Anatomy Trains & Rehab: A Primer for Implementation

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People mistake their tools for their philosophy

~Sue Falsone

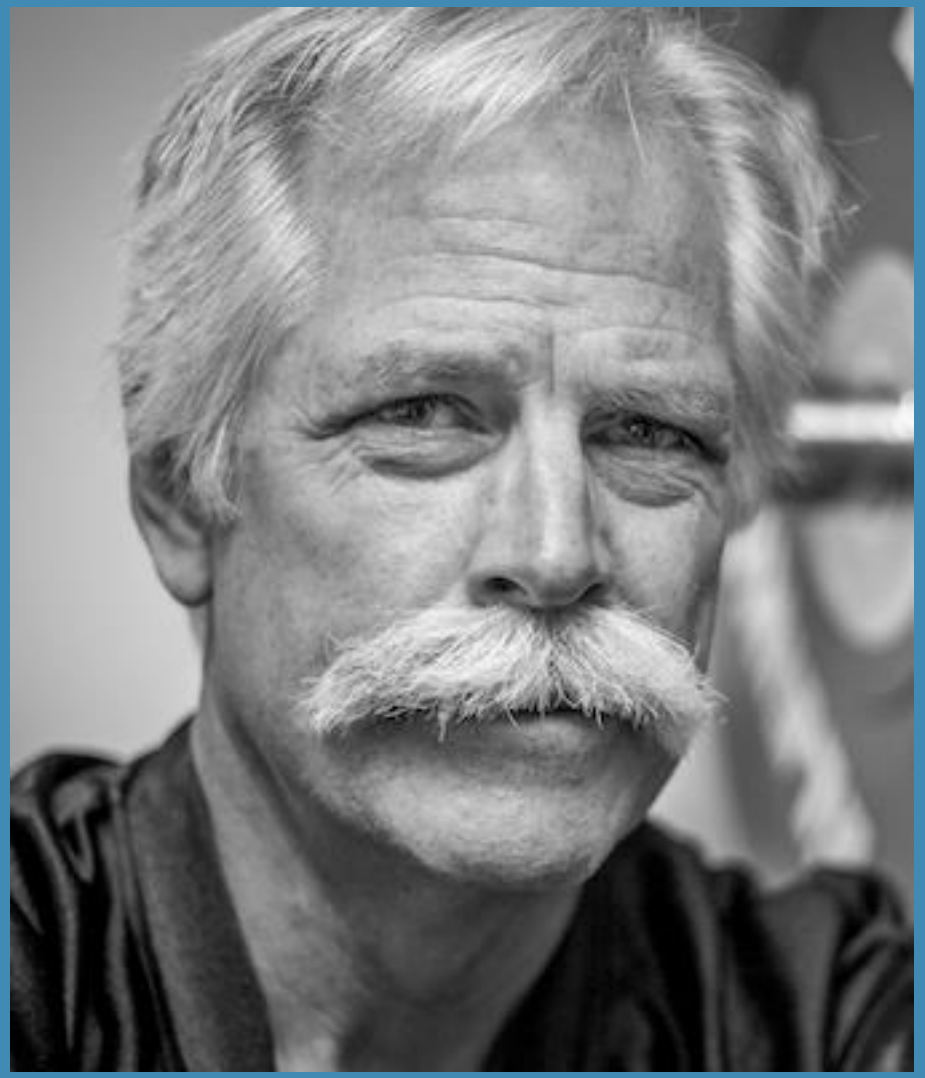
Considering full body mechanics during assessments exposes patterns which can serve as the basis for exercise prescription

Pick the assessment

Find the pattern

Provide intervention

?



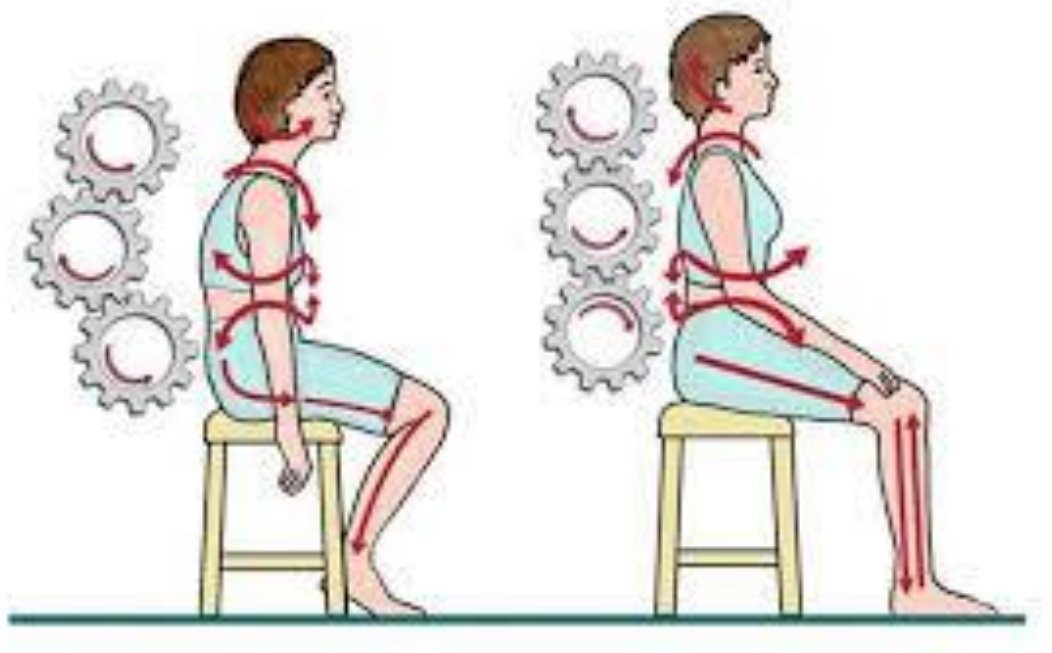
WHY?

Pathoanatomic diagnoses (nerve, disc, joint) are straightforward. Provide therapy to the source and it symptoms resolve.

Common with TRAUMA

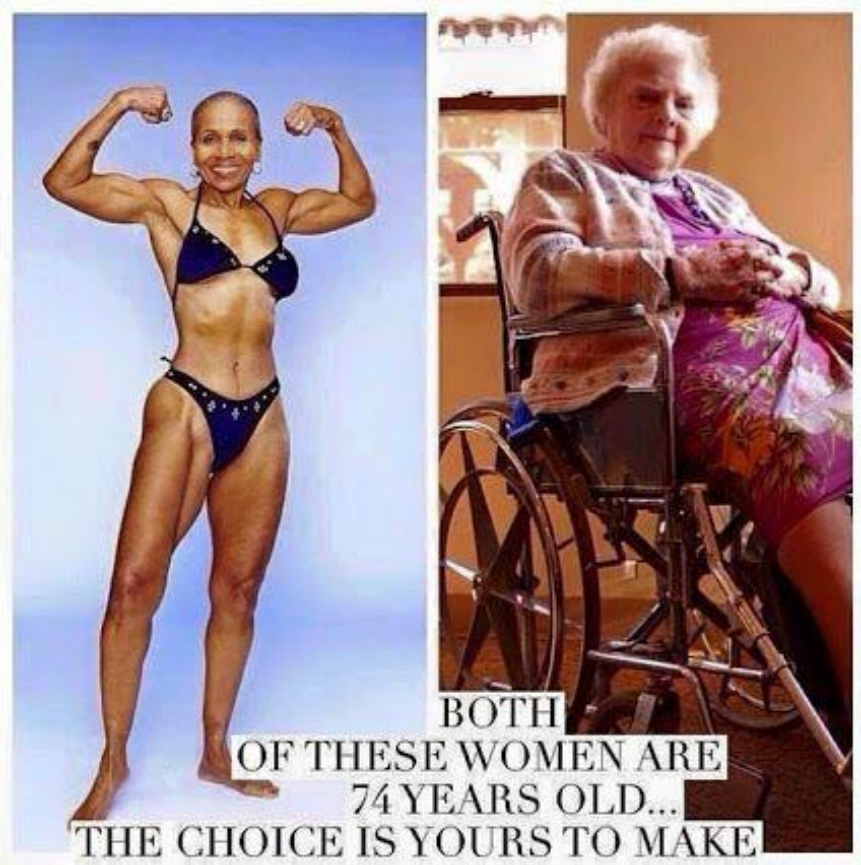
Pathokinesiologic diagnoses can be more complicated as symptoms are secondary to a number of history items and compensations where the underlying cause (typically not the site of pain) must be identified to treat the patient).

Common in chronic compensations.



The Spine Moves together

Why Anatomy Trains?



- Let's go beyond the spine
- Anatomy trains can serve as a basis for ~~pathokinesiologic~~ kinesiopathologic dx & functional training.
- Hodges and Cholewicki (2007)

- Rehab Fundamentals
- Body Design
- Movement & Training Considerations
- Screenings & Assessments

