Scoliosis & Kyphosis

Andrew Darmahkasih, MD PGY-2 UCI-CHOC Pediatric Residency Program



Normal Spine

- Straight in the anteroposterior plane, but normally has curvatures in the lateral plane
- Normal cervical lordosis, thoracic kyphosis, and lumbar lordosis are important for maintaining balance and body forces against gravity
- Plumb line: vertebral line drawn from the center of the 7th cervical vertebra should fall through the posterosuperior corner of sacrum





Scoliosis

- From the Greek *skolios* (bent or curved)
- It is a complex, 3D spinal deformity, mainly involving lateral deviation, but also by necessity also associated with vertebral +/- rib cage rotation
 - This causes the stereotypical "rib hump" that often develops

Box 22.1 Causes of Scoliosis

Structural Scoliosis

Idiopathic Congenital Neuromuscular Other conditions that may result in scoliosis:

- Myopathic disorders
- Neurofibromatosis
- Mesenchymal disorders
- Osteochondrodystrophies
- Metabolic disorders
- Trauma, surgery, irradiation, burns

Functional Scoliosis

Herniated lumbar disks Postural derangements Limb length inequality Irritative or inflammatory disorders Hysteria



Scoliosis

- Most cases of structural scoliosis are idiopathic and have their onset in early adolescence
- May have a familiar disposition but inheritance is multifactorial
- Females > males
- Neuromuscular and congenital forms of scoliosis tend to have more rapid progression of curvature than idiopathic

Scoliosis

- Infantile (0-3 years old) less common
 - Usually also develops plagiocephaly and flattening of head on the concave side of the curve and a prominence on the other side
 - Also have increased incidence of associated hip dysplasia, congenital heart disease, inguinal hernia, and mental retardation
- Juvenile (3-10 years old) less common
- May also scoliosis after conditions (trauma, surgery, spasms) - usually goes away when underlying disorder is treated

- Pain is usually NOT a complaint
 - If any pain, nerve root compression, or evidence of neuro deficits, should look for another treatable underlying cause
- Only true pathognomonic sign: presence of a curve noted on forward bending (positive Adams forward bend test)

 May also noticed convex posterior chest wall prominence ("rib hump") or paralumbar prominence

- Can also see stigmata signs:
 - Shoulder asymmetry
 - Scapular prominence
 - Waist asymmetry
 - Chest or paralumbar humps

 The presence of stigmata signs does not automatically imply the presence of scoliosis, so be sure to actually do the Adams forward bend test



А



Figure 22.71 Moderate idiopathic thoracic scoliosis in an adolescent. A, Scapular asymmetry is easily discernible in the upright position. This results from rotation of the spine and attached rib cage. B, Forward flexion reveals a rib hump deformity.



Figure 22.73 Neuromuscular scoliosis. This 12-year-old boy has cerebral palsy and scoliosis. Note that his sitting balance is affected by the curve of his spine, which extends from the upper thorax to his pelvis, resulting in pelvic obliquity and inability to sit independently. This is typical of spinal deformity in patients with neuromuscular disorders.



Figure 22.72 Lumbar scoliosis. Pelvic obliquity is present, with prominence of the left flank.



FIG. 699.1 Structural changes in idiopathic scoliosis. A , As curvature increases, alterations in body configuration develop in both the primary and compensatory curve regions. B, Asymmetry of shoulder height, waistline, and elbow-to-flank distance are common findings. C, Vertebral rotation and associated posterior displacement of the ribs on the convex side of the curve are responsible for the characteristic deformity of the chest wall in scoliosis patients. D, In the school screening examination for scoliosis, the patient bends forward at the waist. Rib asymmetry of even a small degree is obvious. (From Scoles PV: Spinal deformity in childhood and adolescence. In Behrman RE, Vaughn VC III, editors: *Nelson textbook of pediatrics, update 5,* Philadelphia, 1989, WB Saunders.)



- Up to 5% of school-age children and adolescents have lateral curvatures, routine screening should be done by the pediatrician from 6-7 years old until the end of puberty
- 7 degrees or more may be the suggested cutoff for referral (although there is disagreement)

- Should let the orthopedic surgeons do the XR that they want because they need high-quality XR
- Needs standing, high-quality PA and lateral radiographs for the entire spine
- Determine the Cobb angle (angle between the the superior and inferior vertebrae most tilted into the curve



FIG. 699.2 A-C, Cobb angles measurements. (From Morrissy RT, Weinstein SL: Lovell & Winter's pediatric orthopaedics, ed 6, Philadelphia, 2006, Lippincott Williams & Wilkins.)



