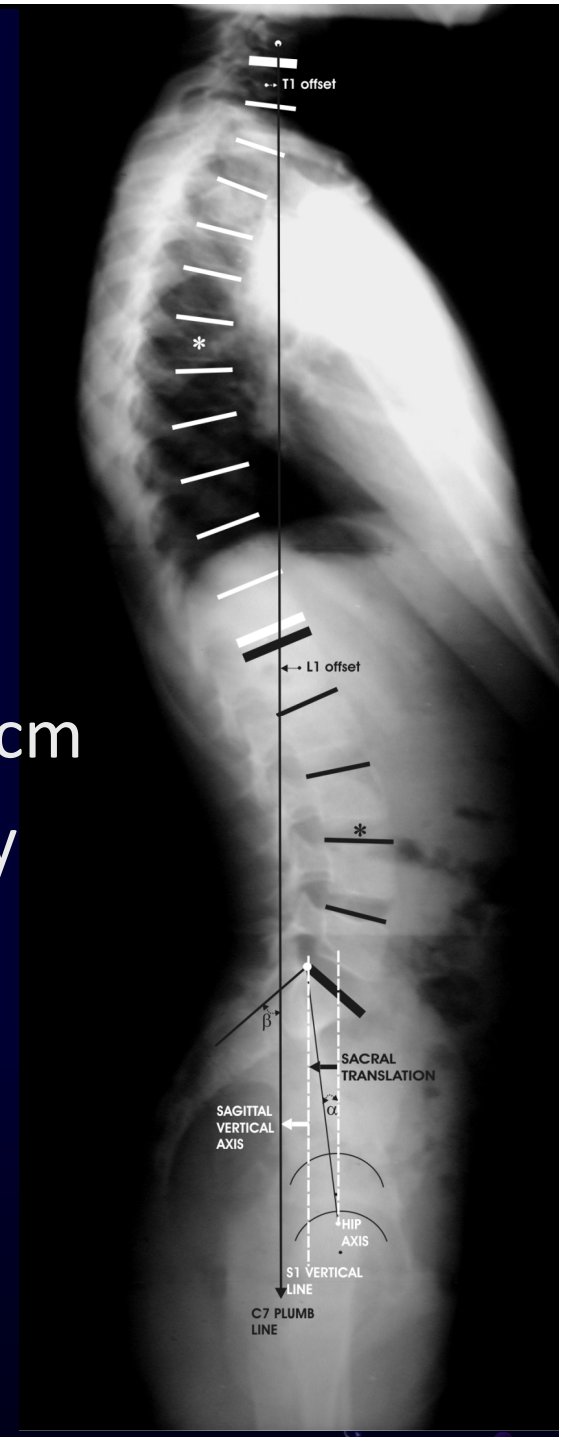
- ❑ To describe the normative data of the sagittal plane on pediatric age population
- ❑ To document the evolution of sagittal alignment with growth

# Materials&Methods

- ❑ 151 children (72 girls, 79 boys)
  - ❑ No musculoskeletal abnormality
    - ❑ Spine deformity
    - ❑ Limb length inequality
    - ❑ Hip or knee contracture
  - ❑ No previous spinal surgery
  - ❑ Age, 3 to 15
    - ❑ Minimum of 10 children in each age group
    - ❑ At least 4 of them from one sex

