Scoliosis and Short leg Syndrome

RICHARD S. DOBRUSIN DO FACOFP
BOARD CERTIFIED FAMILY PHYSICIAN
INCOMING AOMA PRESIDENT

THANK YOU TO AOMA FOR ALLOWING ME TO SPEAK

I have no disclosures
I want to take a moment to thank our fabulous AOMA staff. Janet Weigel, Teresa Roland and Kristen Strong without whom this virtual convention would not have happened.

LEARNING OBJECTIVES

- Define scoliosis and short leg syndrome with the aid of clinical osteopathic examples.
- Define the unique biomechanics of scoliosis.
- Discuss physical exam techniques used to diagnose scoliosis and short leg syndrome.
- Discuss the difference between S and C shaped scoliosis curves.
- Define Cobb angle and skeletal maturity score.
- Discuss Ferguson’s Angle.
- Discuss when a heel lift initiated and when we get a scoliosis series.
- Review the Heilig formula and when we use it.
Case History

- 17-year-old female gymnast presents complaining of low back pain.
- Dull, achy pain most days for the past 3 years, located at the SI joint level bilaterally.
- Improvement with rest and ibuprofen.
- No history of trauma but is a competitive athlete.
- No x-rays in the past.
- ROS: no numbness, weakness, tingling, bowel or bladder control issues, no fevers, no weight loss, no night sweats, normal childhood development.
- Family, Surgical, Social history are all negative.
- No other meds except occasional NSAIDs.

Physical Exam

- Height 5'4, Weight 100 lbs, BP 100/78, Pulse 67.
- General impression: well appearing, thin female, no acute distress.
- HEENT, heart, lungs, abdomen- all normal.
- Musculoskeletal:
  - FROM in all extremities and cervical spine.
  - Thoracic ROM decreased sidebending-Right.
  - Forward bending test (Adams test)-paravertebral humping on the Right thoracic, Left lumbar.
  - Tenderness noted over the SI joint areas bilaterally, no midline spinous process tenderness.
  - Tenderness over the T6 transverse process-Right
    - Shoulder lower- Left.
    - Positive standing flexion test-Left.
    - Short leg- Left.
- Neuro exam: CN 2-12 intact, DTR 2/4 bilateral LE and UE, motor 5/5 bilateral LE and UE, sensation normal throughout to light touch.
Case History Assessment

Scoliosis dedicated XRAY shows “S” shaped curve 15 degrees thoracic curve rotated Right. First orient yourself on the x-ray to left and right

(Dextroscoliosis) with a secondary mild lumbar curve 8 degrees rotated Left (Levoscoliosis).

Mild Scoliosis in post puberty gymnast.

Short leg syndrome, short leg on the Left.

Background/ Prevalence

Scoliosis- lateral curvature of spine ≥ 10 degrees in the coronal plane while standing. About 2% of the general population has adolescent scoliosis, with 80% idiopathic.

Study in Hong Kong: Cross-sectional analysis of retrospective cohort study
- 3.5% of adolescents diagnosed with adolescent idiopathic scoliosis (AIS)
- 306,144 children and adolescents had medical records evaluated
  - Prevalence of Cobb angle ≥ 10 degrees
    - 3.5% overall
    - 4.8% of girls and 2.2% of boys
  - Prevalence of Cobb angle ≥ 20 degrees
    - 1.8% overall
    - 2.8% of girls and 0.7% of boys
  - Prevalence of Cobb angle ≥ 40 degrees
    - 0.2% overall
    - 0.4% of girls and 0.07% of boys

Increased risk of curve progression: curve (> 30 degrees), skeletal immaturity, and female gender. Consider screening for scoliosis; twice in girls, at ages 10 and 12 years, and once in boys ages 13-14 years.
Natural History

Consider curves may worsen during puberty and growth spurt ages 8-15.
- Stabilized after puberty.
- In girls generally curves progress 2 years before and 2 years after menarche

*Likely no change in adulthood in curves less than 40 degrees.*

However, the longer the curve has persisted in the body, there is an increase in compensation made by other structures.

---

Why do we find Scoliosis in Adults?

- Arthritis
- Back pain
- Chest cage pain
- Neck pain
- Headaches
- Symptoms of organ dysfunction
Definitions

Scoliosis
◦ A rotary deformation of the spinal vertebrae resulting in a sideways curve.
◦ Sideways curves in the spine cause an “S” or “C” shape in the spine.