- Idiopathic curves of 25 to 30 degrees or more and lesser curves are treated with spinal bracing and exercise program
 - BRAIST study shows efficacy of bracing
- Curves exceeding 45 to 50 degrees or those that rapidly progress despite bracing require operative intervention
- Those with untreated curvatures extending 75 to 80 degrees likely will develop secondary cardiopulmonary problems



H

FIG. 699.3 Preoperative standing posteroanterior radiograph of a 14 yr old girl who was skeletally immature and developed a 68-degree right thoracic and a 53-degree left lumbar scoliosis (A). Her trunk was shifted to the right, and the left shoulder was slightly depressed. Based upon the risk of future progression, she was treated by an instrumented posterior spinal fusion from T3 to L3 with correction of the right thoracic curve to 20 degrees and the left lumbar curve to 10 degrees (B). Coronal spinal balance was restored, and shoulder height was maintained.



Kyphosis

- Curvature of the spine in the sagittal plane exceeding the typical curvature
 - Thoracic spine kyphosis of 25-50 degrees
 - Lumbar spine lordosis of 25-50 degrees
- Excessive kyphosis may be purely postural in nature
 - Can correct the curvature voluntarily
 - May be accompanied with mild aching discomfort
 - No pathologic changes noted with the involved vertebrae
 - No evidence to progress to structural deformity

Table 699.2

Conditions Associated With Hyperkyphosis

- Trauma causing spinal fractures
- Spinal infections resulting from bacteria, tuberculosis, and fungi
- Metabolic diseases such as osteogenesis imperfecta or osteoporosis
- Iatrogenic (laminectomy, spinal irradiation)
- Neuromuscular diseases
- Neoplasms
- Congenital/developmental
 - Disorders of collagen such as Marfan syndrome
 - Dysplasias such as neurofibromatosis, achondroplasia, and mucopolysaccharidoses

Scheuermann Kyphosis

- Most common form of structural hyperkyphosis
- Defined by wedging of >5 degrees of three or more consecutive vertebral bodies at the apex of the deformity on a lateral XR
- May have a genetic or metabolic pathology, or simply the secondary insult of mechanical overload
- Incidence varies from 0.4% to 10%, affecting males 3x more than females

Scheuermann Kyphosis

- Can be distinguished from structural kyphosis by inherent stiffness and greater magnitude of the deformity
- Pain is typically a common complaint
- Only partially correctible or fails to correct on hyperextension or the application of pressure over the apex of curve
- XR: standing PA and lateral
 - Can see evidence of end-plate erosion of the involved vertebrae and Schmorl nodules



FIG. 699.9 Standing lateral radiograph of a 14 yr old boy with severe Scheuermann kyphosis. This measures 92 degrees between T3 and T12. Note the wedging of the vertebrae at T6, T7, T8, and T9. The normal thoracic kyphosis is ≤40 degrees.



Figure 22.76 Moderate thoracic kyphosis secondary to Scheuermann disease. **A**, The patient is attempting to correct the deformity, but because of its fixed nature, he cannot do so and must compensate for this with an increased lumbar lordosis. **B**, This tomographic cut shows anterior wedging of three consecutive vertebral bodies and clearly demonstrates the associated erosion of the vertebral end plates and Schmorl nodules.

В

Scheuermann Kyphosis

- Exercise and bracing can be effective in mild structural kyphosis
 - May have to be worn for 23 hours daily
 - Goal of bracing is to prevent progression
- In patients with with progressive deformity >70-80 degrees who is dissatisfied with cosmetic appearance or has persistent back pain, may consider spinal fusion
 - These surgical procedures have higher risk than fusions for AIS



References

- Kliegman RM, St Geme JW, Blum NJ, Shah SS, Tasker RC, Wilson KM. *Nelson Textbook of Pediatrics*. Elsevier Health Sciences. 2020, 21st ed.
- Zitelli BJ, McIntire SC, Nowalk AJ. Zitelli and Davis' Atlas of Pediatric Physical Diagnosis. Elsevier Health Sciences. 2018, 7th ed.