- Regional Implementation
- Spine
- Upper
- Lower

POLITE POLICE

POLITE

Prevent, Proprioception

Optimal Loading

Instrumentation, Ice

Taping, Tech

Education, Ergonomics, Eat

POLICE

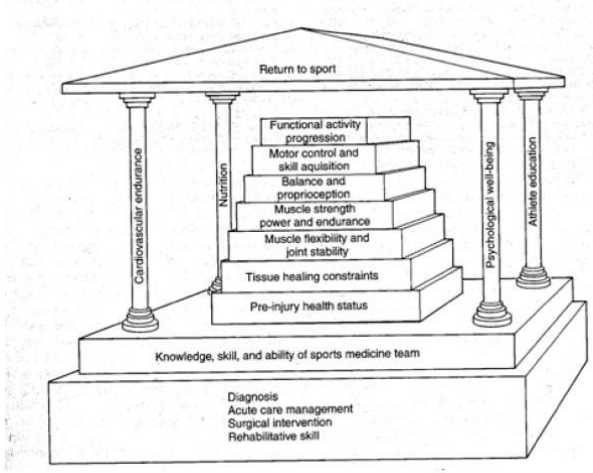
Protect

Optimal Loading

Ice

Compression

Elevation



Rehab Pyramid

Mobility

Strength & Endurance

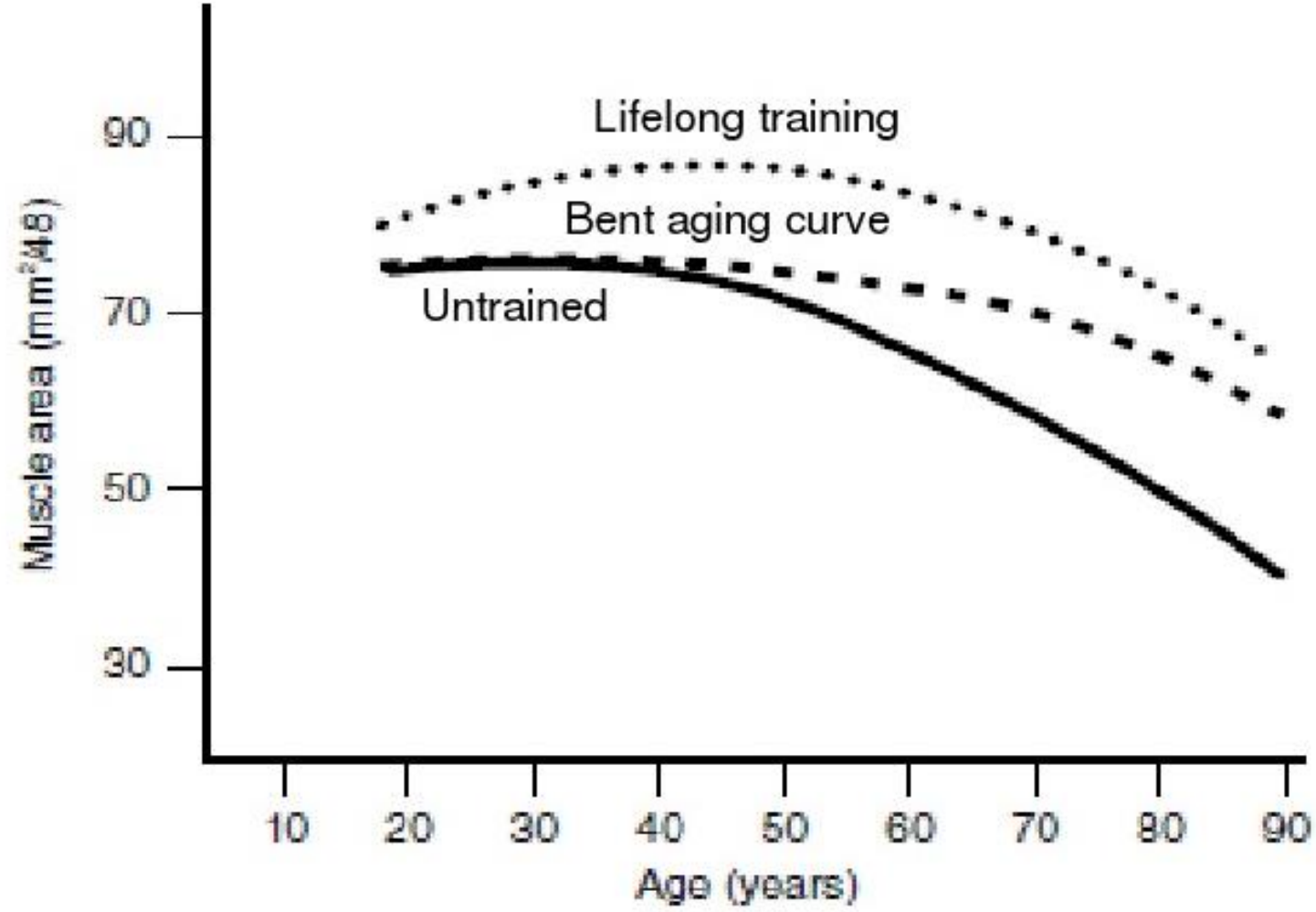
Motor Control & Skills

Functional Training

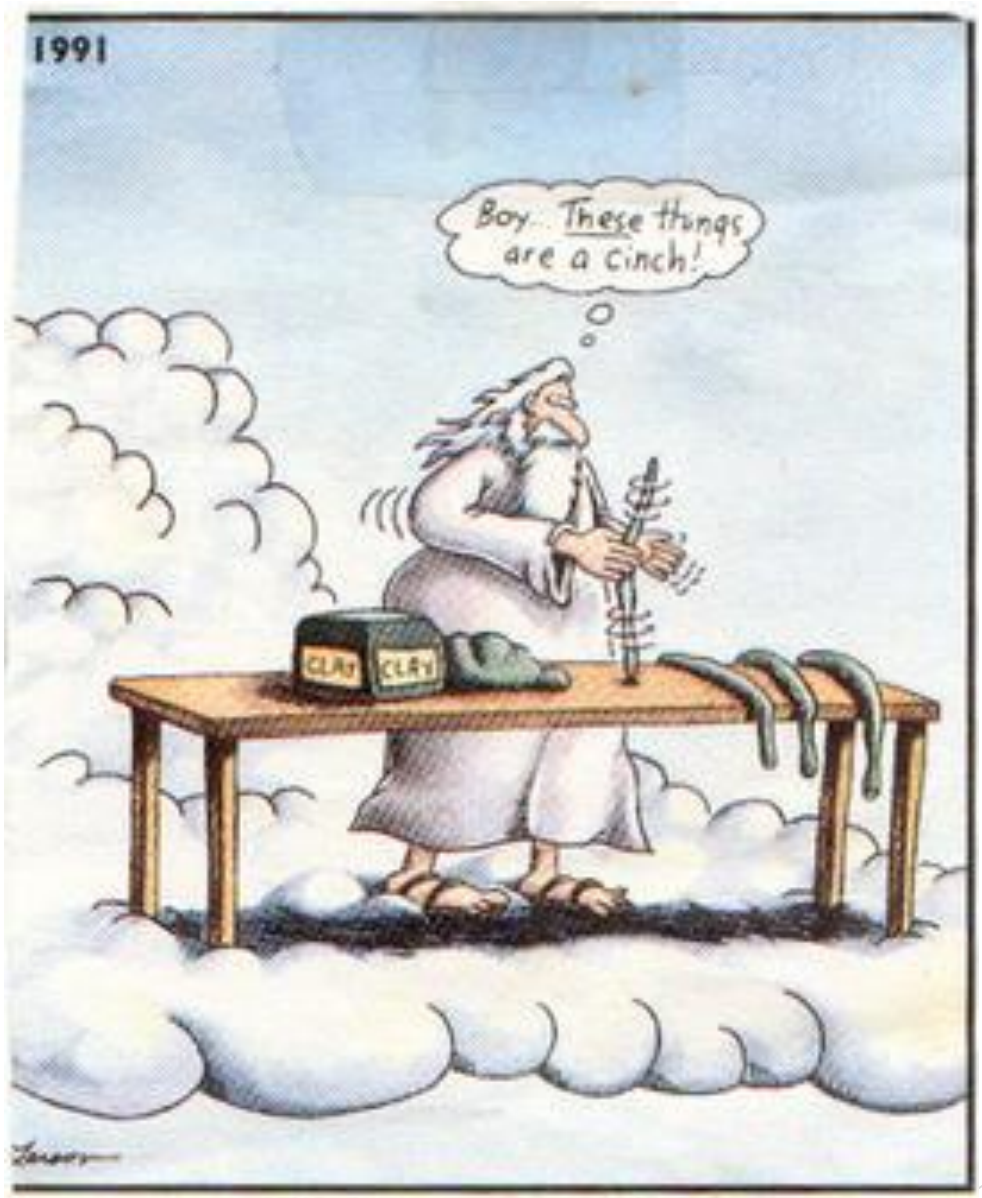
- Functional training is multifaceted including:
- Patient goals – ADLs
- Improved performance
- Improved **longevity**
- Using trains leads docs to areas which may be included in the presenting complaint and gives opportunities to structure exercise programs.
  - Strength!

Longevity

- What are some fitness metrics that lead to longevity?
  - Muscle mass
  - Strength
  - Bone density
  - Body composition
- Things Rehab can address?



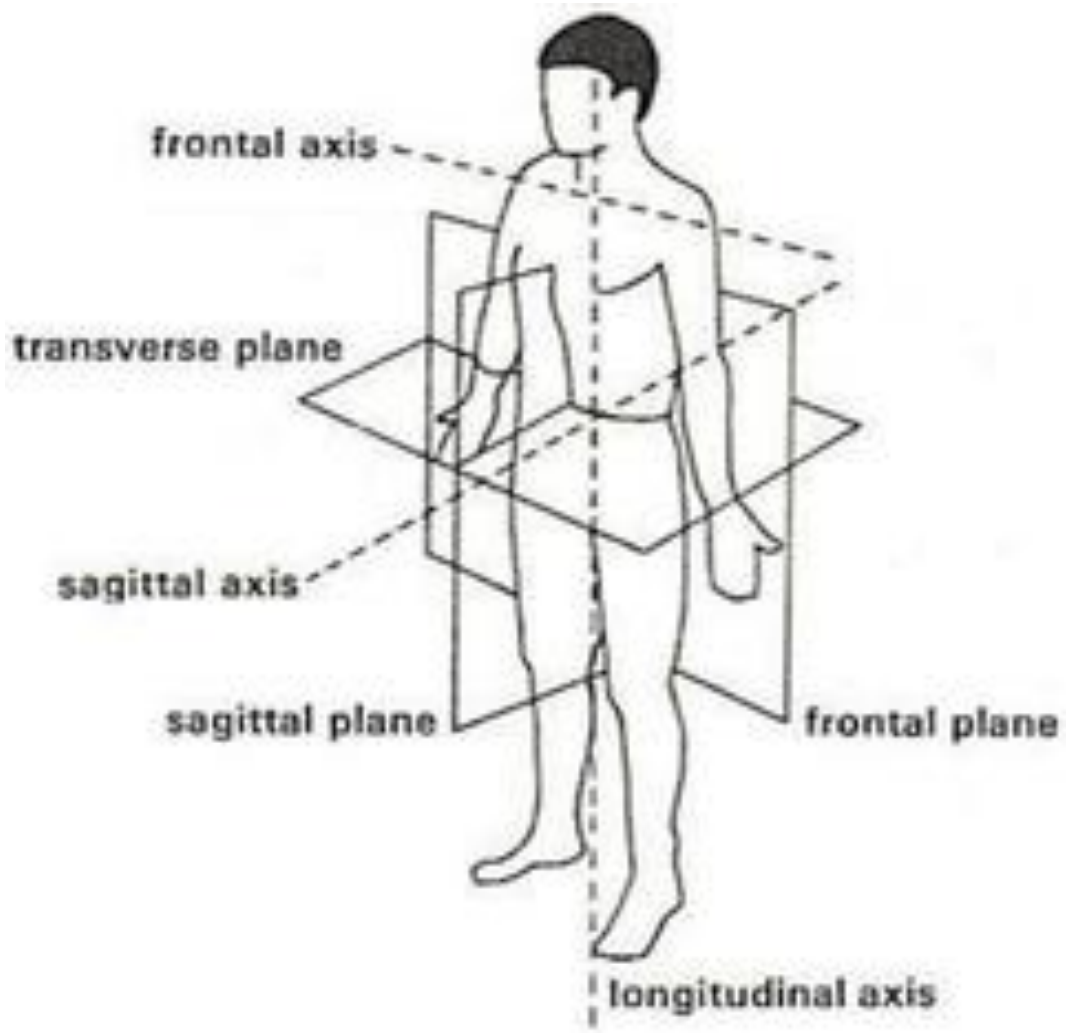
Body Design

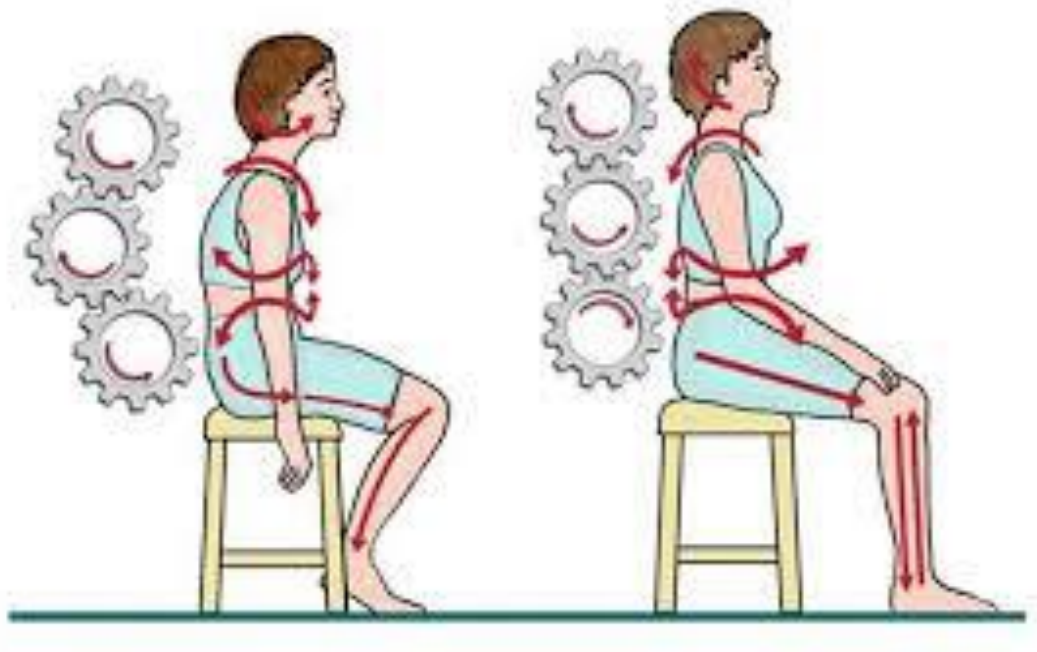


God makes the snake

Triplanar Motion

- Movement in one plane often sees weakness about that axis.
- Functional movements engage in 3 dimensions





The Spine Moves together

Postures: Dynamic vs. Static

POSTURE

Static posture

a vertical line, directly through the center of gravity of the body must fall within the base of support

the net torque about each articulation of the body must be zero

Dynamic posture

that which is adopted while the body is in action, or in the anticipatory phase just prior to an action

Symmetry and Equality are NOT the order of biological structures; adaptation is.