Short Leg Syndrome
◦ Un-leveling of the sacral base.
◦ Often caused by a compensation for scoliosis in the spine.

Etiology of Scoliosis

**Idiopathic (70-90% of cases): based on age of onset**

1. **Infantile** (age of onset 0-3 years)
   - 1% of idiopathic scoliosis cases
   - More common in boys (ratio 3:2)
   - 75%-90% reported to be convex left curves

2. **Juvenile** (age of onset 3-10 years)
   - 12%-21% of idiopathic scoliosis cases
   - Slightly more common in girls
   - Most are right thoracic curves
   - Early onset <5 years

3. **Adolescent** (age of onset 10-18 years)
   - Most common type of idiopathic scoliosis
   - More common in girls

**Congenital Malformation**

- 1. Abnormal shaped vertebrae at birth
  - Hemi and wedged shaped
Etiology of Scoliosis - Other

CNS tumor, infection, inflammation, irradiation

Trauma, fracture, hip prosthesis

Metabolic: Osteomalacia, Rickets (VITAMINS)

Neuromuscular
- Cerebral Palsy
- Duchenne’s Muscular Dystrophy
- Polio
- Neurofibromatosis
- Connective tissue disorder

Somatic Dysfunction
- Psoas Syndrome
- Sciatic irritability
- Cranial dysfunction
- Sacral base un-leveling - short leg syndrome

Terminology

- Structural
  - Inflexible or fixed
  - Muscles and ligament shortened on the concave side

- Functional
  - Flexible
  - May become structural

- “C” or “S” shaped curves
  - Balanced or Unbalanced
  - Single or Double major

- Primary or secondary curves
  - Usually the thoracic curve is the primary curve with the lumbar curve acting as a compensatory or secondary curve.
Biomechanics

- The curve sidebends one direction and rotates the opposite direction.

- Type I

- Within the curve, at “key points” there are hidden ERS and FRS (Type II mechanics).

- Found at transition points:
  - Top and bottom of the curve
  - Apex
  - Crossover points in an “S” curve

Biomechanics

The curve is identified and named for the CONVEXITY; this is the way the vertebrae are ROTATED!!

The sidebending component is thus on the CONCAVITY.

Terminology used:
- Dextroscoliosis (rotated to the RIGHT/ convex RIGHT)
- Levoscoliosis (rotated to the LEFT/ convex LEFT)
Postural Imbalance Considerations

Standing posture exam
- Levels of the occiput, shoulder, iliac crest, PSIS, trochanteric planes.
- Hand height
- Spinous processes.

- Forward bending test - Adams test
- Have the patient bend forward, observe and palpate for paravertebral muscle mass asymmetry. The paravertebral muscle mass over the convexity becomes more prominent during postural flexion.

Pelvic side shift
- Shifts easier (free) to the long leg side
- For pelvic side shift, with patient standing on two feet, exert a lateral force at the level of the greater trochanter
- A positive test is when the patient shifts one direction more than the other. The direction of greater motion/ease is the patient's longer leg. (i.e. if patient shifts more to the left, the left leg is the longer leg)

Postural Imbalance Considerations

Tension in latissimus dorsi, psoas and erector spinae muscles may affect range of motion in the hip, pelvis, and shoulder
Compensation in the Pelvis

- Common compensation pattern:
  - The same side of the lumbar convexity is usually where the shorter leg is found with respect to sacral base unleveling.

Appreciate that over time, the body may adapt to alternative compensatory patterns.

Visual Examples
Key Areas of Somatic Dysfunction:

- Spine: “hidden” ERS & FRSs lock down the curve
  - Crossover point - between 2 curves
  - Apex - midpoint of curve
  - Top & Bottom of curve

- Spine: Type I dysfunction group will benefit from stretching the concavity.

- Sacral torsions and sacral base unleveling

- Pelvic compensation pattern
  - *Functional Short Leg - on same side as convexity of curve*

Typical S shaped curve

**Thoracic - Dextroscoliosis**
- Convex right, rotated right
- Sidebent left

**Lumbar spine - Levoscoliosis**
- Convex left, rotated left
- Sidebent right

Shoulder low on left

Forward bend test humping on the right upper thoracic and lower lumbar
Typical C Shaped Curve

Lumbar spine **convex Left**
- Levoscoliosis, rotated left
- Sidebent right

Possible shoulder height un-level

Forward bend humping on the low lumber left.