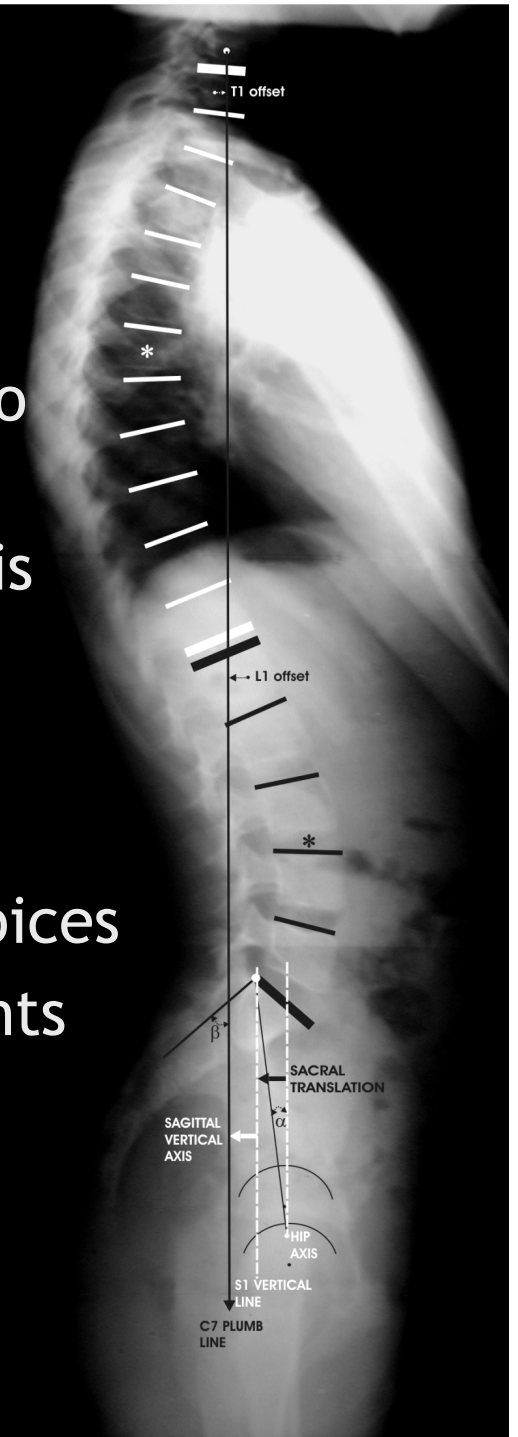
# Materials&Methods

- Standart radiograms
  - Same technician
  - Left side at the cassette side
  - Tube-cassette distance, 150 cm
  - 36-inch standing lateral X-ray with the arms flexed at  $30^{\circ}$



# Variables

- ❑ Segmental angulations from T1-2 to L5-S1
- ❑ Global kyphosis (T1-12) and lordosis (L1-S1)
- ❑ Apices
- ❑ T1 and L1 offsets
- ❑ Location of thoracic and lumbar apices
- ❑ Spinopelvic alignment measurements
  - ❑ Alpha and Beta angles
  - ❑ Sagittal vertebral axis (SVA)
  - ❑ Sacropelvic translation (SPT)
  - ❑ Sacral translation(HA-S1)



