Scoliosis: Measurement Modifiers and Surgical Indications

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Your Goals in Deformity Surgery
Terminology:

- **Scoliosis** –
  - Coronal Plane Curvature > 10 Deg.
  - Can involve any segment, but thoracic is most common in adolescents, lumbar more often in adults
  - Curves may be stable or progressive, primary or compensatory, rigid or correctable

Terminology in Deformity:

- **Idiopathic Scoliosis: AIS**
  - Most common type, but “We don’t know why”
  - A sex-linked, family-linked curvature in Coronal and Sagittal plane (think 3-D), with vertebral rotation and loss of thoracic kyphosis.
  - Trunk asymmetry and rib prominence
  - Progression is painless
  - < 10% require surgery
Causes of Idiopathic Scoliosis

• Etiology: multifactorial and not fully understood:
  – Heredity – clear relationship, but variable penetrance
  – Hormonal/Growth – progression during growth-spurt
  – Environmental Factors
  – Connective Tissue
  – Neuromuscular Factors
  – Muscle Abnormalities
  – Spine Biomechanics

Congenital Scoliosis

• Failure of Formation vs failure of Segmentation
• Hemivertebra
• Unilateral Bar
• Associated Anomalies
  – IntraDural Anomalies
    • 25-40%
  – Cardiac Anomalies 10%
  – GenitoUreteral Anom 25-40%
**Terminology - Neuromuscular Scoliosis**

- **Neuropathic**
  - Tethered Cord
  - Paralytic Syndromes
  - Spastic Syndromes
  - Myelomeningocele
- Progressive beyond skeletal maturity
- Particular Issues:
  - Seating Balance
  - Nursing/Skin Care
- Require a different approach altogether…

**Neuromuscular Scoliosis:**

- Neuromuscular curves require fusion to pelvis for skin-care and sitting balance
- Constructs must span LS and SI joints to anchor sacral fix’n
- Because these curves are severe but supple, sublaminar wires were applied as the earliest applications of segmental fixation
Deformity - Neuropathology

- Syrinx
- Tethered Cord
- Spinal Cord Tumor
  - Young patients, with *acute* curves, that *progress rapidly* - MRI

More rare – Pathologic: Tumor

- Painful Scoliosis
  - Osteoid Osteoma
  - Osteoblastoma
- Painful scoli is not normal!
- Can result in Structural Scoliosis if unresolved
Adult Scoliosis:

Pre-Existing Deformity persists, progresses or degenerates

Progression is not always an indication for Fusion, but...

If there is unchecked progression it is not just a “cosmetic” issue
Physical Examination

Physical Examination in Spinal Deformity

- Coronal Balance – Where does the head sit relative to the sacrum?
- Clinical Exam
  - Neutral Posture: a plumb line dropped from the C7 Spinous Process falls within 1.5 cm of the gluteal cleft
Physical Examination

• Rib Rotation – Rotation of the vertebra throws the ribs up (hump) on the convex side
• Seen most clearly in forward flexion
• Clinical exam:
  – Paraspinous rib prominence caused by thoracic vertebral rotation.
  – Lumbar paraspinous muscle prominence in TL curves

Physical Examination

• Shoulder Symmetry – what's happening at the top of the curve?
• Clinical exam:
  – Relative elevation or depression of the shoulder girdle due to the chest wall deformity
  – Often most noticeable change for patient
Radiographic Evaluation: Defining the Curve Magnitude

- Cobb Method – defined for Coronal Plane
  - Select End Vertebrae
  - Draw Perpendicular to Superior and Inferior end Plates
  - Angle subtended is the curve magnitude

Radiographic Evaluation: Defining the Curve

- Curve Apex-
- Level of the Vertebrae or Disc shifted the greatest distance from the vertical axis of the patient – Center Sacral Line
Radiographic Evaluation: Defining the Curve

- **End Vertebrae**
  - The most cranial and caudal vertebrae of a curve, whose superior and inferior surfaces tilt maximally toward the concavity of the curve.
  - The most rotated vertebrae are apical – end vertebrae are typically nearly neutral in rotation.

