Disclosures

• Neither I nor any member of my family has a financial relationship or interest with any proprietary entity producing health care goods or services
Educational Objectives

• Learn how to conduct a clinical exam for scoliosis
• Understand the differential diagnosis of back pain in children and adolescents
• Recognize indications for referral of back pain and scoliosis to a specialist
Additional Educational Objectives

• Primary care management of muscular back pain
• Indications for advanced imaging in children with back pain
Spinal Anatomy

- 7 cervical
- 12 thoracic
- 5 lumbar
- Sacrum
- Coccyx
Spinal Growth

• Birth → 5 years:
  • Growth velocity of T1-L5 greatest (2cm/yr)
  • 50% increase in spine length
  • 2/3 of final sitting height achieved by age 5 years
• Average thoracic height norms
  • Newborn: 11cm
  • 5 yo: 18cm
  • 10 yo: 22cm
  • Adult: 26.5cm (female); 28cm (male)
Spinal Growth
Spine Pathology in Infants

• Deformity
• Infection
• Tumor
Infant Spine Examination

- Alignment
- Rib humps
- Skin changes
  - Hairy patches
  - Dimples – can you see a floor?
- Sitting x-rays if possible
- Reflexes - Observation
Early Onset Scoliosis

• Onset age < 6 years
• Variety of causes
  • Congenital deformities
  • Syndromic
  • Neuromuscular
  • Idiopathic
Early Onset Scoliosis

• Pulmonary Development
# Congenital Scoliosis

<table>
<thead>
<tr>
<th>Defects of Segmentation</th>
<th>Block vertebra</th>
<th>Unilateral Bar</th>
<th>Unilateral Bar and Hemivertebra</th>
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<tbody>
<tr>
<td></td>
<td>Bilateral failure of segmentation</td>
<td>Unilateral failure of segmentation</td>
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</table>

<table>
<thead>
<tr>
<th>Defects of Formation</th>
<th>Hemivertebra</th>
<th>Wedge vertebra</th>
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<tbody>
<tr>
<td>Unilateral complete failure of formation</td>
<td>Unilateral partial failure of formation</td>
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</table>

<table>
<thead>
<tr>
<th>Fully segmented</th>
<th>Semi segmented</th>
<th>Incarcerated</th>
<th>Nonsegmented</th>
</tr>
</thead>
</table>
Congenital Scoliosis

- Due to bony malformation
  - Failure of segmentation
  - Failure of formation
Congenital Kyphosis
Treatment

• Observation
• Casting
• “Growth Sparing” Surgery
• Spinal Fusion
Casting Frame / Positioning
Applying Padding
Plaster Application
Cast Molding
Molding Over Hips
Trimming Windows
Treatment VEPTR/Growing Rods
Treatment of Hemivertebrae
Treatment of Congenital Kyphosis
Diskitis

- Inability/unwillingness to ambulate
- Unwilling to flex spine
- ± fevers
- Elevated ESR/CRP
- Loss of disc space height
- Medical management
Diskitis
Spine Pathology in Children & Adolescents

- Deformity
- Infection
- Trauma
- Tumor
- Pain
Examination

- Standing alignment
- Shoulder balance
- Forward bend test
- Flexibility/Range of Motion
  - Spine & Extremities
- Motor/Sensory evaluation
- Straight Leg Raise
- Reflexes
- Gait
Examination

- Assess shoulder heights
- Scapular asymmetry
- Waist asymmetry
Coronal Plane
Sagittal Plane
Axial Plane
Examination

• Forward bend – use of scoliometer
• 5-7 degree threshold for referral
Scoliometer

iPhone app
$0.99
Validated – J Peds Ortho 2012

$48
www.scoliosis.org
National Scoliosis Foundation
Examination

• Range of motion
• Hamstring tightness
  • Associated with spondylolysis & spondylolisthesis
Examination

- Straight Leg Raise
Neurologic Examination

• Motor exam
  • Hip flexion – L1-L2
  • Adductors – L2-L3
  • Abductors – L5
  • Quads – L2-4
  • Hamstring – L2-4
  • Dorsiflexion Ankle - L4
  • Dorsiflexion Great Toe – L5
  • Plantarflexion S1

• Sensory exam – dermatomal
• Reflexes – symmetry
• Upper tract signs – clonus/Babinski
L4 Nerve Root

L4 NEUROLOGIC LEVEL

MOTOR
Tibialis Ant.

REFLEX

SENSATION
L5 Nerve Root

L5 NEUROLOGIC LEVEL

MOTOR
Ext. Hal. Lg.

REFLEX
None

SENSATION
L5
S1 Nerve Root

S1
NEUROLOGIC LEVEL

MOTOR
Peroneus L. + b.