~Celenza

The body takes the path of least resistance for movement. It hurts where it moves and it moves where it's the easiest to move

~Sahrmann

Scoliosis

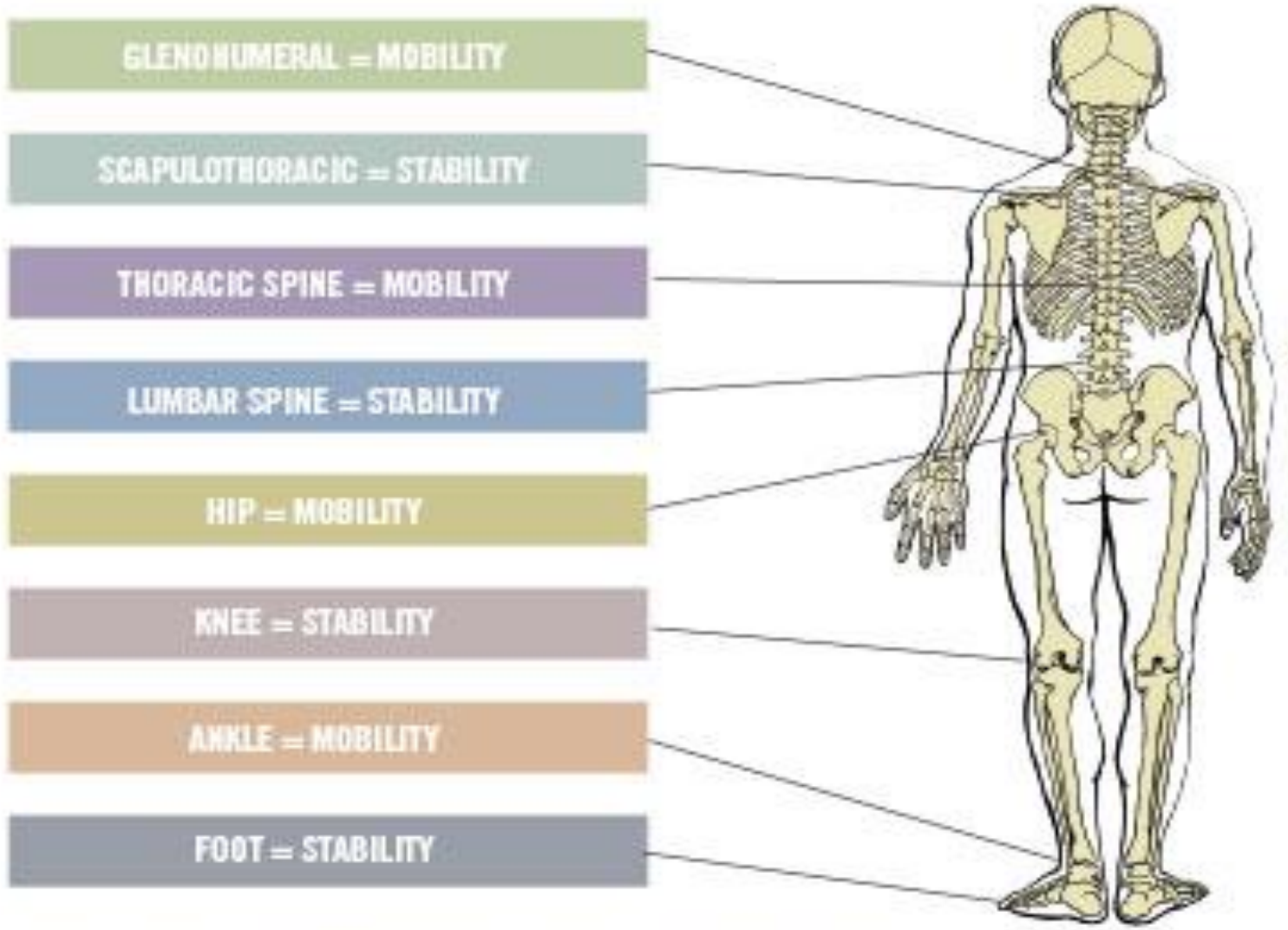
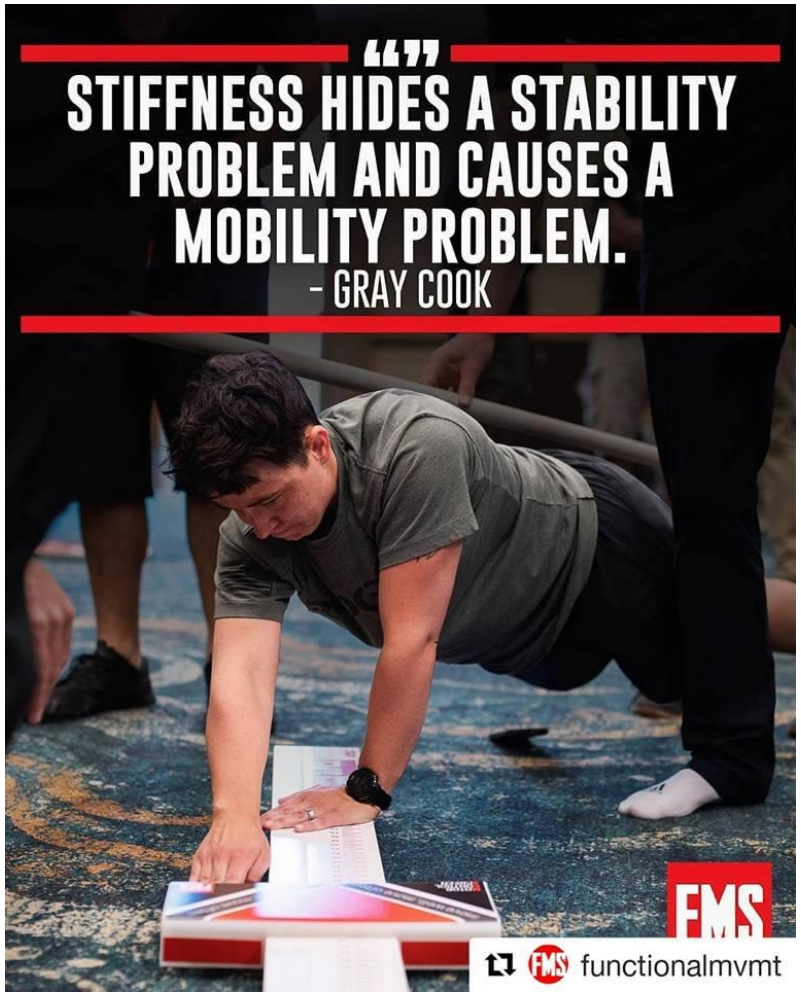


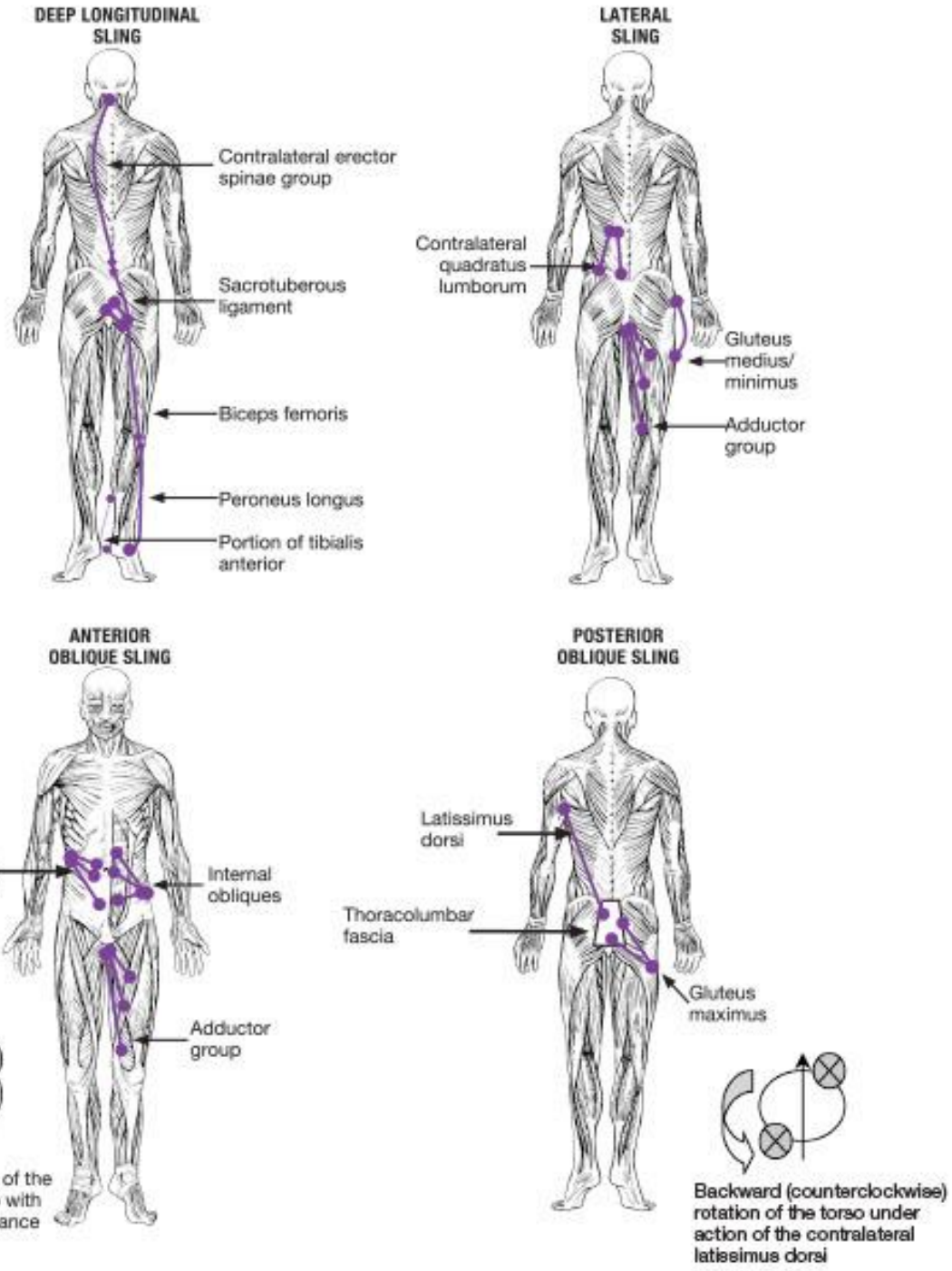
FIGURE 1. MOBILITY AND STABILITY OF THE KINETIC CHAIN

Mobility, Flexibility, Stability



Slings the Physio way

- Anterior Oblique Sling
- Posterior Oblique Sling
- Deep Longitudinal Sling
- Lateral Sling