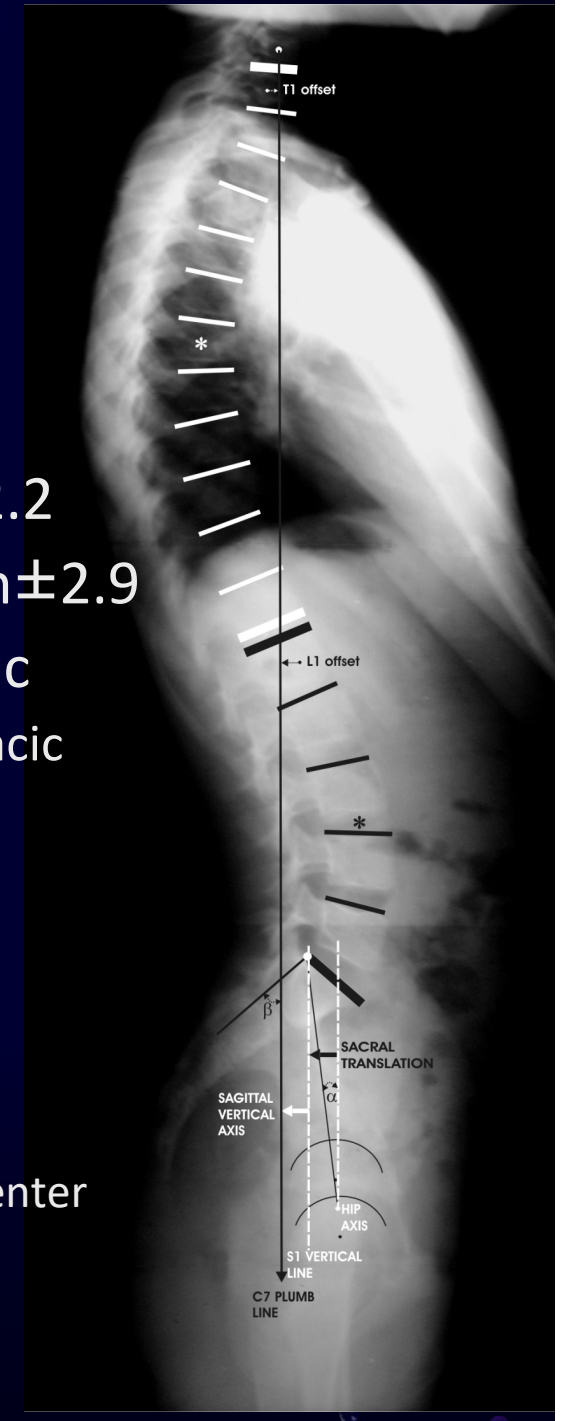
# Statistical analysis

- ❑ Grouping in terms of ages
  - ❑ Group I (3 to 6 years of age)
  - ❑ Group II (7 to 9)
  - ❑ Group III (10 to 12)
  - ❑ Group IV (13 to 15)
- ❑ Intra-observer error
  - ❑ Re-measurement of 20 radiograms



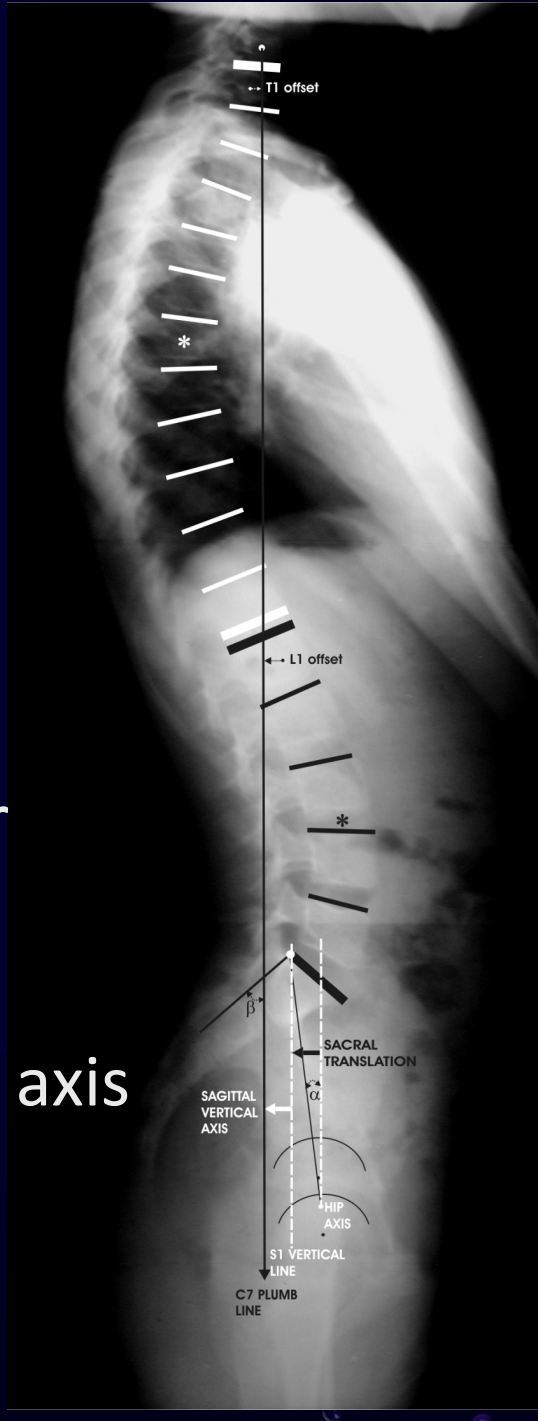
# Results

- ❑ Intraobserver error
  - ❑ Segmental measurements  $2.4^{\circ} \pm 2.2$
  - ❑ Milimetric measurements  $2.6 \text{ mm} \pm 2.9$
  - ❑ Upper thoracic area is problematic
    - ❑ Difficulty in defining the upper thoracic vertebral endplates
- ❑ HA-S1 and alpha angle
  - ❑ 94 X-rays only
    - ❑ Quality
    - ❑ <5 years of age
      - ❑ Lack of femoral head ossification center



# Results

- ## ❑ Greater thoracic kyphosis



# Results/

## Significant difference among Groups

### ❑ Junctions

- ❑ Segmental angulations of T1-2 (p=0.015)

- ❑ T10-L2 (p=0.014)

- ❑ L4-S1 (p=0.001)

- ❑ Global kyphosis angle (p=0.005)

