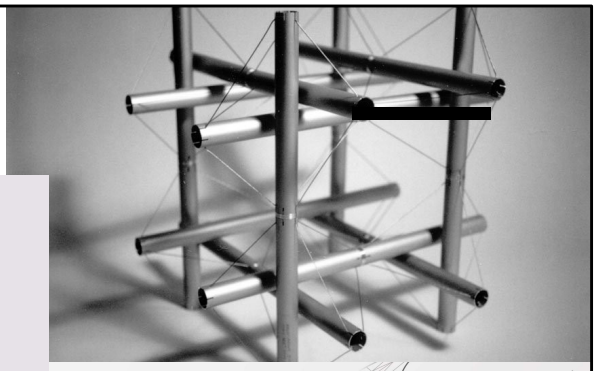
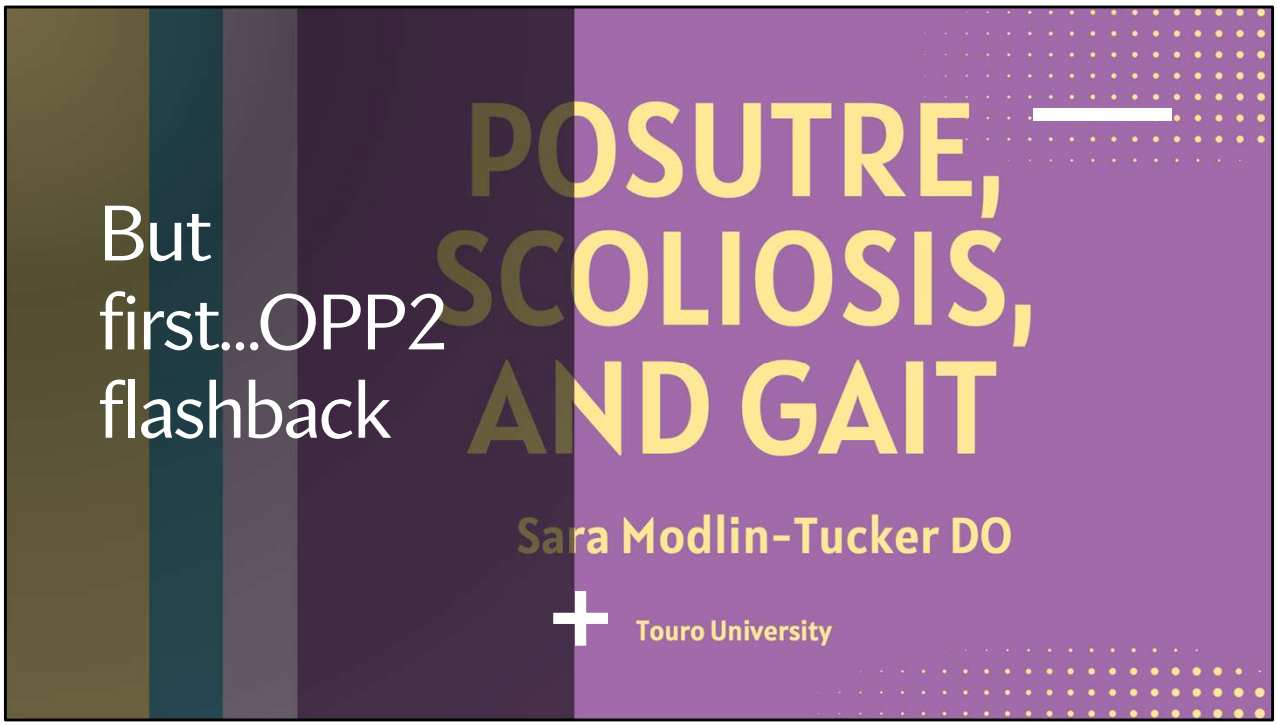
Clinical Applications of Tensegrity

Alecia Lentz, DO



But first...OPP2 flashback



SCOLIOSIS

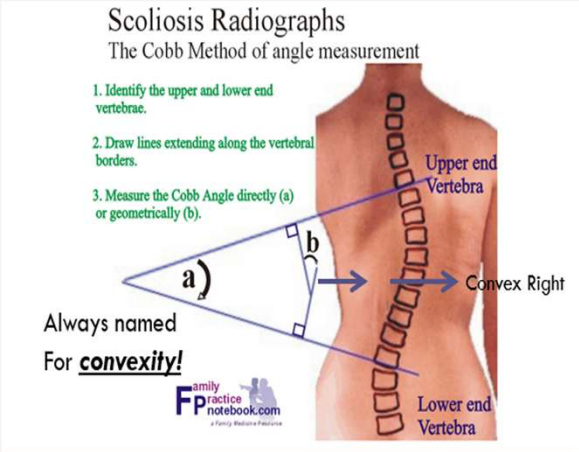
Definition: Pathological or functional lateral curvature of the spine.
- Levo or Dextro (named for convexity)

Structural:
- Not reversible
- Fixed or Primary

Functional:
- Can be reduced with side-bending
- Secondary

Mixed:
- Structure and function interrelated- many are mixed.