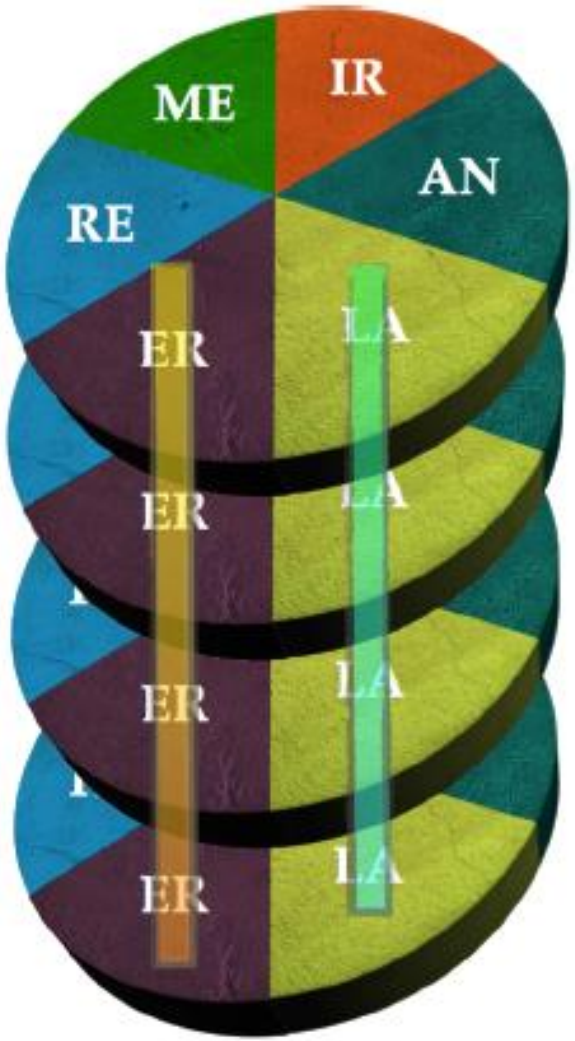
MYOFASCIAL SEQUENCES

CX

GE

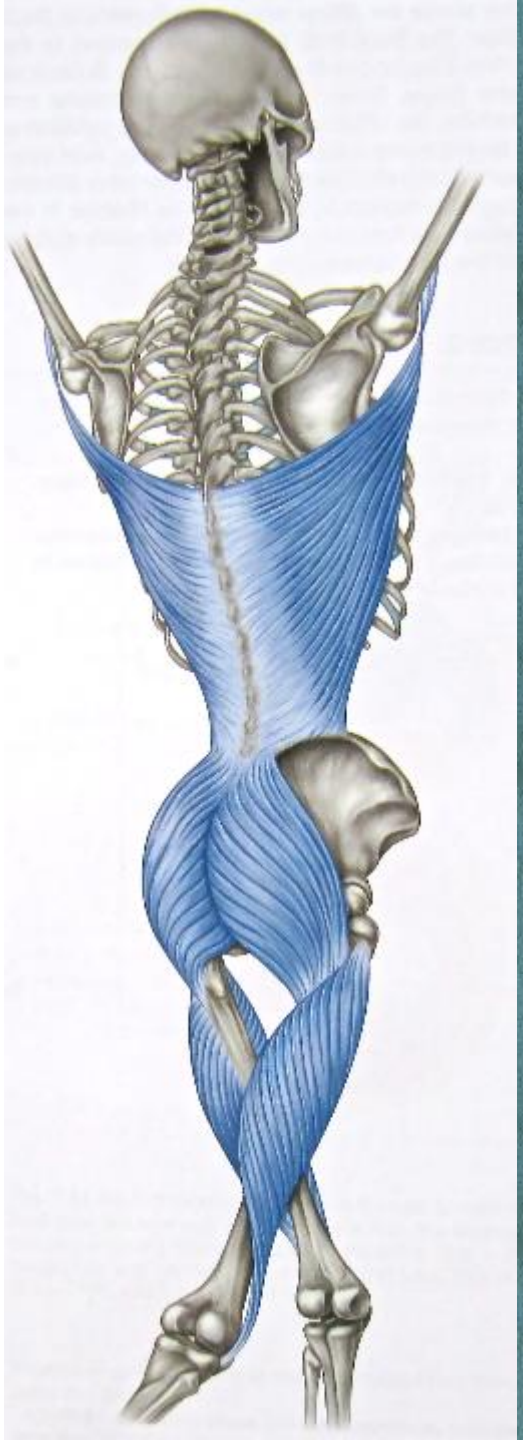
TA

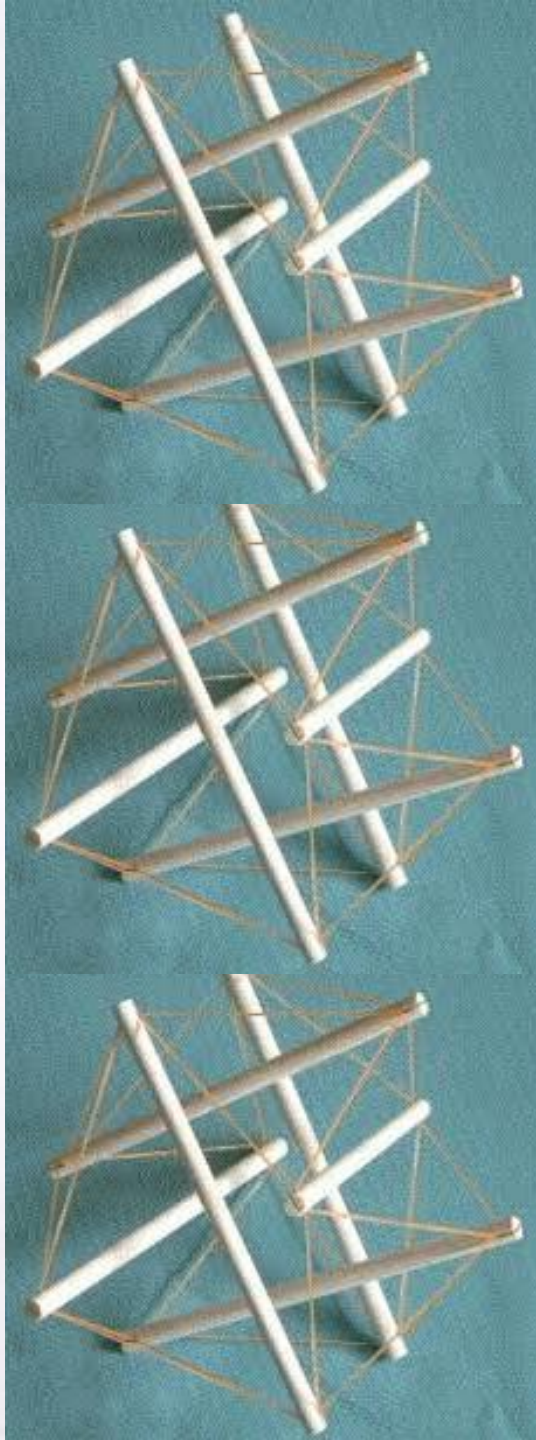
PE



Trains put everything together

- What's a Train?
  - Tracks and Stations (basically a sling)
  - Tensegrity
- Evidence of Myofascial Chains:
  - Strong: SBL, BFL, FFL
  - Mod-Strong: Spiral, Lateral
  - No evidence: SFL
  - Deep Front Line?





Wilke J, Krause F, Vogt L, Banzer W. What is evidence-based about myofascial chains? A systematic review. Arch Phys Med Rehabil. 2015. doi: 10.1016/j.apmr.2015.07.023.

SBL

- Plantar surface of toe phalanges,
- **Plantar fascia and short toe flexors**,
- Calcaneus,
- **Gastroc/Achilles**,
- Femoral Condyles,
- **Hamstrings**,
- Ischial tuberosity,
- **Sacrotuberous lig.**
- Sacrum,
- **Sacrolumbar fascia/erector spinae**,
- Occipital ridge,
- **Galea aponeurotica/scalp fascia**,
- Frontal brown ridge.

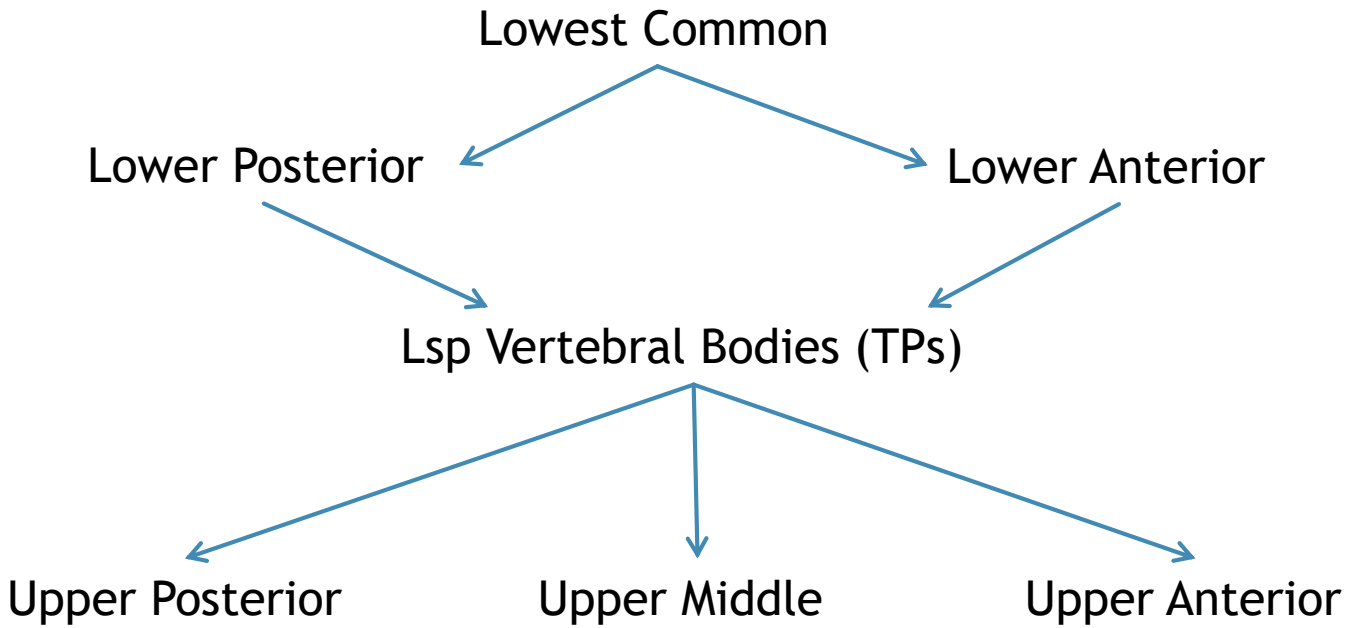
Lateral Line

- 1st & 5th metatarsal bases
- **Peroneal muscles, Lateral crural compartment**
- Fibular head
- **Ant. lig fibular head**
- Lateral tibial condyle
- **IT tract/abductor muscles**
- **TFL**
- **Gluteus maximus**
- Iliac crest, ASIS, PSIS
- **Lateral abdominal obliques**
- Ribs
- **Ext./Int. intercostals**
- 1st & 2nd ribs
- **Splenius capitis/SCM**
- Occipital ridge/mastoid process

Spiral Line

- Occipital ridge/mastoid process/atlas/axis TPs
  - **Splenius capitis & cervicis**
- Lower Csp/Upper Tsp SPs
  - **Rhomboids major/minor**
- Medial border scapula
  - **Serratus anterior**
- Lateral ribs
  - **External oblique**
  - **Abdominal aponeurosis, linea alba**
  - **Internal oblique**
- Iliac crest/ASIS
  - **TFL, IT tract**
- Lateral tibial condyle
  - **Tibialis anterior (TA)**
- 1st metatarsal base
  - **Peroneus longus**
- Fibular head
  - **Biceps femoris**
- Ischial tuberosity
  - **Sacrotuberous lig.**
- Sacrum
  - **Sacrolumbar fascia, erector spinae**
- Occipital ridge

Deep Front Line



Functional Lines

- Connects opposite shoulder and leg
- Accelerates and decelerates trunk rotation
- Produces torque and power
- Integrates multiple planes of motion