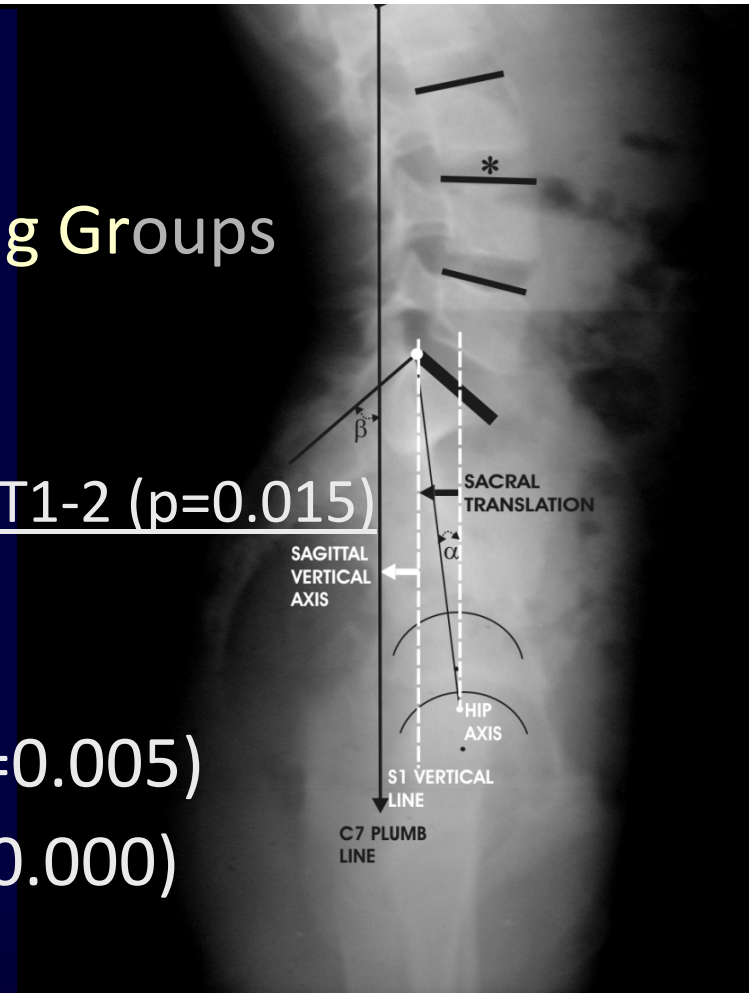
- ❑ Global lordosis angle (p=0.000)

- ❑ Thoracic apex (p=0.007)

- ❑ T1 offset (p=0.000)

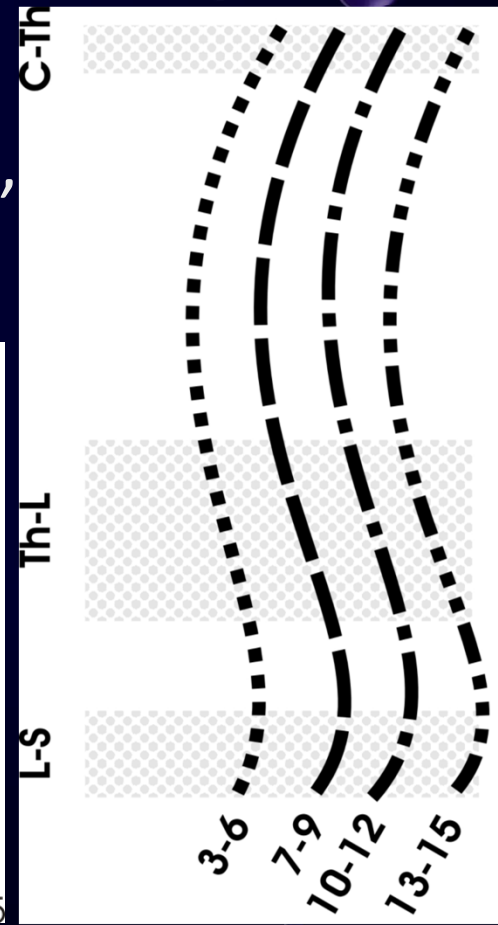
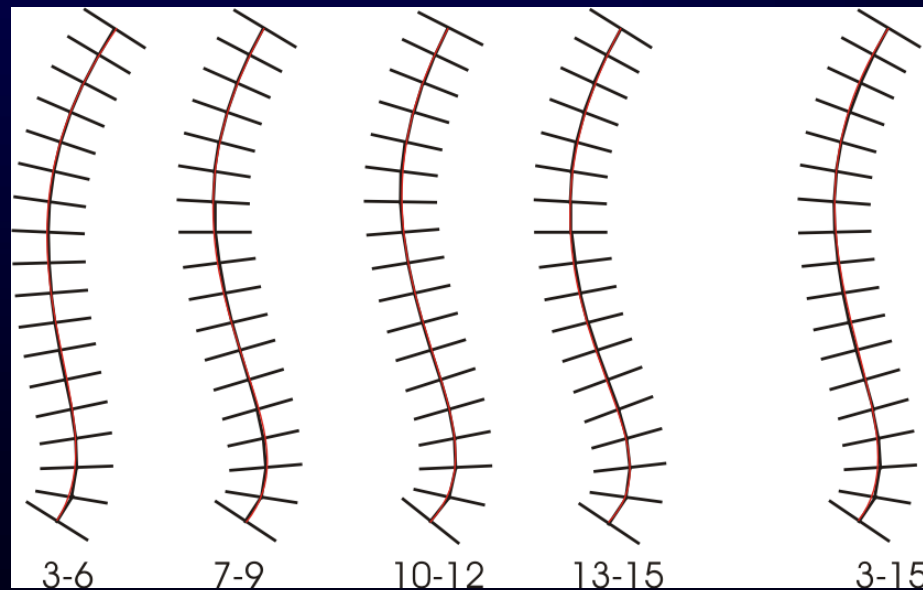
- ❑ SVA (p=0.004)