Indication for OMM:
- Scoliosis not an indication
- Somatic dysfunction only indication for OMM
- Scoliosis does not necessarily equal pain (compensated can be asymptomatic)

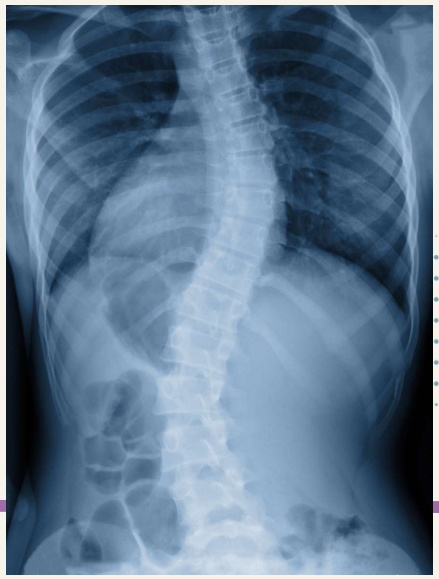


ADOLESCENT IDIOPATHIC SCOLIOSIS MANAGEMENT

Depends on the degree of the curve

OMT is always appropriate to evaluate for SD(PT as well)

- <10 degrees – no further management required
- 10-20 degrees – observe with radiographs q 6mo until skeletal maturity
- 20-40 degrees – observation and bracing may be recommended
- >40 degrees – refer to orthopedics for surgical eval



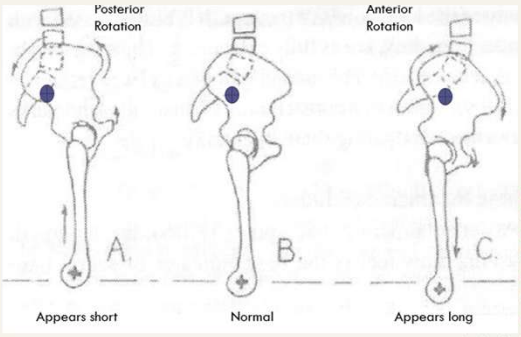
SHORT LEG SYNDROME

Anatomic:
- Measurable bony asymmetry of one or more of the structures between the head of the femur and calcaneus.

Etiology:
- Congenital, traumatic, neoplastic, degenerative, infectious, surgical.

Functional:
- Physiologic response to altered biomechanics along the kinetic chain.
- More common than anatomic

Etiology:
- Ankle, foot, pelvis mechanics compensating for altered mechanics of spine or cranium.
- Sacral base unleveling
- Somatic Dysfunction (innominate rotation or Type I lumbar somatic dysfunction)
- Muscle imbalance



LEG LENGTH INEQUALITY

- Often asymptomatic, 90% of general population have some LLI
- Check for scoliosis
- LBP often presents in late 30's and 40's

Correlation with pain:

Different findings of relationship in literature

- 2019 study of meat-cutters found that 6mm LLI was associated with more frequent back pain and greater days missed from work due to back pain
- Studies of patients with pain demonstrated that mean inequality was similar to the general population (5.2 mm)

PELVIC SIDESHIFT AND ROTATION

Pelvic side shift (PSS) Test:

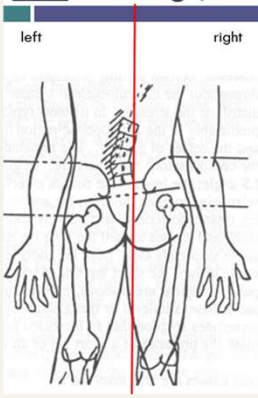
- Patient in uniform base, physician induces lateral translation of the pelvis in a coronal plane
- Named for the side to which pelvis most easily shifts

Pelvic rotation (PR) test:

- Patient in uniform base, physician induces rotation of the pelvis in a transverse plane
- Named for the side to which pelvis most easily rotates

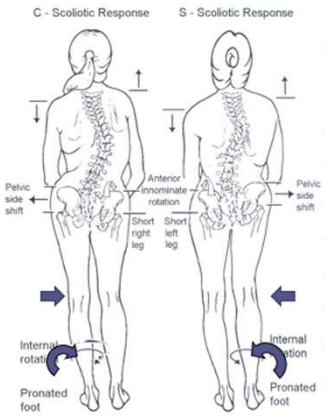
- Both will tend to deviate AWAY from the short leg side
- i.e. TOWARD the long leg side

Expected Standing palpatory findings:
Left short leg (anatomic *or* functional)



- Ilium: low left
- Lumbar spine
  - Sidebent: right
  - Rotated: left
    (type 1 mechanics)
- Sacrum
  - Base deep on the left
  - ILA posterior/inferior on right
- (R on R) Forward sacral torsion
  - Lumbar spine rotated opposite
- Pelvic rotation easier to right
- Pelvic side shift easier to right

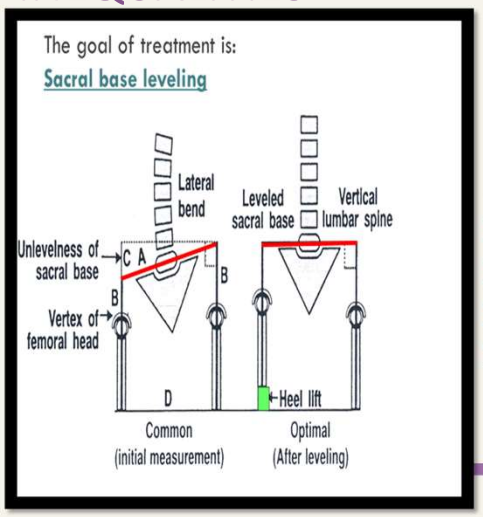
Postural Adaptations to Leg-length Inequality