REFLEX

SENSATION
S1
Physical Examination of the Spine & Extremities

Stanley Hoppenfeld
Idiopathic Scoliosis

- Scoliosis – curvature greater than 10°
- No known cause
- Incidence – 1%
- 7:1 female predominance in those requiring orthopaedic treatment
Idiopathic Scoliosis

- **Treatment**
  - **Observation**
    - Curves < 20°
    - After completion of spinal growth
  - **Bracing**
    - Growing children with curves 20-45°
    - Katz JBJS 2010
  - **Surgery**
    - Curves >45-50°
Surgical Technique - Scoliosis

• Remove cartilage from joints
• Use of screws, hooks, wires to anchor spine
• Correction of deformity
• 2 rods to hold corrected position
Spinal Cord Monitoring

- Sensory and motor pathways
- Real time spinal cord function
- Offers ability to detect injury early and make adjustments to prevent permanent injury
Facet Joints
Spinal Anchors
Referral for Scoliosis

- Scoliometer $> 5\text{-}7^\circ$
- Curve greater than $10^\circ$ in a growing child
- Curve greater than $40^\circ$ in a child who has completed spinal growth
- Any neurologic signs
- Any patient you are concerned about
- Curves should be measured on *full length* standing scoliosis films
- If any doubt – refer
Scheurmann’s Kyphosis

- Sagittal plane deformity
  - “humpback”
- Generally treated non-surgically
- Physical therapy
- Bracing controversial
Scheurmann’s Kyphosis - Operative

- Progressive deformity > 90 degrees
- Improves cosmesis
- Unpredictable effect on pain
Neuromuscular Scoliosis

- Cerebral palsy
- Myelomeningocele
- Duchenne’s muscular dystrophy
- Spinal muscular atrophy
Neuromuscular Scoliosis

Bracing generally not effective
Often require surgical management
Back Pain

• Common in children/adolescents
• 50% by 15yrs of age
• Persistent in up to 10%

• Younger children more likely to have pathology beyond muscular pain/deconditioning
Back Pain: DDX

- Infection
- Spondylolysis
- Spondylolisthesis
- Herniated nucleus pulposus
- Tumor
- Muscular

Scoliosis ≠ Back Pain
Osteomyelitis

- Insidious pain
- Delay in diagnosis
- Elevated ESR/CRP
- Disc space loss
- Vertebral body collapse
- Medical management
  - Biopsy may be beneficial
  - Culture positive only 30-50%
Spondylolysis

- Most frequent radiographic finding associated with back pain
- Incidence 5% in population
- Associated with hyperextension activities
  - Gymnastics, football linemen
Spondylolysis

• Diagnosis – lateral or oblique x-rays
Spondylolysis

- Bone scan
- CT scan – to assess healing
Spondylolysis

- Treatment controversial
  - Activity modification/bracing
  - Benign neglect
  - Surgical repair
Spondylolisthesis

• Forward slippage of vertebra
• Most frequently at L5-S1
• Dysplastic vs stress fracture
Spondylolisthesis

- Hamstring tightness
- Abnormal gait
- Severe cases can have neurologic findings
Spondylolisthesis

- Low grade – physical therapy
  - Low rate of progression <5%
- High grade – surgery
Herniated Nucleus Pulposus

- Infrequent in children/teenagers
- Conservative management unless cauda equina symptoms or persistent motor weakness
  - Rest
  - NSAIDS
  - Physical therapy
Spine Tumors

- Night pain
- Pain that does not resolve with rest
- Constitutional symptoms
- Neurologic symptoms
Benign Spine Tumors

- Osteoid osteoma
- Osteoblastoma
- Langerhans cell histiocytosis
- Aneurysmal bone cyst
Osteoid Osteoma

- Pain resolves with NSAIDS
- Night pain
- May have scoliosis, concavity on side of osteoid osteoma

Treatment:
- Excision vs radiofrequency ablation
Osteoblastoma

- Similar histology as osteoid osteoma
- Larger size, >1.5cm
- Also may cause scoliosis

Treatment
- Excision
- Check CXR
  - Lung metastasis
Langerhans Cell Histiocytosis

• Hallmark is vertebra plana
• Biopsy if there is associated soft tissue mass on MRI
• Treatment: Observation
Langerhans Cell Histiocytosis
Aneurysmal Bone Cyst

• Expansile lesion seen on radiographs
• Fluid-fluid levels on MRI
• Treatment: Excision, spinal stabilization
Malignant Spine Tumors

• Leukemia – 6% present with back pain
• Ewing’s sarcoma – frequently in pelvis/sacrum
• Osteosarcoma – infrequent in spine
Muscular Back Pain

- Most common diagnosis
- Resolves with rest/sleep
- Not associated with lower leg pain
- No urinary symptoms
- Does not usually prevent patient from school/sports
Imaging for Back Pain

• None if less than one month and no concerning symptoms

• AP/lateral standing spine for duration > 1 month – no shields
  • Pelvic/sacral tumors hidden
Imaging for Back Pain

- Can consider bone scan
  - “shotgun” imaging
- Hold on MRI until ordered by orthopedics
Treatment

- Therapy to focus on strengthening/stretching
- Improving sleep
- Reducing stress
- Home remedies
  - Massage, heat, ice
  - NSAIDS
  - No narcotics
Physical Therapy

• Requires daily commitment from patient
• PT role is primarily to educate
• Back strengthening
• Abdominal strengthening
• Hamstring stretching
• General fitness/conditioning
Associated Symptoms

- Ask about
  - School
  - Friends
  - Family
  - Sleep
- Back pain often goes hand in hand with stress/depression/other mental disorders
Referral for Back Pain

• Any neurologic signs
• Any concerning history
  • night pain
  • urinary/fecal incontinence
  • inability to ambulate or change in gait
  • increasing severity
• Failure to improve despite good compliance with 2-3 months of conditioning and therapy with home exercises
Questions?

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