Let’s Name Some Curves

**Thoracic**
- Dextroscoliosis
  - Rotated Right
  - Sidebent Left

**Lumbar**
- Levoscoliosis
  - Rotated Left
  - Sidebent Right
Determination of Scoliosis Curve

- Dedicated Scoliosis XRAY
- Cobb Angle

Calculate: Cobb angle (from PA view x-ray)

1. Determine the 2 vertebrae that are at the superior and inferior ends of the curve (the "end vertebrae")

2. Draw lines along the superior end of the superior vertebra and the inferior end of the inferior vertebra (the lines would be horizontal in a straight spine)

3. Draw perpendicular lines to the 2 previous lines (these lines would be vertical in a straight spine)

4. Cobb angle is the angle between the 2 previous lines

Scheuermann’s disease

Thoracic hyperkyphosis

Approximately 4% of the population

More common in boys with a wide chest in the AP diameter
Internal System Compromise

- Rib cage
  - Heart, lungs, GI, GU systems affected
    - Thoracic curve
      - > 50 degrees – respiratory compromise
      - >75 degrees - cardiovascular compromise
      - Viscerosomatic reflexes at crossover points
      - i.e. diarrhea and bloating at T10-11

Internal System Compromise

- All curves > 50 degrees will likely lead to long term physiologic complications/compromise and cosmetic changes.
- These patients will have a disproportionately short torso compared to their legs. Sometimes they say they have “long legs”
Adolescent Screening School Programs

Position Statement - Screening for the Early Detection for Idiopathic Scoliosis in Adolescents

SRS/POSNA/AAOS /AAP Position Statement 9/2/2015 v2
M. Timothy Hresko, MD; Vishwas R. Talwalkar, MD; Richard M. Schwend, MD

The Scoliosis Research Society (SRS)
American Academy of Orthopedic Surgeons (AAOS)
Pediatric Orthopedic Society of North America (POSNA)
American Academy of Pediatrics (AAP)

Believe that there has been additional useful research in the early detection and management of adolescent idiopathic scoliosis (AIS) since the review performed by the United States Preventive Services Task Force (USPSTF) in 2004. The USPSTF has this screening under current review.

Treatment Considerations

Based on skeletal maturity, age, and degree of curvature.

- Mild scoliosis-Conservative management
  - < 20 degrees or if near skeletal maturity
    - OMT, PT, home exercise prescription
    - Goal: improve flexibility, strengthen trunk and abdominal muscles
    - Consider regular x-rays to assess for change
Determination of Skeletal Maturity

- **Risser’s Score/Sign**
  - **Risser 1**: 25% iliac apophysis ossification
    - Seen in prepuberty or early puberty
  - **Risser 2**: 50% iliac ossification
    - Seen immediately before or during growth spurt
  - **Risser 3**: 75% iliac ossification
  - **Risser 4**: 100% ossification
  - **Risser 5**: Iliac apophysis fuses to iliac crest.
    - Indicates cessation of growth

---

**Risser scale x-ray**
Treatment - Bracing

Moderate Scoliosis
- Recommended for curves 25-45 degrees in patients with Risser grade ≤ 2
- In addition to OMT, PT, and core strengthening.

Consultation and referral
- Referral to orthopedist generally recommended if Cobb angle > 20 degrees and patient is skeletally immature
- If connective tissue disorder suspected, refer to genetic and cardiac specialists

Treatment - Surgery

Severe Scoliosis
- > 50 degrees
- Respiratory compromise
- Rapidly progressing curves despite conservative management
- Especially during rapid growth changes in puberty

Figure 1: pre-op

Figure 2: Post-op
Treatment Considerations - OMT

Maintain curve < 40 degrees to avoid surgery
Postural Balance, level the sacral base, consider heel lift
Evaluate compensatory patterns to restore homeostasis
Address viscerosomatic reflexes often found at crossover points (think about symptoms developing in other areas of the body)

Home exercises and proprioceptive retraining.


Decreased pain so patient has an active life

Choice of Technique

- Muscle Energy is King! Treat the “hidden” ERS/FRS that lock down the curve
- SCS - changes neuromuscular programming
  - Iliopsoas, QL, Traps, Serratus, SCM, SSI, LP5
- HVLA - especially chronic segments. Some curves may be hard to articulate
- MFR - soft tissue important technique
Short leg syndrome, sacral base un-leveling

The syndrome is directly related to an un-leveling of the sacral base, which can be caused by multiple factors.