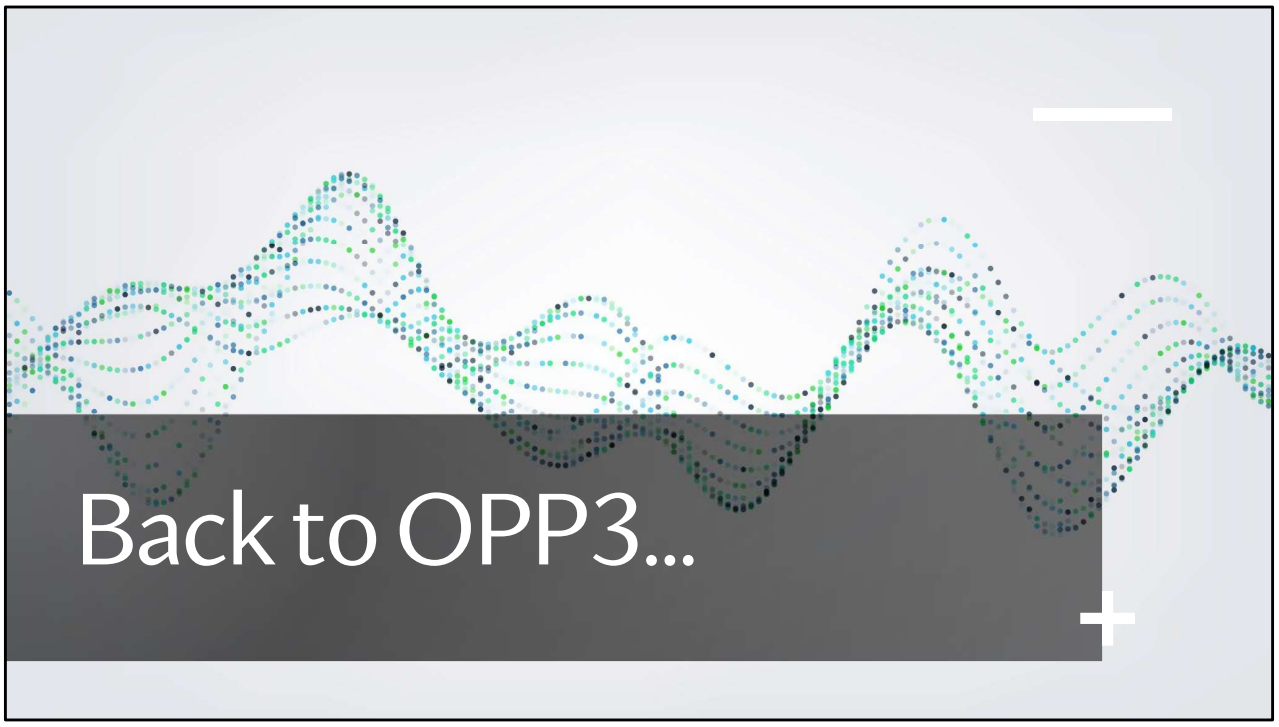


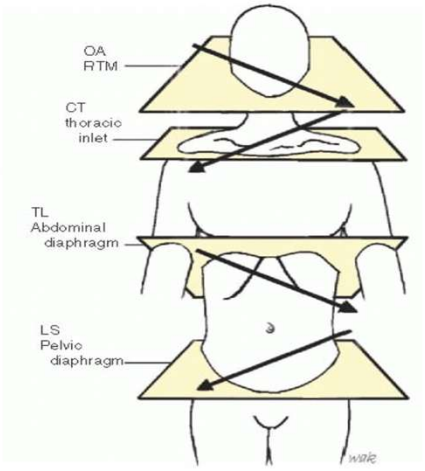
- Shoulder height varies depending on type of scoliotic response
- Lumbar spine
  - Sidebends to the long leg side
  - Type 1 mechanics
- Sacrum rotates toward the long leg
- Iliac crest & trochanter inferior on short side
- Pelvis side-shifts &rotates easier toward long side
- Posterior innominate on long side
- Anterior innominate on short side
- Knee flexes on long side
- Femoral head moves posteriorly on long leg side
- Internal rotation of tibia on long side
- Pronated foot on long side

TREATING LEG LENGTH INEQUALITIES

- For a symptomatic patient that may have a short leg:
  - Treat the whole person based on what you find structurally, but with a method
  - Treat spasm of the hamstrings, psoas, quadratus lumborum, piriformis
  - Treat Mitchell Model Sequence
  - Use orthotics to correct unilateral pes planus, pes valgus, and calcaneal valgus deformities
  - Look for visceral dysfunction and treat as indicated
- If all this fails, x-rays/lifts may be indicated




Back to OPP3...



Tensegrity

- Scoliosis
- Short Leg Syndrome
- Zink
- Pregnant patients
- Crossed Syndromes
- OCMM
- BLT/MFR

Figure 29.4. Compensation in the horizontal planes: alternating pattern of rotation at transition zones. (Courtesy of William A. Kuchera, DO, FAAO.)

Foundations of Osteopathic Medicine, 4th Ed.

Scoliosis Treatment

Dependent on the degree of the curve

- <10° – nothing
- 10-20° – observe/x-rays q 6 months
- 20-40° – observe/brace
- >40° – refer to orthopedics for surgical eval