Arm Lines and Others

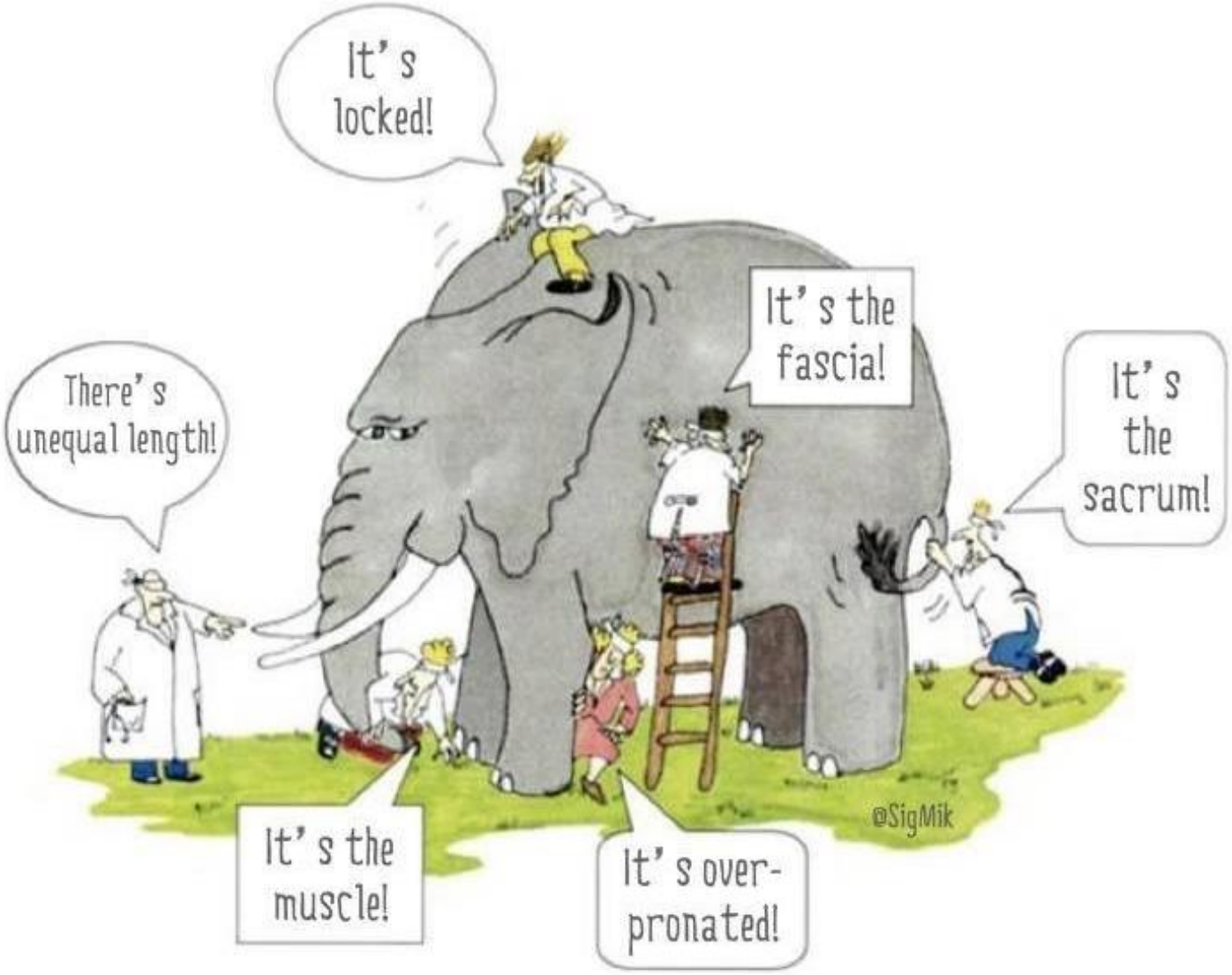
- Deep Front Arm Line (DFAL)
- Superficial Front Arm Line (SFAL)
- Deep Back Arm Line (DBAL)
- Superficial Back Arm Line (SBAL)

Lots to consider…

- Tspine influences
  - On shoulders
  - On neck
- Hip influences
  - On low back
  - On knee
- Core influences
  - On knee
  - On hamstring
- Shoulder influences
  - On neck
  - On elbow

Remember the site too!

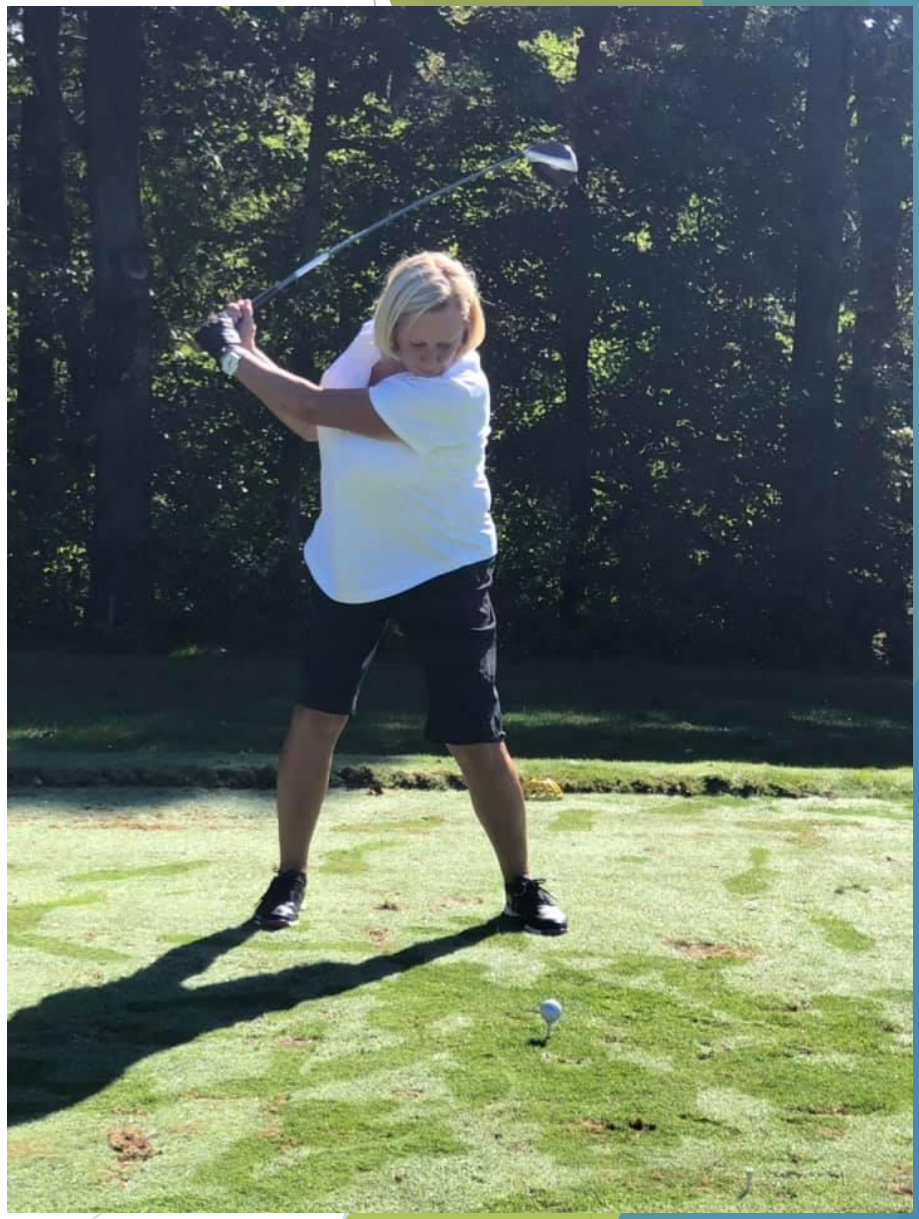
- Disc
- Nerve
- Joint
- Muscle
- Vascular



Golf Pt

- Golf patient with LBP. Trial of PT helpful but tightness and pain remain
- Hx revealed grade three ankle sprain 7 years ago.
- Gait analysis showed ankle still with limited ROM
- Foot function impacted, compensated tightness in ipsi hip and pelvis

- Addressing the ankle and associated LE kinetics led to resolution of LB complaint



Characteristics of functional human motion

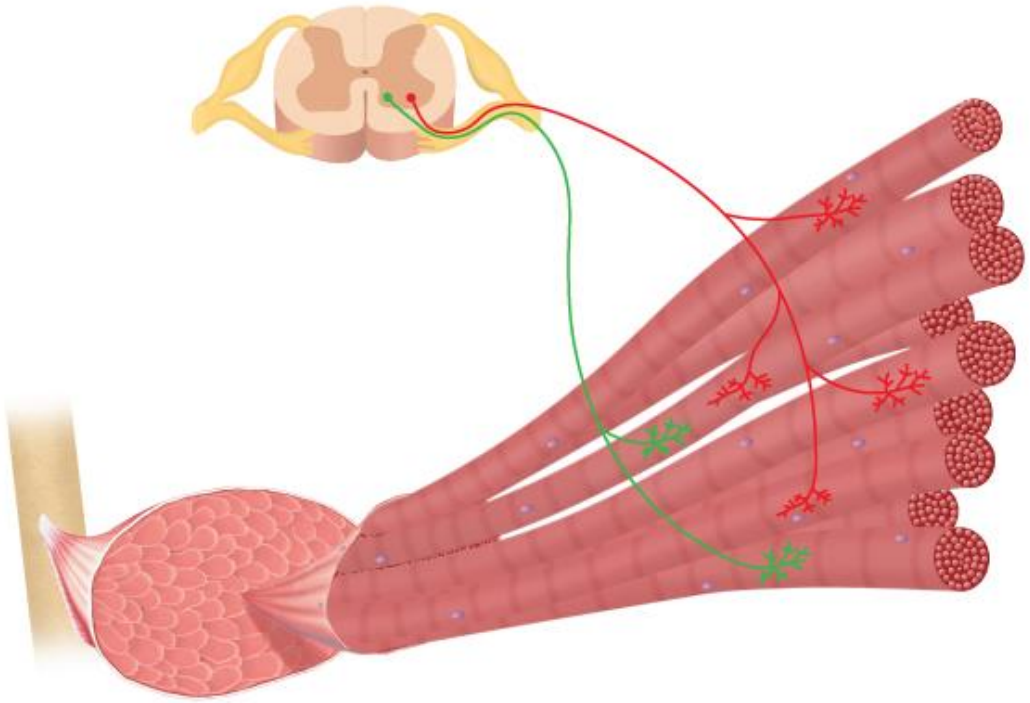
- Eccentric before Concentric
- Go opposite first
- Strength in numbers
- Muscles are stabilizers
- Muscles react to ground forces
- In motion, think distal bone first
- In the spine, think proximal bone first