The Structural Curve

- A lateral curvature which “lacks normal flexibility”.
- Radiographically, lacks flexibility on the supine side-bending films.
- Does not correct to neutral.
The Major Curve

- The Major Curve –
  - Largest Structural Curve, typically Thoracic
- The Minor Curve
  - Smaller and more flexible curve
- Double Major – equal T and TL Curves

The Compensatory Curve

- A curve which occurs above or below a major curve to maintain normal body alignment
- These can become structural
Classifying AIS: Lenke Class’n

- Has largely replaced the King-Moe Classification of thoracic and thoracolumbar curves
- 6 Curve types, with 3 Lumbar modifiers, and 3 Sagittal Thoracic modifiers
- 54 potential classification groups, but most fall into specific categories.
- Does not apply to Lumbar curves, non-idiopathic curves, or Adult curves.

Lenke Classification:

- Lenke 1 – Thoracic Scoliosis – typical R thoracic curve
- Lenke 2 – Double Thoracic Curve
- Lenke 3 – Double Major Curve – Structural Thoracic and Thoracolumbar Curves (Thoracic is Primary)
- Lenke 4 – Triple Major Curve – Thor/ Thor/ Thoracolumbar
- Lenke 5 – Thoracolumbar Scoliosis
- Lenke 6 - Double Major Curve – Structural Thoracic and Thoracolumbar Curves (Thoracolumbar is Primary)
Lenke Lumbar Modifier:

• To all the above, the curve below the TL junction is assessed as
  • A. divided by the CSL
  • B. touched by the CSL
  • C. being lateral to the CSL

Surgical Indications
Decision Making in Spinal Deformity:

Goals of Scoliosis Surgery
- Stop Progression/ Create a Stable Spine
- Obtain Neutral Coronal and Sagittal Balance
- Enhance Fusion Rate
- Enhance Cosmesis

Adolescent Idiopathic Scoliosis
- Progression is directly related to Growth Remaining: risk is highest if pt is
  - Premenarchal female
  - Risser 0, I and II
  - Open tri-radiate cartilage
  - Larger Curve Magnitude
  - Double Major Curves
Adolescent Idiopathic Scoliosis

- **Treatment**
  - Bracing
    - Curves >20, <40
    - Growth Remaining
  - Observation
    - Max Progression 1-2 deg./month
  - Fusion
    - Progressive Curves >40
  - NO benefit - Elec.Stim.
  - NO benefit - Chiropractic

- **Treatment Principles - Initial**
  - **Diagnosis** - R/O Neurogenic Origin etc.
  - **Educate Re**: Natural History of the Specific Condition.
  - **Anticipate** - Understand the Pathogenesis/Progression
    - Neuromuscular Disease
    - Congenital Scoliosis
  - **Initiate Treatment** – Start with most Appropriate Methods
    - Observation
    - Bracing
    - Arthrodesis
AIS: Indications for Observation

- Patients who present with a curve less than 25 degrees
- Patients who present near skeletal maturity (post-menarche, Risser 3 or 4).
- Patients older than 18, with a curve < 45 degrees.
- Progression in AIS is < 1 degree/month: 6 – 8 months observation will rarely complicate subsequent treatment.

AIS: Indications for Bracing

- In young patients (Risser 0, 1) – curve > 25 degrees, or < 25 degrees + 5 degrees documented progression.
- In more mature patients (Risser 2, 3, 4) – curve of 35 – 40 degrees, or < 35 degrees + 10 degrees progression.
- Patients who are skeletally mature (post-menarche, Risser 5) or have a curve already > 45 degrees will not benefit from bracing.
AIS: Indications for Arthrodesis

• Documented Curve Progression or Risk
  • High degree curves (>40 Deg. in immature patients, or >50 Deg. At skeletal maturity)
  • Rapid progression (>10 degrees in young patients)
  • Progression > 40 Deg. despite brace treatment
  • Associated Sagittal imbalance
  • Patient who will not comply or consider bracing...

Choosing the Surgical Approach

• Posterior Thoracic or Thoracolumbar Approaches
• Anterior Release and Instrumentation
• Combined Anterior/Posterior Approach
• Extreme-Lateral Approach to ThoracoLumbar Levels
Going Forward - MIS Options in Scoliosis

• Can we limit morbidity, surgical injury and still accomplish:
  – Ant/Post approaches?
  – Improved sagittal balance?
  – Solid fusion?
  – Durable result?

• MIS ALIF
• Multilevel DLIF
• PSF – percutaneous screws

Conclusions

• Better recognition and understanding = earlier intervention in the proper patients
• New tools and techniques, navigation, percutaneous pedicle fixation etc. = greater power and versatility, reduced morbidity
• Outcome still hinges on Careful evaluation, preoperative planning, and patient selection
The End