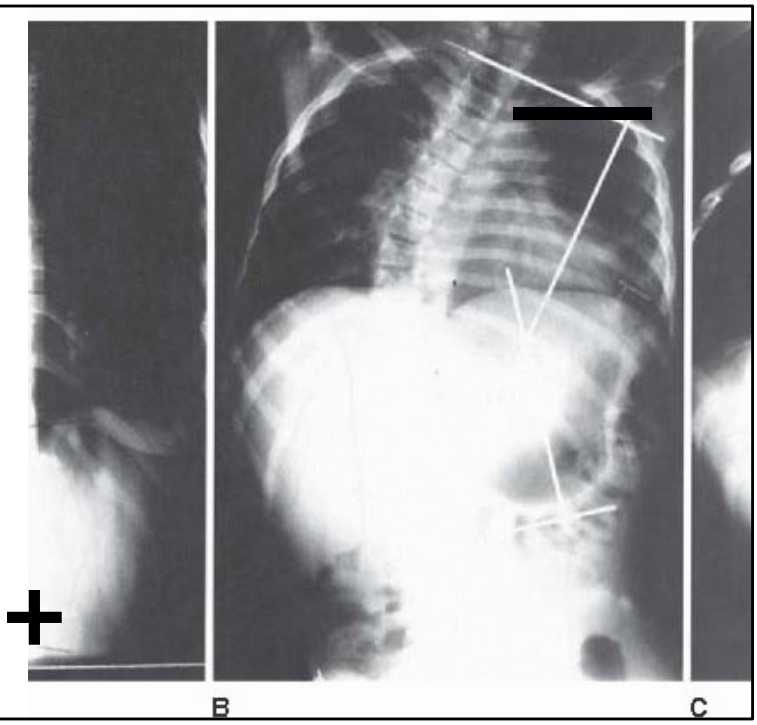
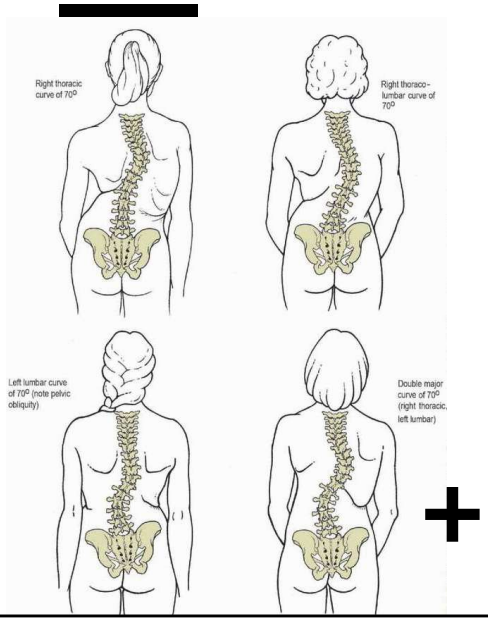


Image from FOM4 showing mild, moderate, and severe scoliosis from left to right



Scoliosis and OMT

- Scoliosis ≠ SD
- Goals = symptomatic relief, maximize function
  - NOT to restore symmetry or "correct" the curve
- Often symptoms are secondary to compensation
  - Rib pain
  - Visceral dysfunction
  - Headaches
  - Gait changes

Scoliosis Diagnosis

- Patient presentations
  - Arthritic symptoms
  - Backaches
  - Chest pains
  - Neck aches
  - Headaches
  - Symptoms of organ dysfunction
- Can miss up to 35-degree curvature without specific evaluation
  - Adams Forward Bend

Scoliosis Screening Exam

– Adams forward bend at ~3 minutes

Short Leg Syndrome (Leg Length Inequality)

Leg Length Evaluation

Standing

- Put patient in uniform base
- Placing hands on top of the iliac crests and evaluate for any difference in level
- Placing hands under the greater trochanters and evaluate for any difference in level

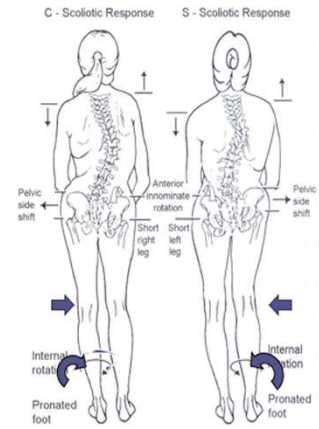
Supine

- Perform a pelvic reseat
- Placing thumbs under medial malleoli and evaluate for any difference in level
- Placing thumbs under the ASISs, evaluate for any difference in level
- Placing hands on top of the iliac crests and evaluate for any difference in level

Leg Length Inequality

Can be from a variety of causes which can include functional (tight hamstrings, psoas, QL, piriformis, etc) or anatomical issues such as scoliosis, prior trauma with fracture, hip/knee replacements

Postural Adaptations to Leg-length Inequality



- Shoulder height varies depending on type of scoliotic response
- Lumbar spine
  - Sidebends to the long leg side
  - Type 1 mechanics
- Sacrum rotates toward the long leg
- Iliac crest & trochanter inferior on short side
- Pelvis side-shifts &rotates easier toward long side
- Posterior innominate on long side
- Anterior innominate on short side
- Knee flexes on long side
- Femoral head moves posteriorly on long leg side
- Internal rotation of tibia on long side
- Pronated foot on long side

Short Leg Syndrome (Leg Length Inequality)

- Treat somatic dysfunction first
- If not improving or patterns recur → Postural radiographs
- Consider management with lifts + OMT

Heel lift Guidelines: FOM

- The lift should be applied to the side of the short leg
- The final lift height should be 1/2-3/4 of the measured leg length discrepancy, unless there was a recent sudden cause of the discrepancy (i.e. hip fracture, hip prosthesis, knee replacement) In this case, lift the full amount that was lost
- The "fragile" (elderly, arthritic, osteoporotic, or having acute pain) patient should begin with a 1/16" (in) (~1.5mm) heel lift and increase 1/16" every two weeks
- The "flexible" patient should begin with 1/8" (~3.2mm) heel lift and increase 1/8" every two weeks
- A maximum of 1/4" (~6.4mm) may be applied to the inside of the shoe. If > 1/4" is needed then this must be applied to the outside of the shoe
- Maximum heel lift possible = ½" (12.7mm). If more height is needed, an ipsilateral anterior sole lift extending from the heel to toe should be used in order to keep the pelvis from rotating to the opposite side.

Gradual Introduction

- Start with a lower lift and gradually increase height if needed to avoid overloading joints and muscles with abrupt changes in biomechanics

Foundations of Osteopathic Medicine, 4th Ed.