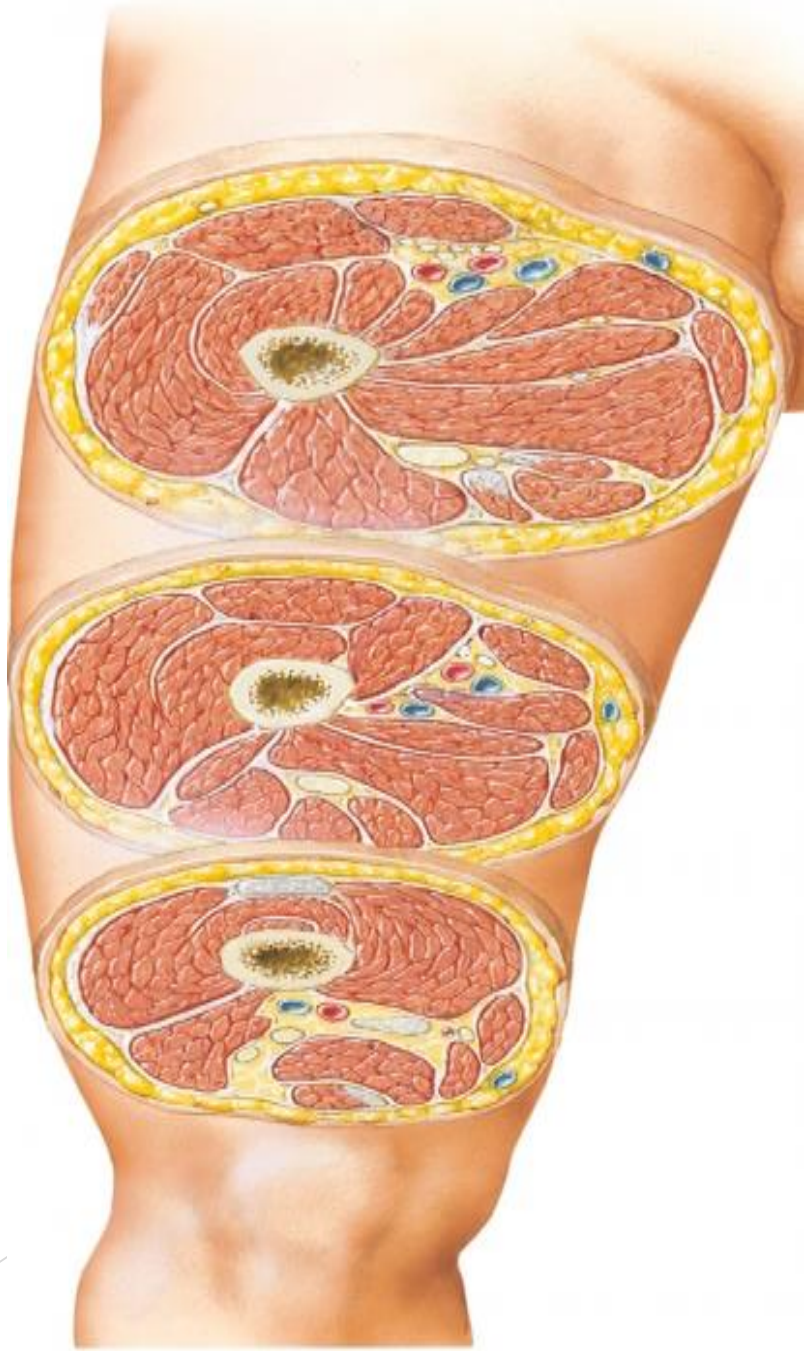
Eccentrics & Going Opposite

- Synergists – Antagonists

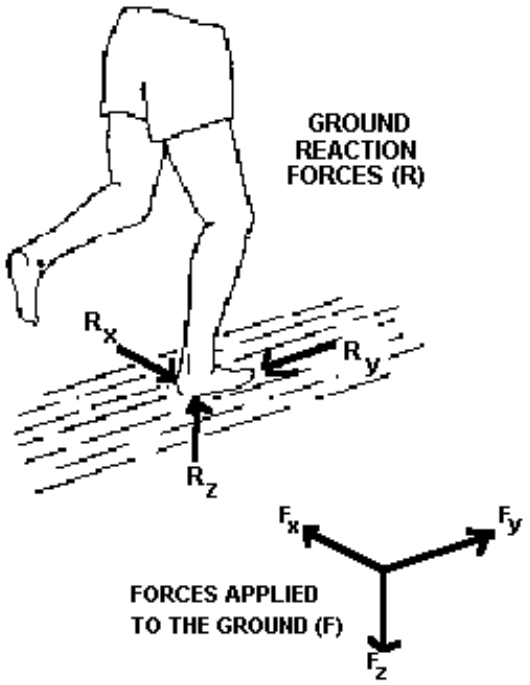
- Deceleration = Preparing Muscles

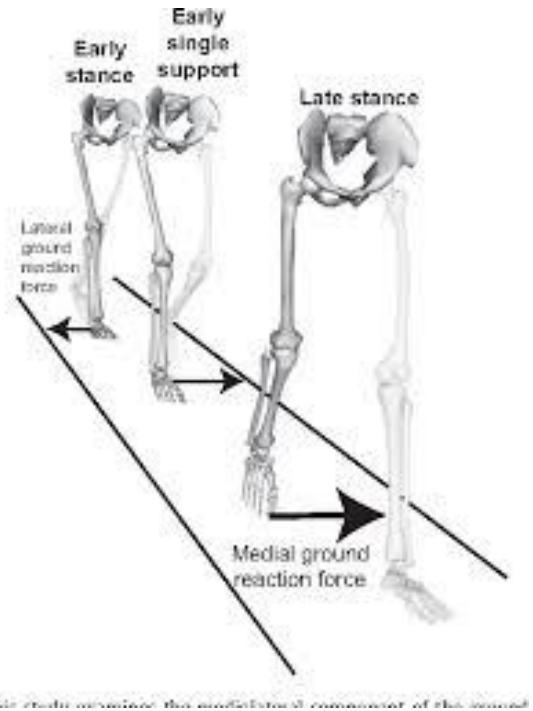
Strength in Numbers & Stabilizers





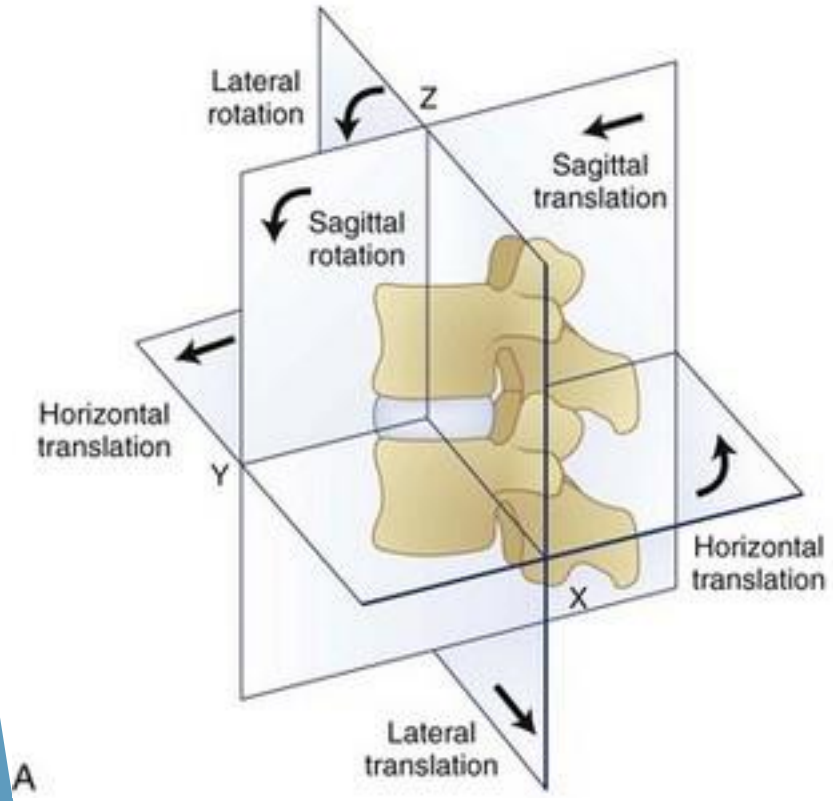
Reacting to Ground Forces

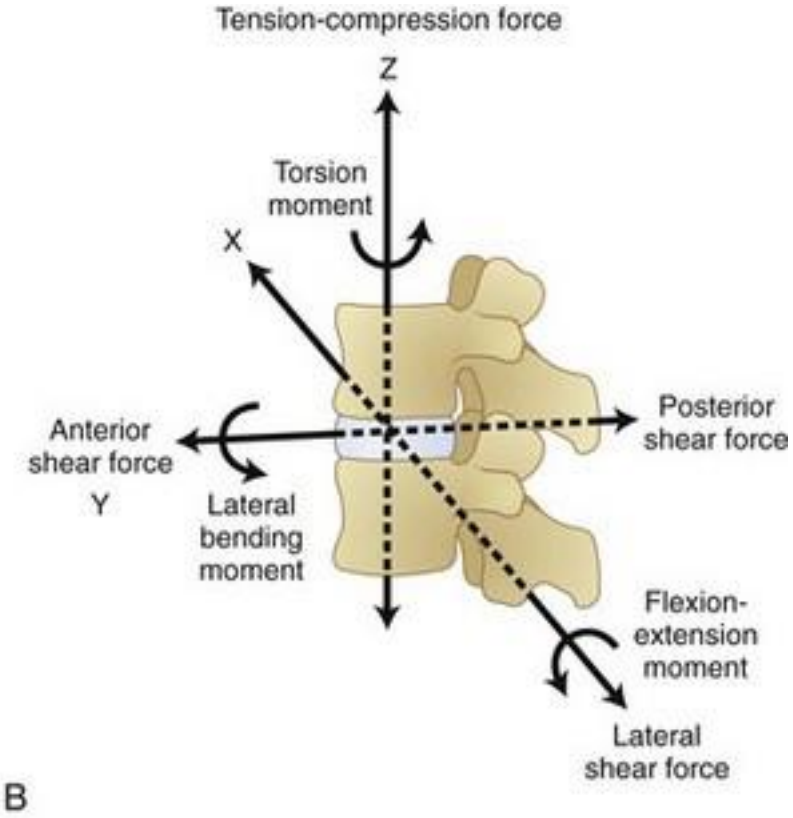




- For every action…
- Newton's 3rd

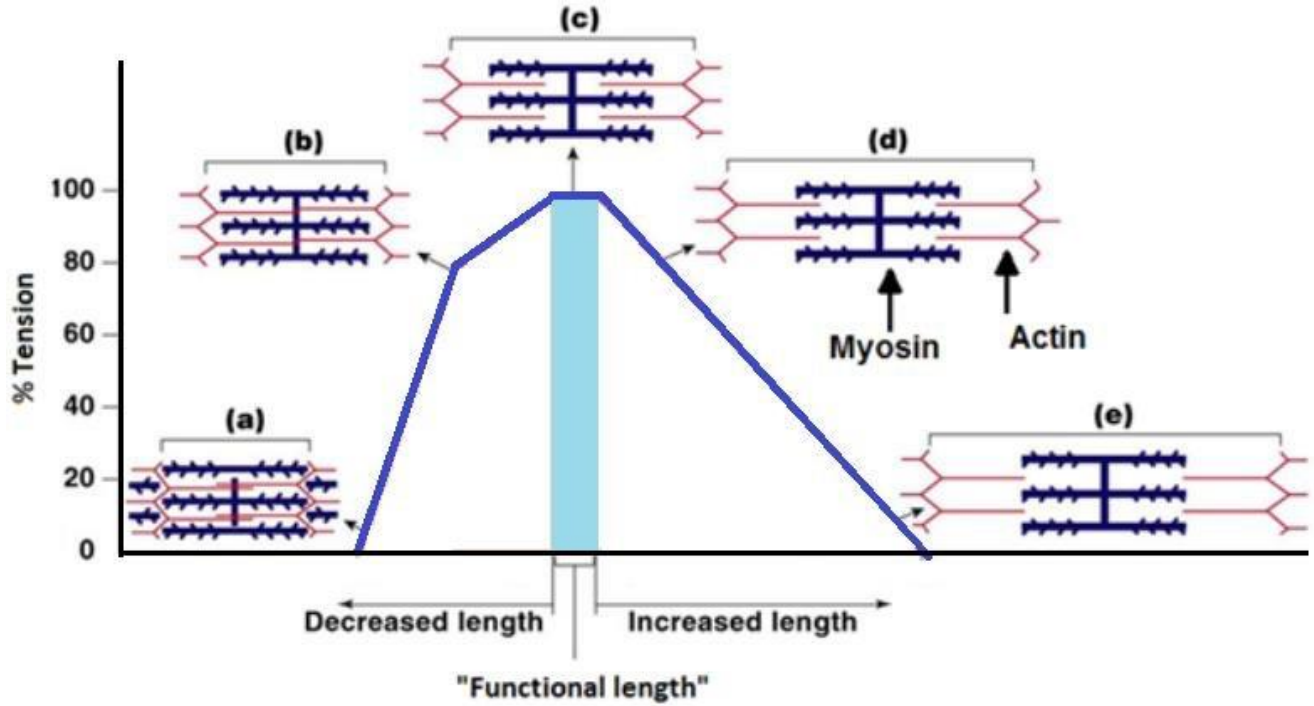
In Motion


Lateral rotation
Z
Sagittal translation
Sagittal rotation
Horizontal translation
Y
Horizontal translation
X
Lateral translation
A


Tension-compression force
Z
Torsion moment
X
Anterior shear force
Y
Lateral bending moment
Posterior shear force
Flexion-extension moment
Lateral shear force
B

Joint Position/Posture

- Essential for normal musc. Function
  - Muscle length & leverage
  - Musc. Function restoration per joint position
    - Mulligan Concept
    - PRI (postural restoration inst)
    - DNS
- “Centration” (DNS)
  - Neutral – somewhere in-between
  - Rich proprioceptive feedback
  - Optimal joint surface congruency
  - Ideal for loading
  - Mechanical advantage