- ❑ Beta angle (p=0.000)



# Results

- ❑ Sagittal spinal alignment is changing as child grows
- ❑ Significant difference especially at cervicothoracic, thoracolumbar, and lumbosacral junctions



# Results

## □ With age

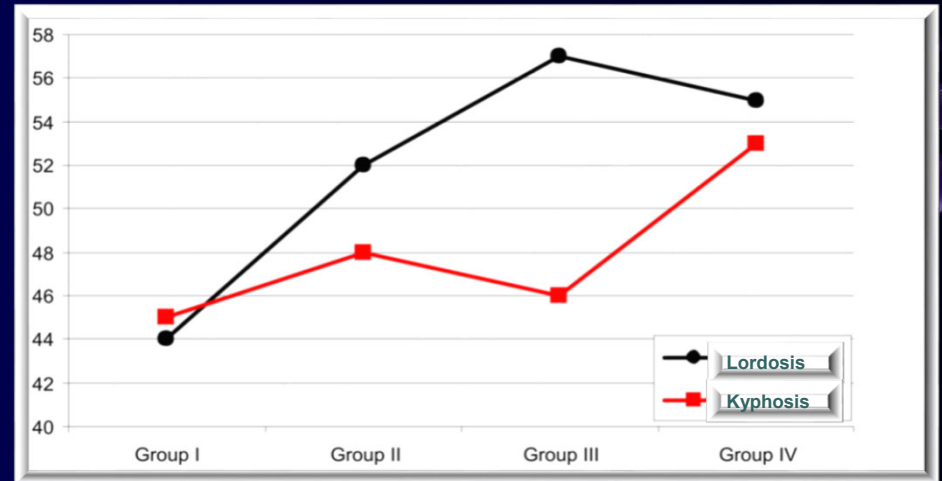
□ Total thoracic kyphosis, and total lumbar lordosis particularly due to lower 2 motion segments, were found to be increased