Short Leg Causes

- Congenital
- Acquired via spinal, pelvic, femoral fracture or degenerative changes
- Functional from somatic dysfunction
- Short leg may cause scoliosis
- Scoliosis can lead to a short leg
Why Do We Care

Sacral base un-leveling is one of the most common findings in patients with low back pain.

Leveling the sacral base with OMT and a heel lift can make a substantial difference for some patients.

Short Leg Syndrome

- Functional short leg- (dynamic) caused by somatic dysfunction.
  - Responds to OMT.

- Structural short leg- caused by an anatomical short leg or fixed muscle/ligament imbalance.
  - This condition often requires a heel lift.
Short Leg Syndrome

- Chronic leg length discrepancies may result in compensatory patterns:
  - Spine (scoliosis)
  - Pelvis (rotation of the innominate)
  - Viscera (hyperactive sympathetic NS in T1-L2)

- A syndrome associated with a variety of biomechanical changes.

Short Leg Syndrome

Compensatory measures are sometimes so good that any **SINGLE** landmark measurement may fail to provide a true and accurate diagnosis.

Don’t get frustrated... trust your diagnostic skills.
Short Leg Syndrome

Compensatory measures are sometimes so good that any SINGLE landmark measurement may fail to provide a true and accurate diagnosis.

Which leg looks shorter?

Short Leg Syndrome-Diagnosis

Consider recurrent patterns of somatic dysfunction

Compare levels of the medial malleoli in the supine position

In the standing position measurement of the iliac crests and greater trochanters may be the most reliable.

Radiographic measurements correlate better. Order a scoliosis series. This will always be standing.
Common Short Left Leg Syndrome Pattern

Sacral base, iliac crest, greater trochanter lower on the short leg side

**Convexity** of lumbar spine on short side

**Anterior rotation** of innominate on short leg side. (This is classically taught)

Sacral sidebending towards short side, rotation towards long side = torsion towards long side.
In this picture rotation would be right. This would probably be a right on right sacral torsion.

Ferguson’s angle – Lumbosacral angle increases 2-3 degrees.

Iliolumbar and SI ligaments stressed on the short leg side.

Compensatory patterns, variations exist

---

Common somatic dysfunctions that cause a functional short leg

Posterior Innominate somatic dysfunction causes a short leg and an externally rotated foot on the side of the dysfunction. The ASIS will be superior on the dysfunctional side.

Anterior Innominate somatic dysfunction causes a longer leg and an internally rotated foot on the side of the dysfunction. The ASIS will be inferior on the dysfunctional side.

The innominates rotate during gait
Question? How can you tell them apart?
Pelvis will shift easier to the long leg side

Pelvic side shift test:
- physician induces lateral translation (in a coronal plane) to the standing patient’s pelvis
- will shift easier (free) to the long leg side

If pt has left or right scoliosis of the lumbar region, then:
- Left leg is short
- Right leg is long
- Paravertebral hump will appear on the side of the convexity (and side of rotation)
- Test will be positive on the right side

The hip will drop easier to the short leg side

Hip Drop Test
- Region of body you are testing
  - Lumbar spine and hip
- What you are testing for
  - Ability of the lumbar and lumbosacral region to sidebend away from the side of the hip drop
- How to do it
  - D.O.’s hands on iliac crest
  - Patient bends on one knee without raising foot.
  - Observe sidebending curve opposite the side of hip drop
- What a + sign means
  - Negative (Normal) — Smooth curve away from side of hip drop at 20° - 25°.
  - Positive Test (Abnormal) — Plane of iliac crest drops <20°, lack of smooth lateral curve opposite side of test.
  - SD in lumbar or thoracolumbar preventing normal SB opposite hip drop side.
Positive Trendelenburg's sign demonstrates opposite leg gluteus medius weakness

David Heilig DO FAAO was the leader in the field of short leg syndrome and lift therapy
Heilig short leg patterns Patterns

I) Lumbar Convexity on the short leg side (variable proportionality). Consider lift therapy. These are the patients we are looking for.

II) No sacral base un-leveling, only femoral head un-leveling. No need for lift therapy

III) Sacral base un-leveling only without femoral head un-leveling. Lift therapy is usually not indicated.

IV) The sacral base and the femoral heads are unlevel to opposite sides. Never use lift therapy.

Can we really make sense of this??
Interpreting Standing Postural Study: How great is the Sacral Base Unleveling (SBU)?