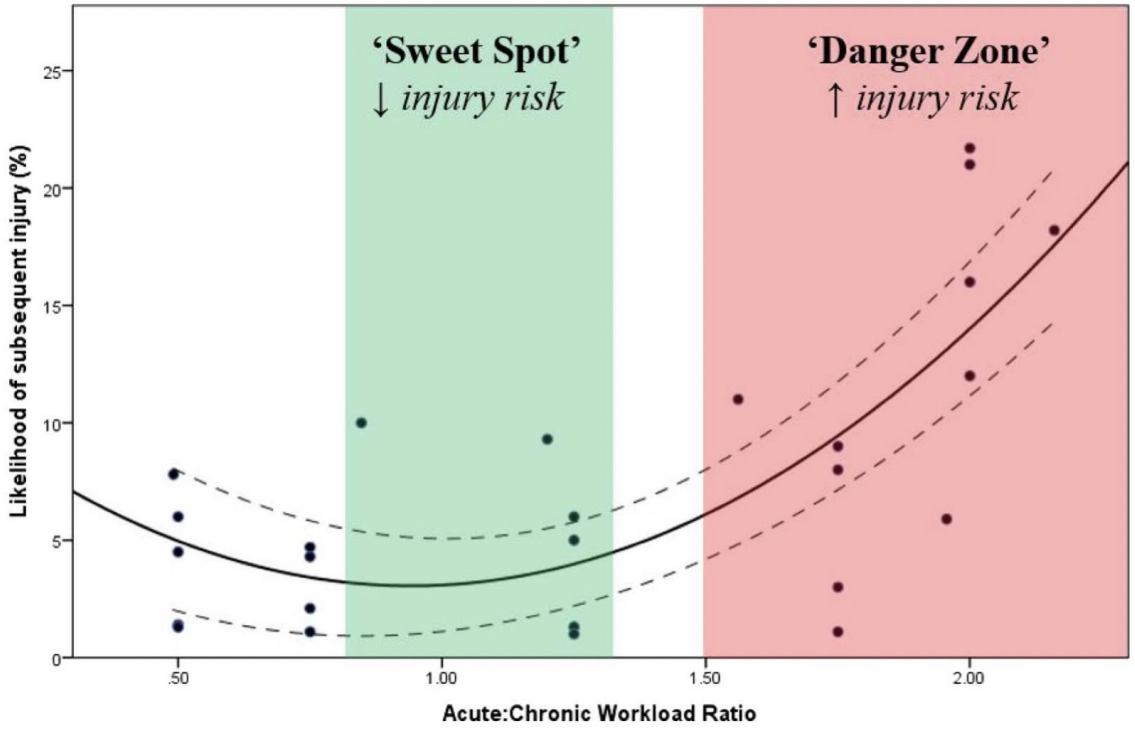


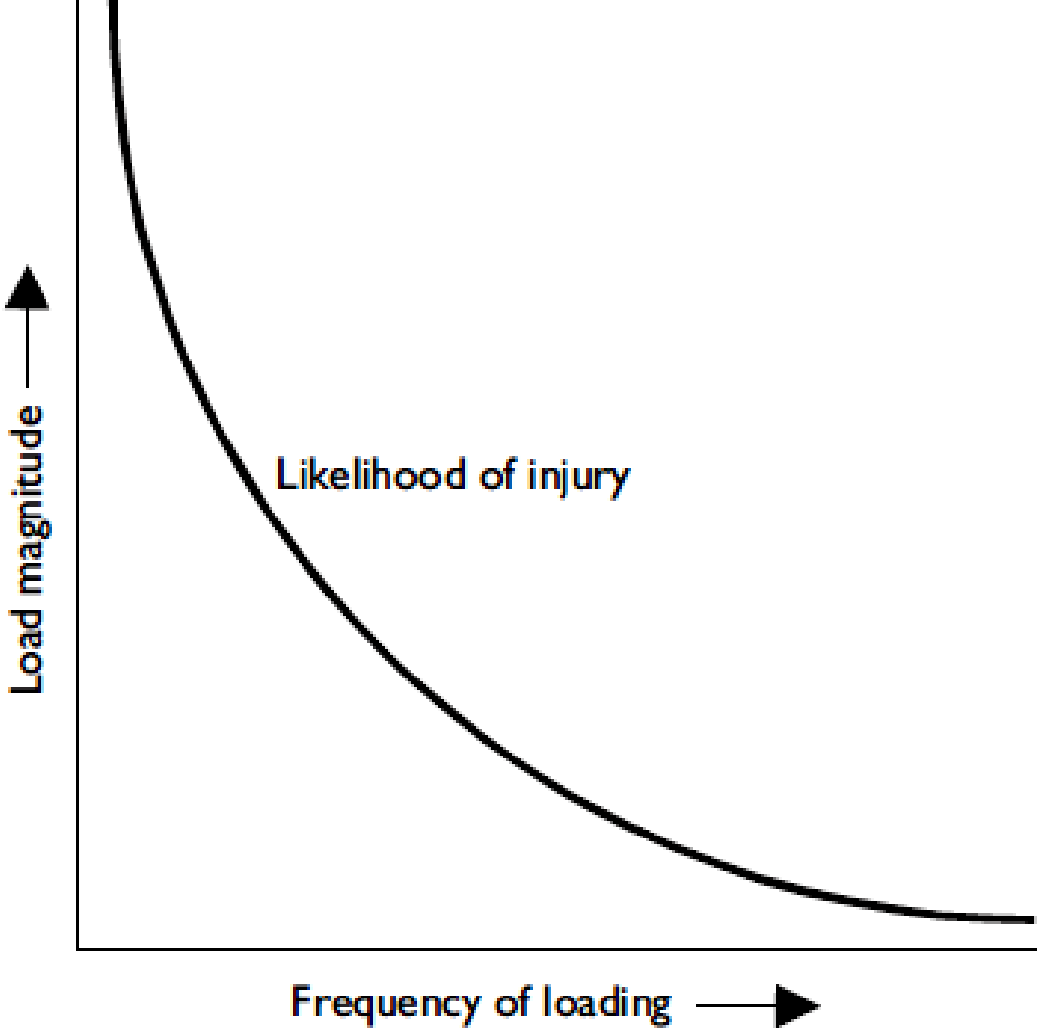
Training

- Purpose
  - Enhanced feedback from muscle spindles when muscles are stretched
  - Sensory feedback to body positioning and mechanics
  - Use information to make necessary adjustments in movement pattern.
- Training
  - Supramaximal holds. Higher than 1RM
  - Hypertrophy, strength, restructuring of muscle, injury prevention
  - DOMS
  - Balance btwn promoting ideal movement mechanics (for each person) but not producing too much soreness

Considerations in Training

- -External Demand, Functional Capacity
- -Load, Rep, Injury
- -Failure tolerance, Load over time
- -Intensity, Pain Risk





Capacity

- Rehabilitation will increase the ‘capacity’ of your …insert musculoskeletal tissue here….” Defining ‘tissue capacity’: a core concept for clinicians.

- There is no “Normal” for human movement
- Personal norms exist (outside averages)
- More important to consider capacities
- Focus on building system’s resilience

Slow Hold

1RM

What's the Basis of Prescription?

Stretch

Strength

High Rep

Endurance

Open & Closed Kinetic Chains

Example: PFPS

Herrington et al

Witvrouw et al

Outcome:

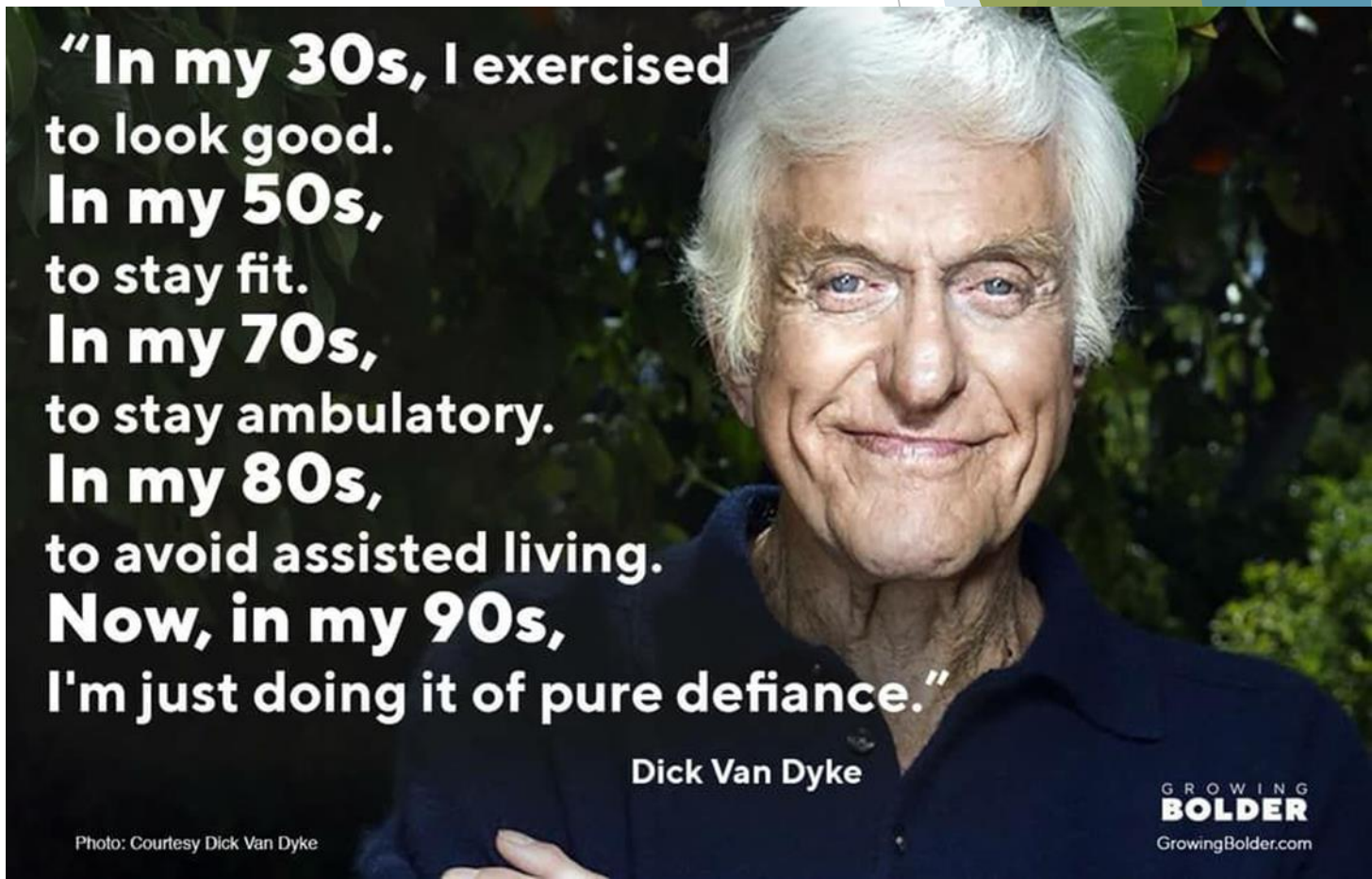
Pain, Function, Strength

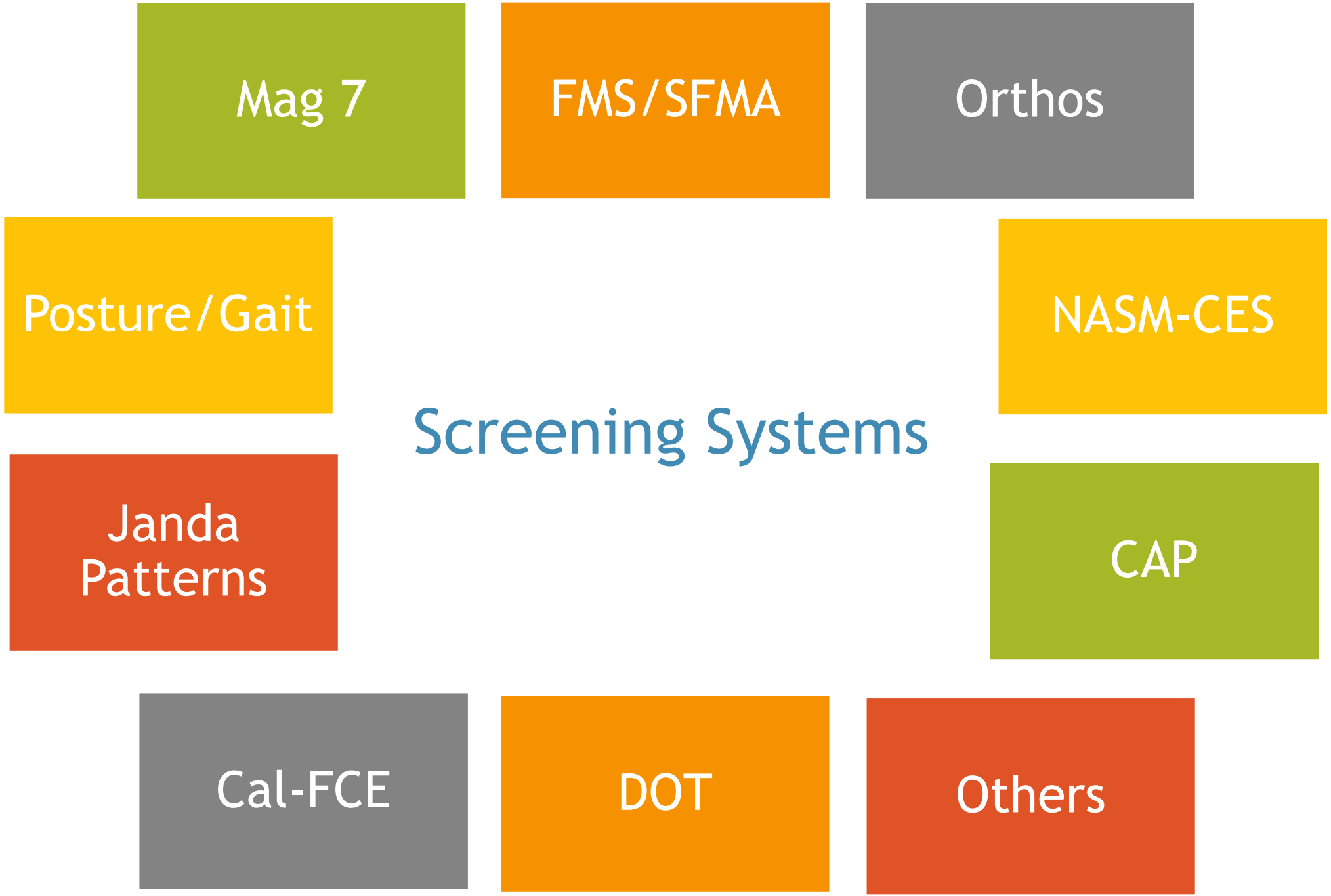
Conclusion:

OKC & CKC equally effective

Ultimately, what is Rehab?