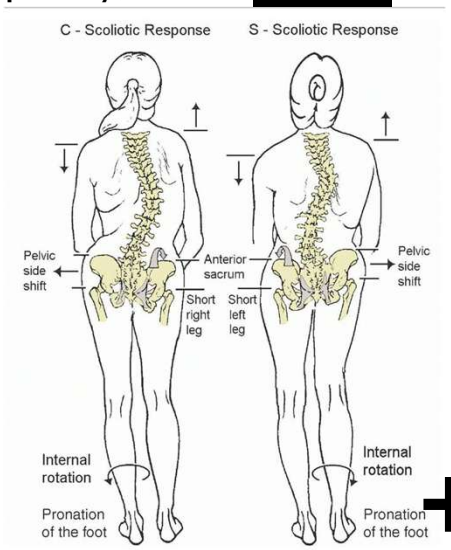
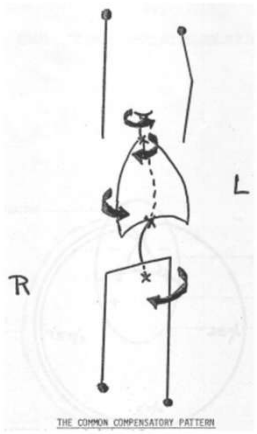


Figure 29.3. Typical postural compensation for short-leg syndrome. (Courtesy of William A. Kuchera, DO, FAAO).

For more reading: FOM 4th edition, Chapter 29 - **Postural Considerations in Osteopathic Diagnosis and Treatment**



+

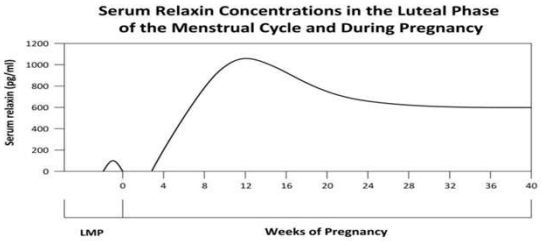
Zink

Reference OMS1 directed study and lab

Tensegrity in Pregnant Patients

Joint laxity begins in the first trimester

- Due to increased levels of relaxin, progesterone - peaks at 12-14 weeks
- Pregnant patients report changes in gait as early as 6 weeks



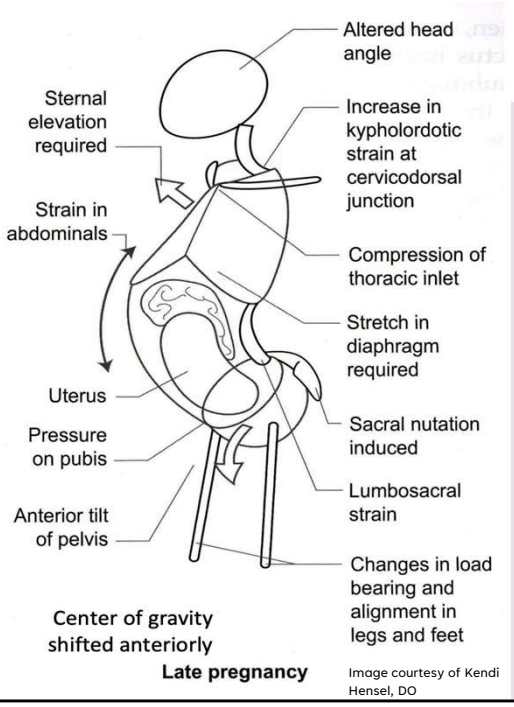
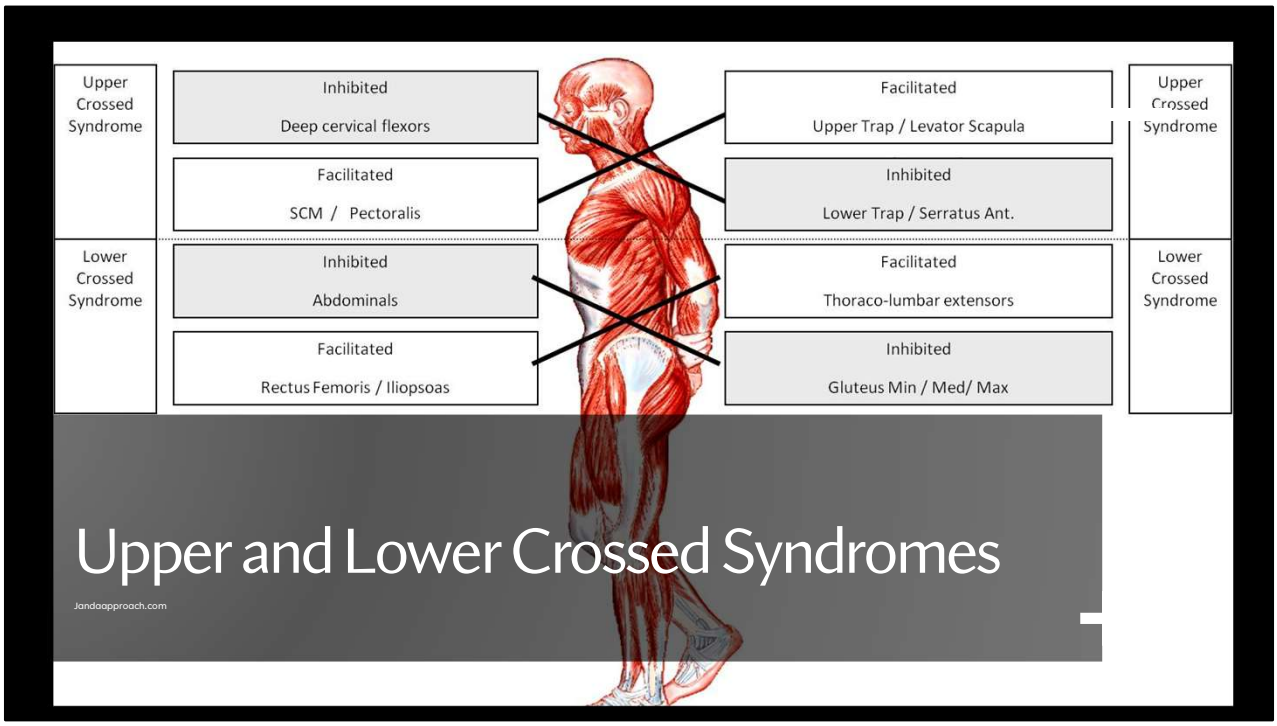