## □ Not linear

□ Group III/adolescent growth spurt

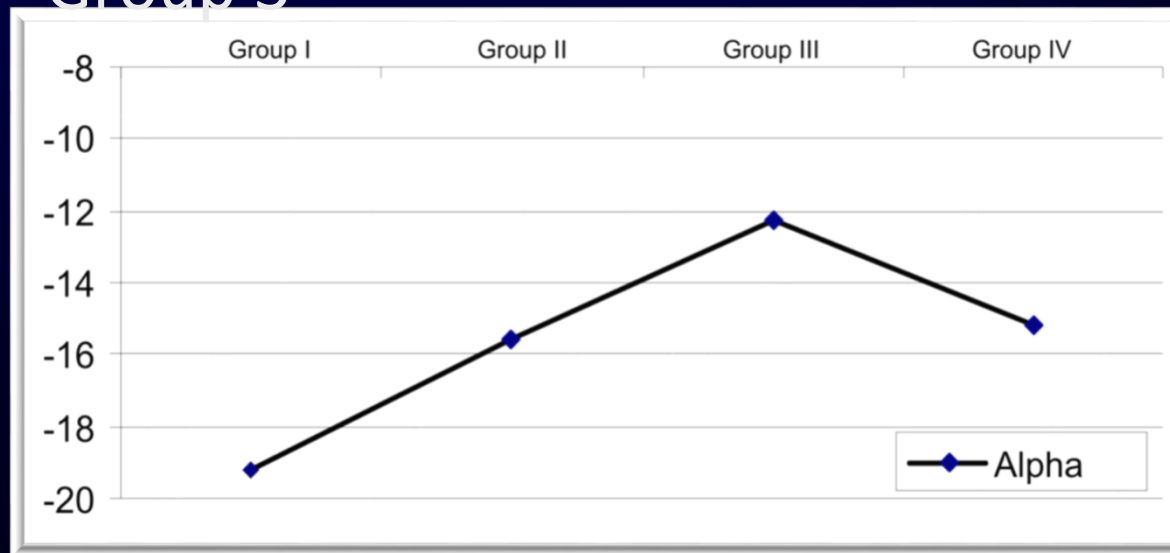
□ Anterior column growth exceeds posterior

□ Thoracic apex moved upwards



# Results

- ❑ The position of the sacrum (inclination and translation), and spatial orientation changes with growth
- ❑ Older children to stand with a more negative SVA
- ❑ Trend of alpha angle was disturbed because of Group 3



# Drawbacks

- ❑ Not regular randomization
  - ❑ Same technician
  - ❑ Random selection
    - ❑ No bias
- ❑ Only ten subjects in each group
  - ❑ Statistical power?
  - ❑ Regrouping
- ❑ Cross-sectional design
  - ❑ Prospective study??

# Conclusion

- ❑ Not a smaller model
- ❑ Alignment dynamically changes
- ❑ Young patients who require spinal instrumentation!!!
  - ❑ Negate the adverse effects of sagittal malalignment
  - ❑ Risk for abnormal loading
    - ❑ Adjacent spine segments
    - ❑ Hip, knee

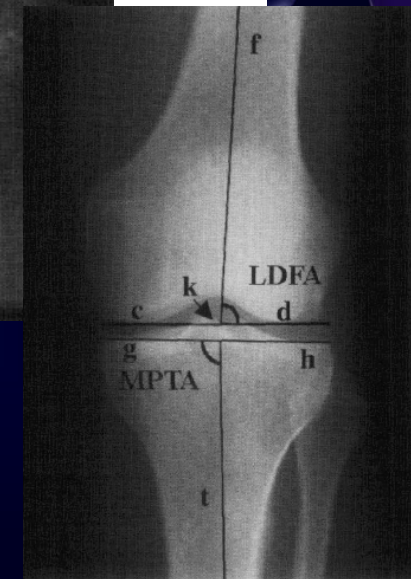
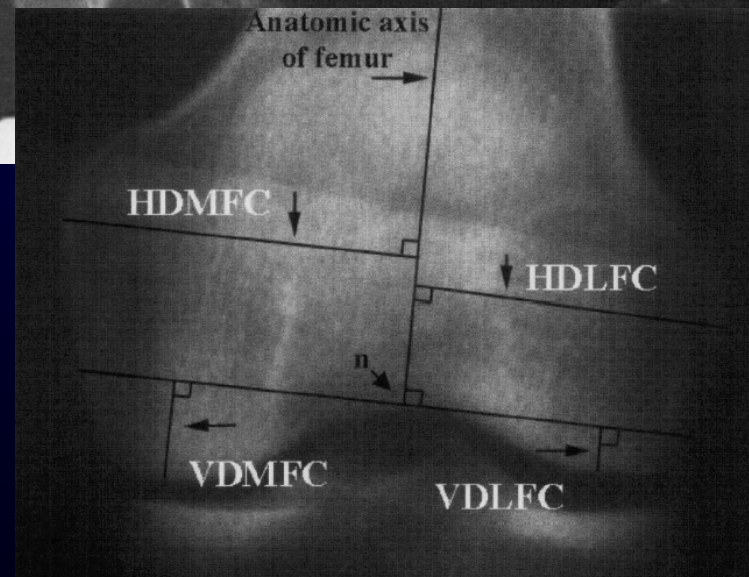
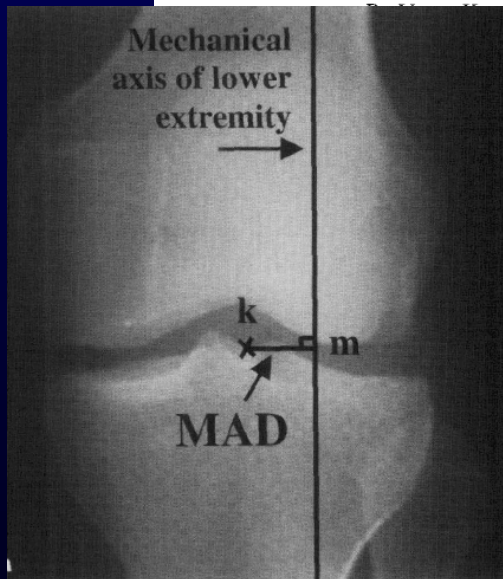