Heilig Formula:
- Uses the sacral base un-leveling as previous
- SBU = H - G
- Adds duration (D) [1-3]
  - present to 10 years = 1
  - 10-30 years = 2
  - more than 30 years = 3
- Compensation (C) [0-2]
  - no compensation = 0
  - rotation of the lumbar spine to the convexity of the formed sidebending curve = 1
  - wedging of the vertebrae etc = 2
- L = SBU/D + C
- L represents the lift height required

Goals for Clinical Sacral Base Leveling (More level) Heel Lift Therapy

- With heel lift application:
  - Sacral base is level
  - Iliac crest heights when standing are level
  - Standing flexion test is negative
  - Forward bending of the spine is improved
  - Lateral trunk bending is symmetrical

The goal is: **Sacral base leveling**:
Ferguson’s Angle

Observed laterally
Lumbosacral angle formed by intersection of a horizontal line and a line at the base of the sacrum (between L5 and sacral base)
Normal angle = 25° - 35°
An increase in Ferguson’s angle causes shear stress on lumbosacral joint
This translates into low back pain
Ferguson’s angle increases 2-3 degrees in Short Leg Syndrome.
Increased Ferguson’s angle would increase the lumbar lordosis and decrease the size of the intervertebral foramina

Congenital variations at the Lumbosacral area
This is by far the most common area in the spine to see congenital variations
Lumbarization
Sacralization
I see these very frequently

http://www.studyblue.com
How to Level the Sacral Base

1. OMT First
   - Improve the compensatory pattern & muscle imbalances.
   - Heel lift needed if not achieving results desired.

2. Postural x-ray study (Scoliosis series):
   - Measures sacral base and femoral head un-leveling.
   - Start heel lift only after the first set of x-rays.
   - If sacral base un-leveling is > 4 mm, consider heel lift

3. Use a sample heel lift to identify the appropriate height.
   - Heel lift is applied to the short leg side (usually worn at all times)
   - Choose one that offers the best function and symptom improvement.

What to order

Scoliosis series with cobb angles (and risser score if skeletally immature)
AP and lateral standing lumbar and thoracic spine
Read them yourself in front of patients (They love it)
Look for transitional segments and congenital variations
Get it from a place that has an on-line portal
Learn the toolbar and use a place with a good toolbar
Dextroscoliosis with severe degeneration and a level sacral base

Levoscoliosis with short left leg
Drawing the lines with measurement.
Dextro or Levo? Type I, II, III or IV?
Severe dextroscoliosis with concavity degeneration

Dextroscoliosis with short right leg
Femoral Head Unleveling

Sacral Base Unleveling with Cobb Angle
Sacral Base Unleveling

Sacral Base Unleveling with Cobb Angle
Heilig IV with markings. Does lifting the left leg make sense to you? 

Interpreting Standing Postural Study: 
How great is the Sacral Base Unleveling (SBU)?

**Heilig Formula:**
- Uses the sacral base unleveling as previous
- SBU= H-G
- Adds duration(D)(1-3)
  - present to 10 years=1
  - 10-30 years=2
  - more than 30 years=3
- Compensation(C)(0-2)
  - no compensation=0
  - rotation of the lumbar spine to the convexity of the formed sidebending curve=1
  - wedging of the vertebrae etc=2
- L= SBU/D+C
- L represents the lift height required
Prescribing a Heel Lift

Lift is applied to short leg side (un-level sacral base)
Final height of lift should be $\frac{1}{2} - \frac{3}{4}$ of the measured leg length discrepancy
If the patient has a sudden leg length change (hip fx, prosthesis), lift the full amount as needed.

Prescribing a Heel Lift

- For elderly patients, osteoporosis, or significant acute pain, begin with a lift that is 3mm
  - Increase heel lift by 2mm every two weeks

- All other patients, begin with 3-5mm
  - Adjust every 2 weeks as tolerated, increasing by 2mm

- Maximum of 9mm can be applied to inside of shoe
  - If >9mm is needed, additional lift must be applied to the outside of shoe.

- Maximum lift = 9mm. If more needed an entire sole lift (extending from toe to heel) should be used.
- Heel lifts can be purchased from several companies. Patients can buy them online.
References

- Phillip Greenman Lift Therapy: Use and Abuse Journal AOA December 1979 pp 238-250

---

Thank you to Shannon Scott DO FACOFP for help with this slide presentation
I thank you for your trust and support. We at AOMA wish you all the best of health and happiness in this stressful time. We look forward to meeting in person at our fall and spring conventions. We appreciate you all for your help and participation. We welcome your membership and participation.

Questions? RDobrusin@gmail.com