Image courtesy of Kendi Hensel, DO


Upper Crossed Syndrome
Inhibited
Deep cervical flexors
Facilitated
SCM / Pectoralis
Facilitated
Upper Trap / Levator Scapula
Inhibited
Lower Trap / Serratus Ant.
Upper Crossed Syndrome
Lower Crossed Syndrome
Inhibited
Abdominals
Facilitated
Rectus Femoris / Iliopsoas
Facilitated
Thoraco-lumbar extensors
Inhibited
Gluteus Min / Med/ Max
Lower Crossed Syndrome
Upper and Lower Crossed Syndromes
Jandaapproach.com

OCMM

Available online at www.sciencedirect.com
ScienceDirect
International Journal of Osteopathic Medicine 11 (2008) 80–89
www.elsevier.com/locate/ijosm

Research report

A model of the cranial vault as a tensegrity structure, and its significance to normal and abnormal cranial development

Graham Scarr*
60 Edward Street, Stapleford, Nottinghamshire NG9 8FJ, UK

Received 20 September 2007; received in revised form 5 January 2008; accepted 27 March 2008

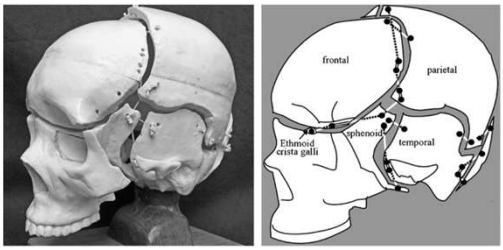


Fig. 4. Tensegrity skull model, antero-lateral view.

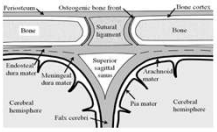


Fig. 2. Schematic diagram of the superior sagittal suture in coronal section. Note the firm adherence of the endosteal 'layer' of dura mater at the bone margins, and reduplication of the meningeal 'layer' of dura mater between the cerebral hemispheres to form the falx cerebri (drawing not to scale).

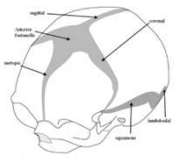
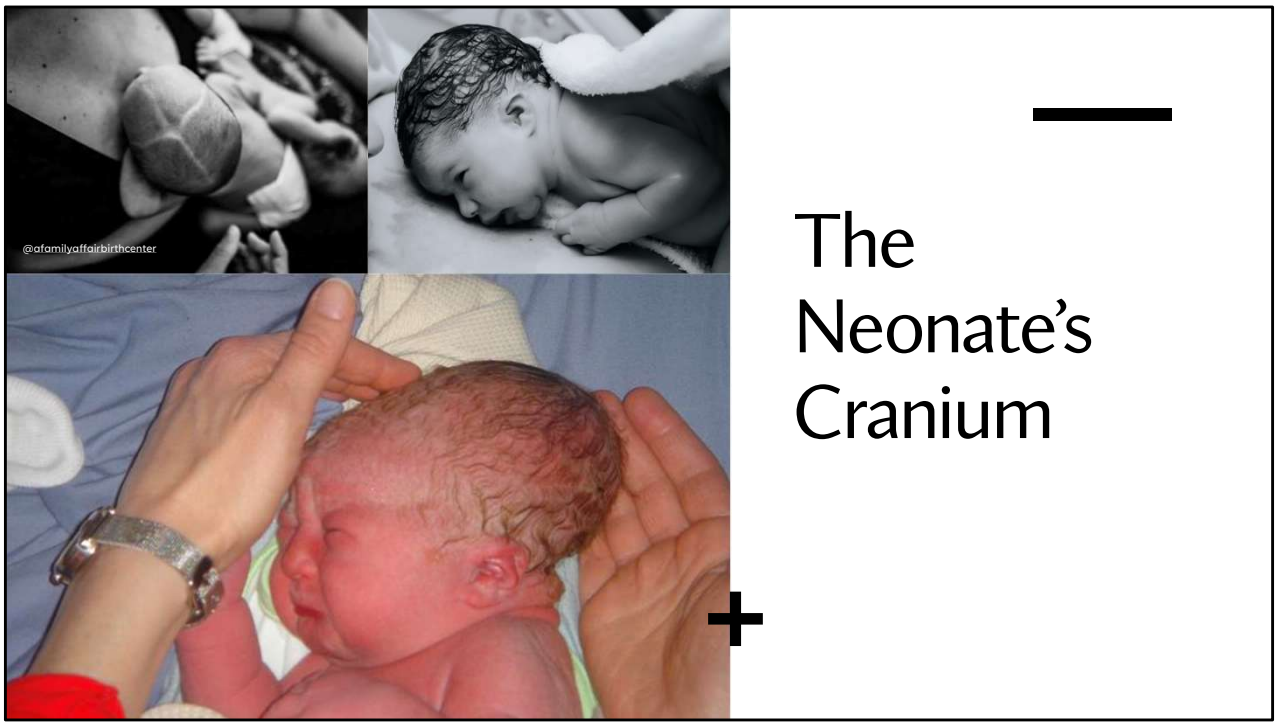
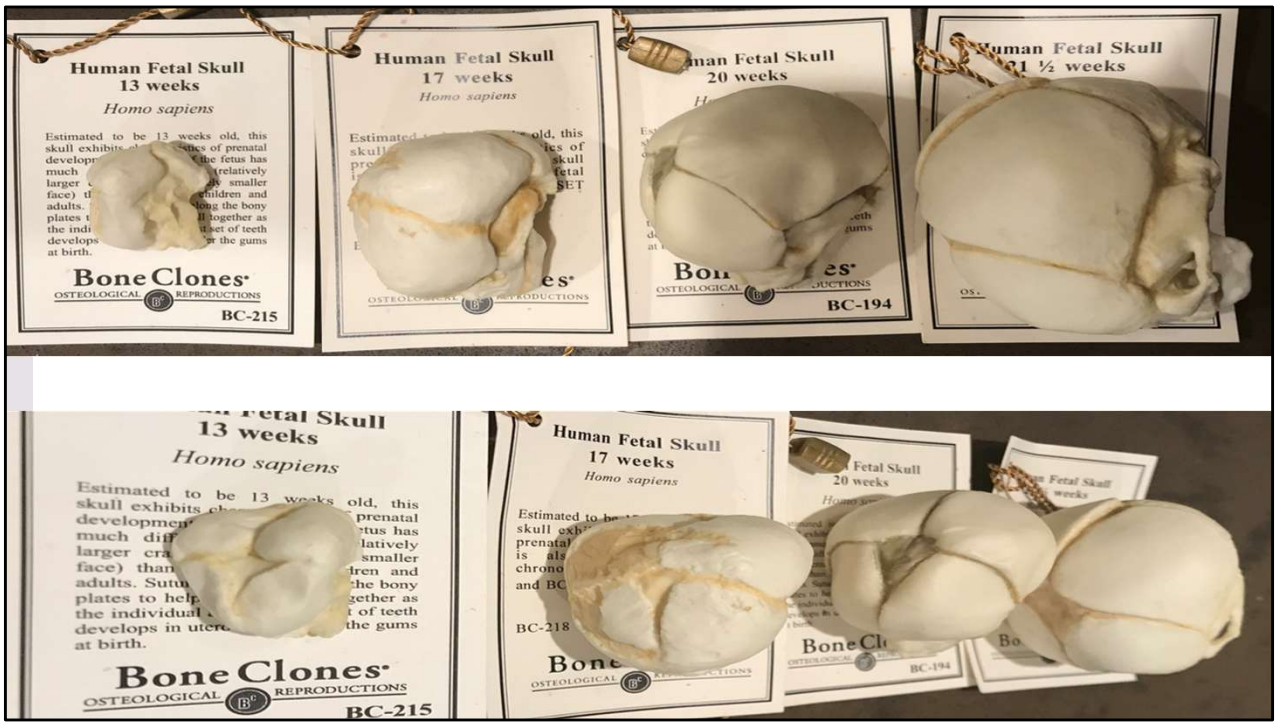