# DDH and knee study

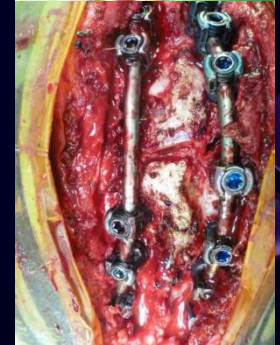
2249

COPYRIGHT © 2002 BY THE JOURNAL OF BONE AND JOINT SURGERY, INCORPORATED

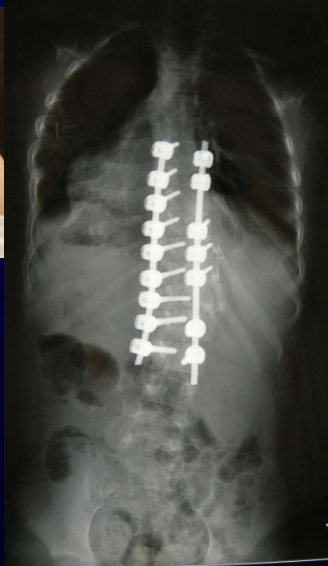
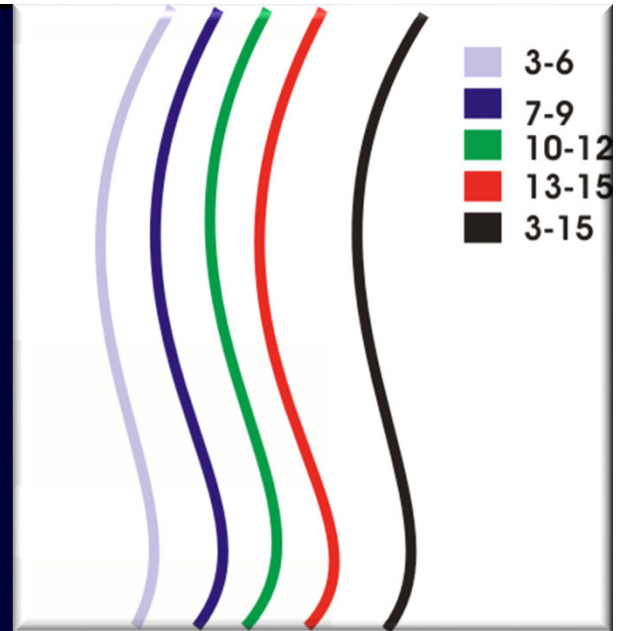
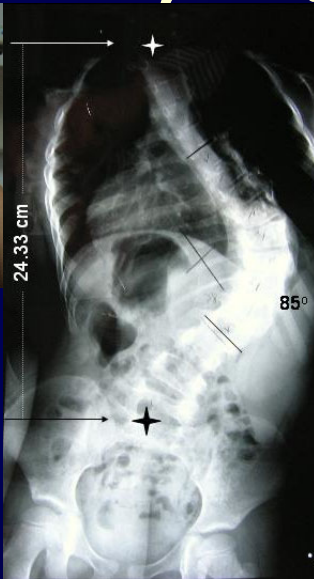
M  
I  
Ne



# Early spine fusion







# Conclusion

- ❑ Whether sagittal alignment should be restored according to the normative data for the child's age or to the normative data for the adulthood?
  - ❑ Adult data
    - ❑ Abnormal loading
  - ❑ Pediatric data
    - ❑ Adult posture can never be attained