Fig. 1. Full-term foetal skull showing vault sutures and anterior fontanelle.

+



Color image: Image: http://dou-la-la.blogspot.com/2010/08/postpartum-ocd-part-2-of-2-mom-who.html



Dr. Wolf's fetal skull collection

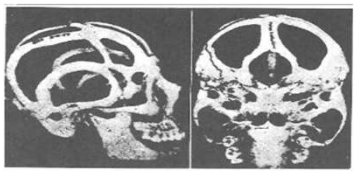
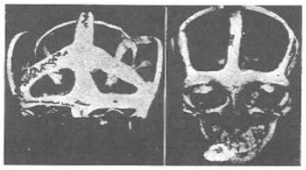
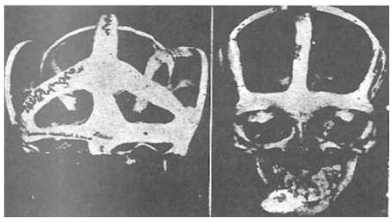
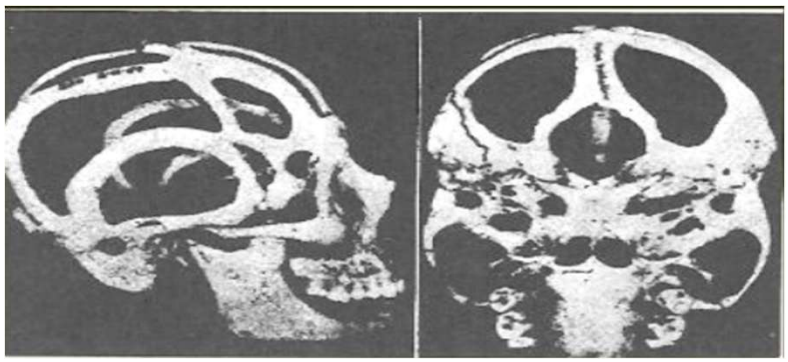


FIG. 2— CRANIAL BUTTRESSES







Buttresses

The Selected Writings of Beryl Arbuckle

Stress Bands/Fibers

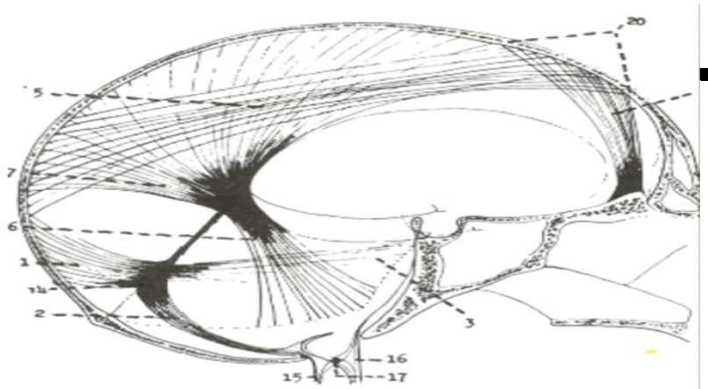
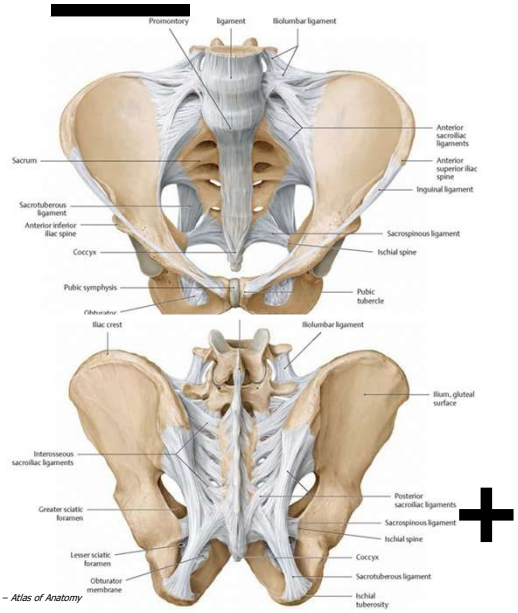


FIG. 1. — STRESS FIBERS OF

HORIZONTAL
1. Falx cerebri inferior
2. Falx cerebelli—tripod—19 } —from torcular mass
3. Tentorium
4. Sphenoidal
5. Falx cerebri superior

VERTICAL
6. Tentorium
7. Falx cerebri posterior
8. Falx cerebri anterior—crista galli tripod—18

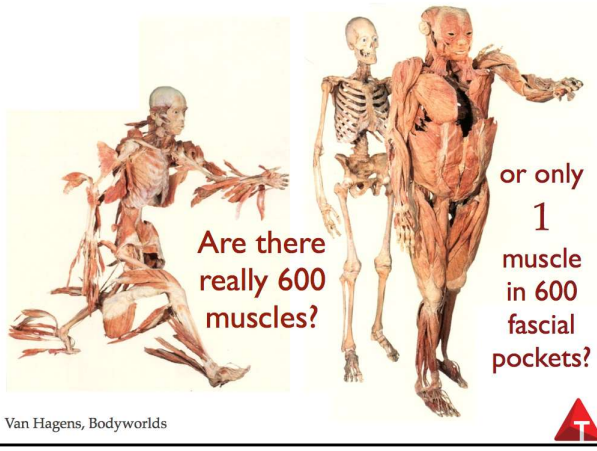
The Selected Writings of Beryl Arbuckle



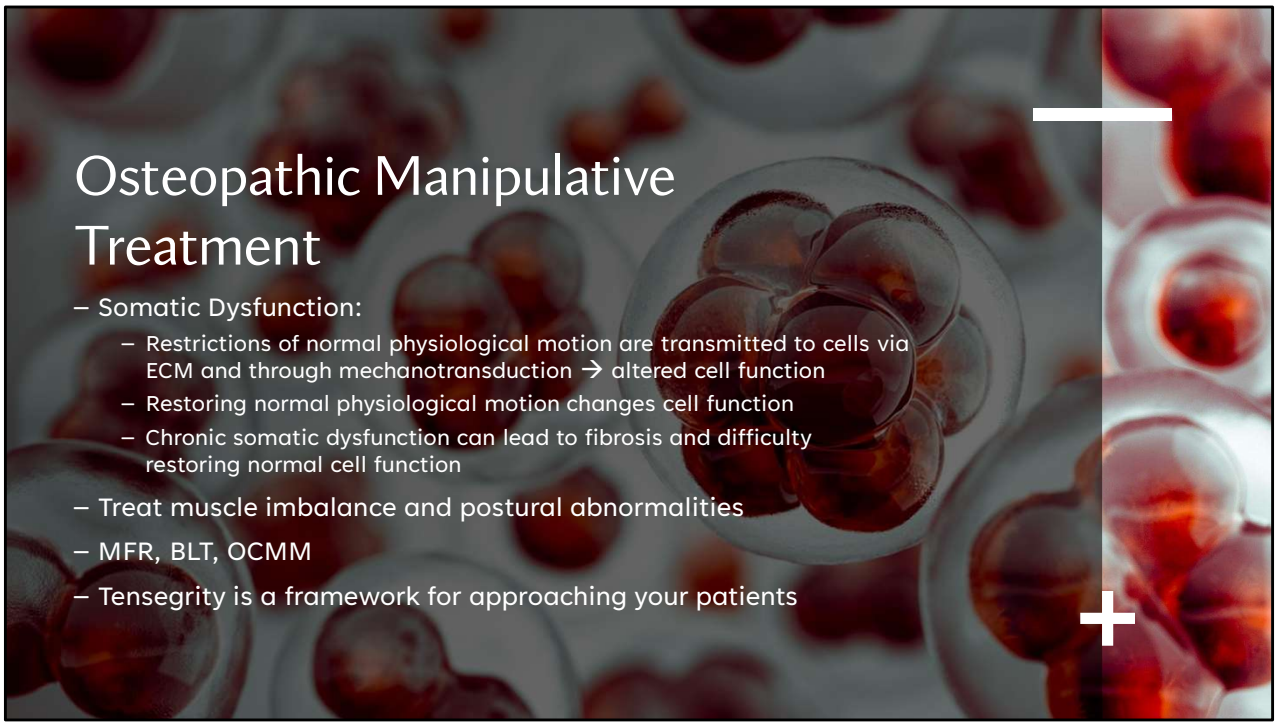
Thieme – *Atlas of Anatomy*

+

BLT and MFR



Van Hagens, Bodyworlds


Osteopathic Manipulative Treatment
– Somatic Dysfunction:
– Restrictions of normal physiological motion are transmitted to cells via ECM and through mechanotransduction → altered cell function
– Restoring normal physiological motion changes cell function
– Chronic somatic dysfunction can lead to fibrosis and difficulty restoring normal cell function
– Treat muscle imbalance and postural abnormalities
– MFR, BLT, OCMM
– Tensegrity is a framework for approaching your patients

Gratitude

- Appreciation for how understanding of these concepts, including biotensegrity, mechanotransduction, posture, and the application of OMT can dramatically influence our care for our patients
- For the development of these materials through the efforts of faculty member Kimberly Wolf, DO, Sara Modlin-Tucker, DO