- Rehab works to:
  - Engage… neuro drive
  - Build strength
- Strength is neurologic
  - Increase rate of motor unit firing
  - Motor recruitment + Skill development
- Strength potential increasing through lifespan indefinitely
  - Longevity metrics!
- How do we get there…




Mag 7
FMS/SFMA
Orthos
Posture/Gait
NASM-CES
Screening Systems
Janda Patterns
CAP
Cal-FCE
DOT
Others

Screens of the Day – “OL” Insights

- Posture/Gait
- Squat,
- Single-Leg Stance,
- Push-Up,
- Apley’s,
- Wall Angle,
- Birddog,
- Deadbug,
- Respiration

- Reference Hand-outs

Posture/Gait

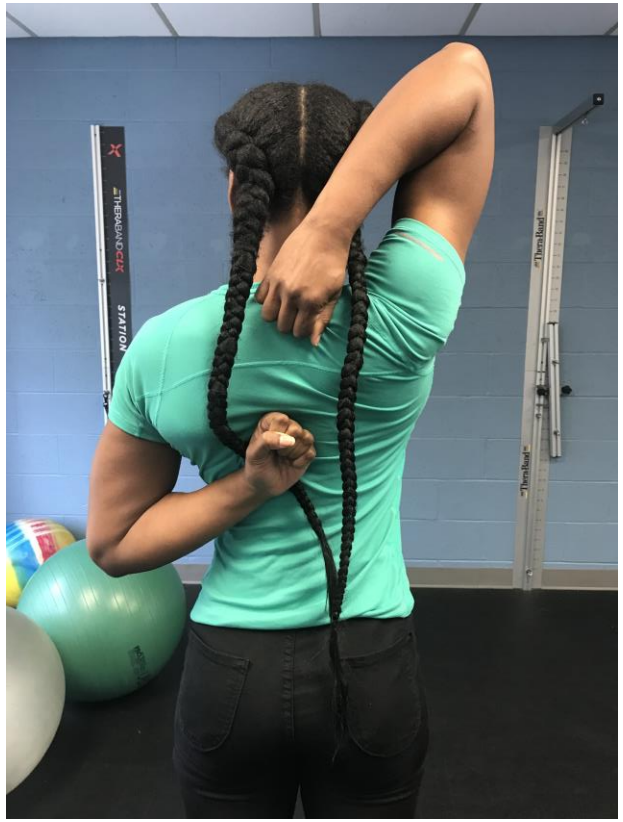
- MTrPs thought to begin after a micro/macrotrauma, or a sustained muscle contraction from a postural dysfunction, which can become a site of sensitized nerves with altered metabolism
- Gait:
  - Increased tone with weakness → UMNL
  - Decreased tone with weakness → LMNL

Overhead Squat

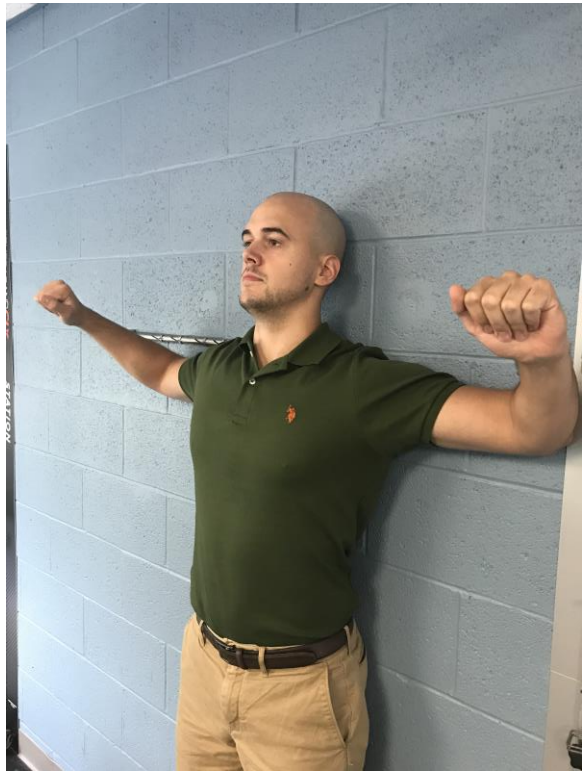
Single Leg Stance

Pushup

Apley’s Scratch Test



Wall Angel (Tsp Mobility Screen)



Birddog

Dead Bug

Respiration Assessment

Importance of Functional Screening

- Shows biomechanical dysfunction and overloaded areas of the body
- tells us what muscles are overactive and which ones are weak
- guides us to important joint areas that need attention [hypo AND hyper-mobility] ← yes, it can move too much
- gives us a view of the CNS

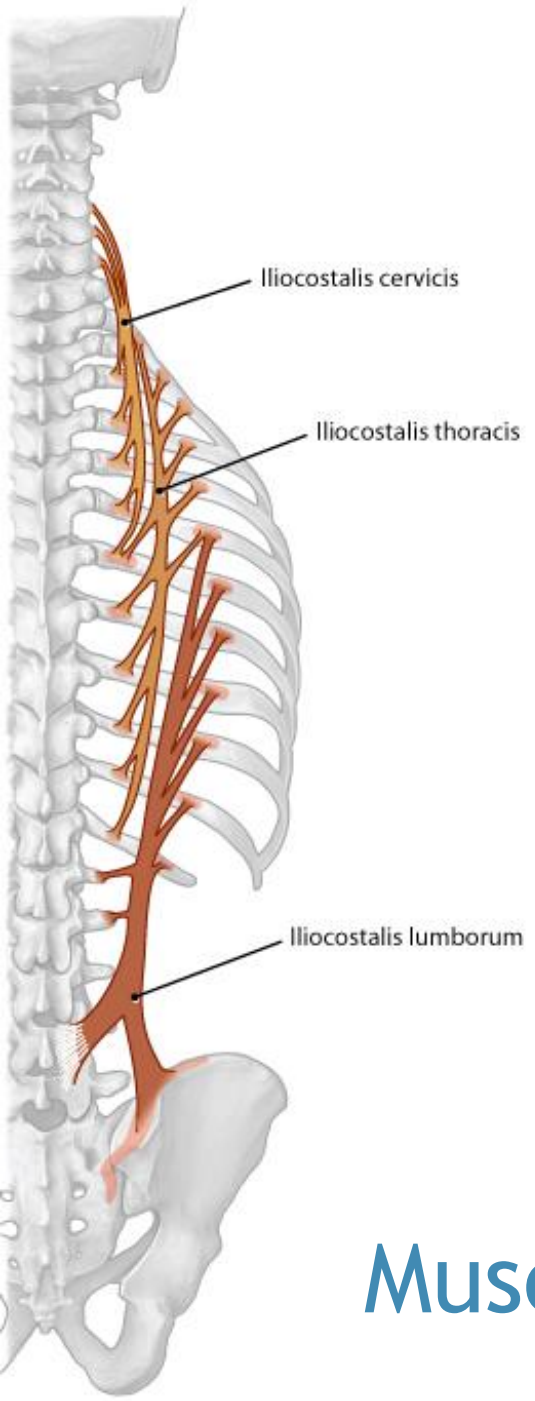
MOTION PALPATION INSTITUTE

Fix yourself

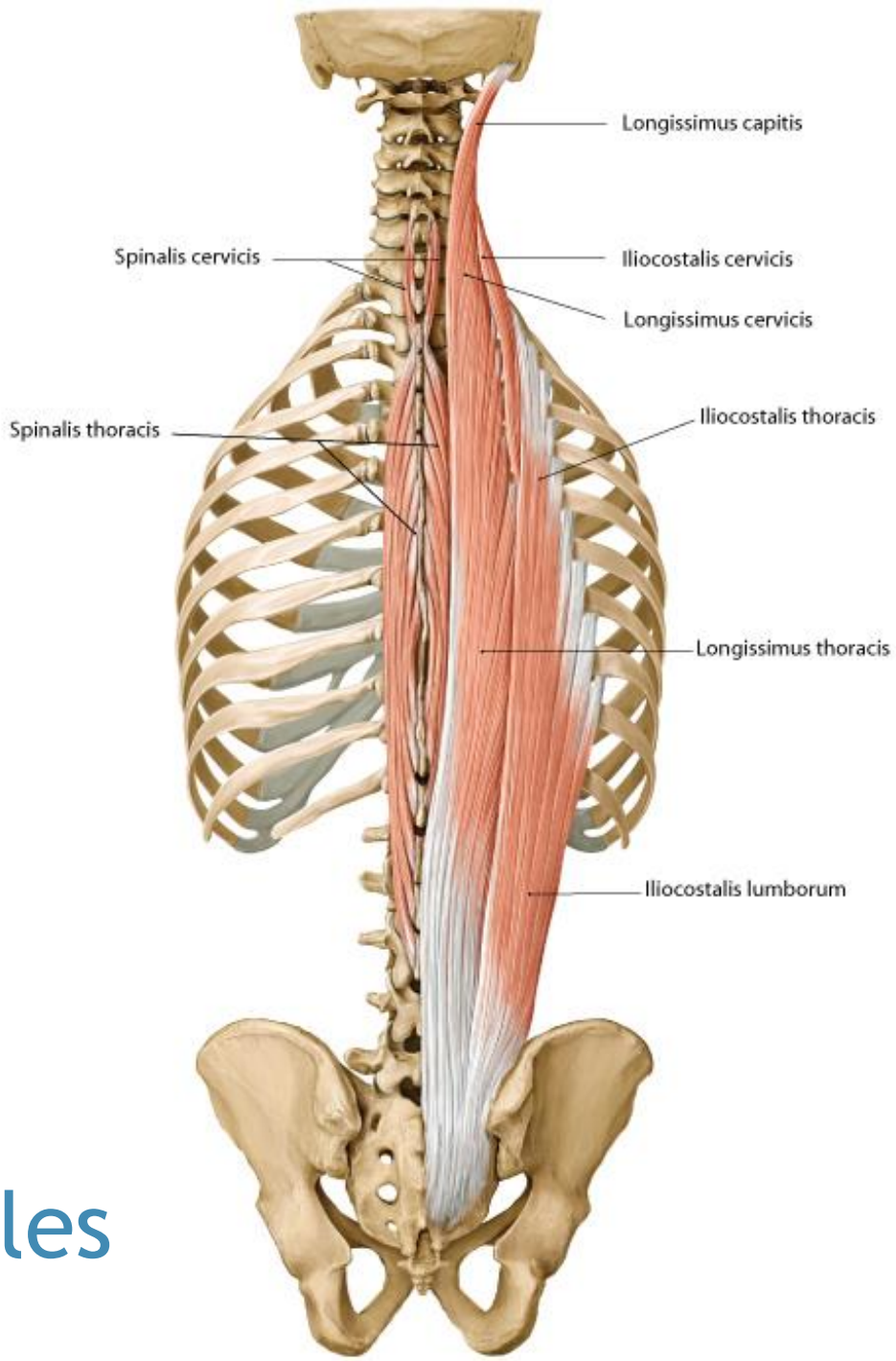
- Remember how Rehab works
- Anything can be a screen (“Mechanical Sensitivity”)
- Take cues from your body

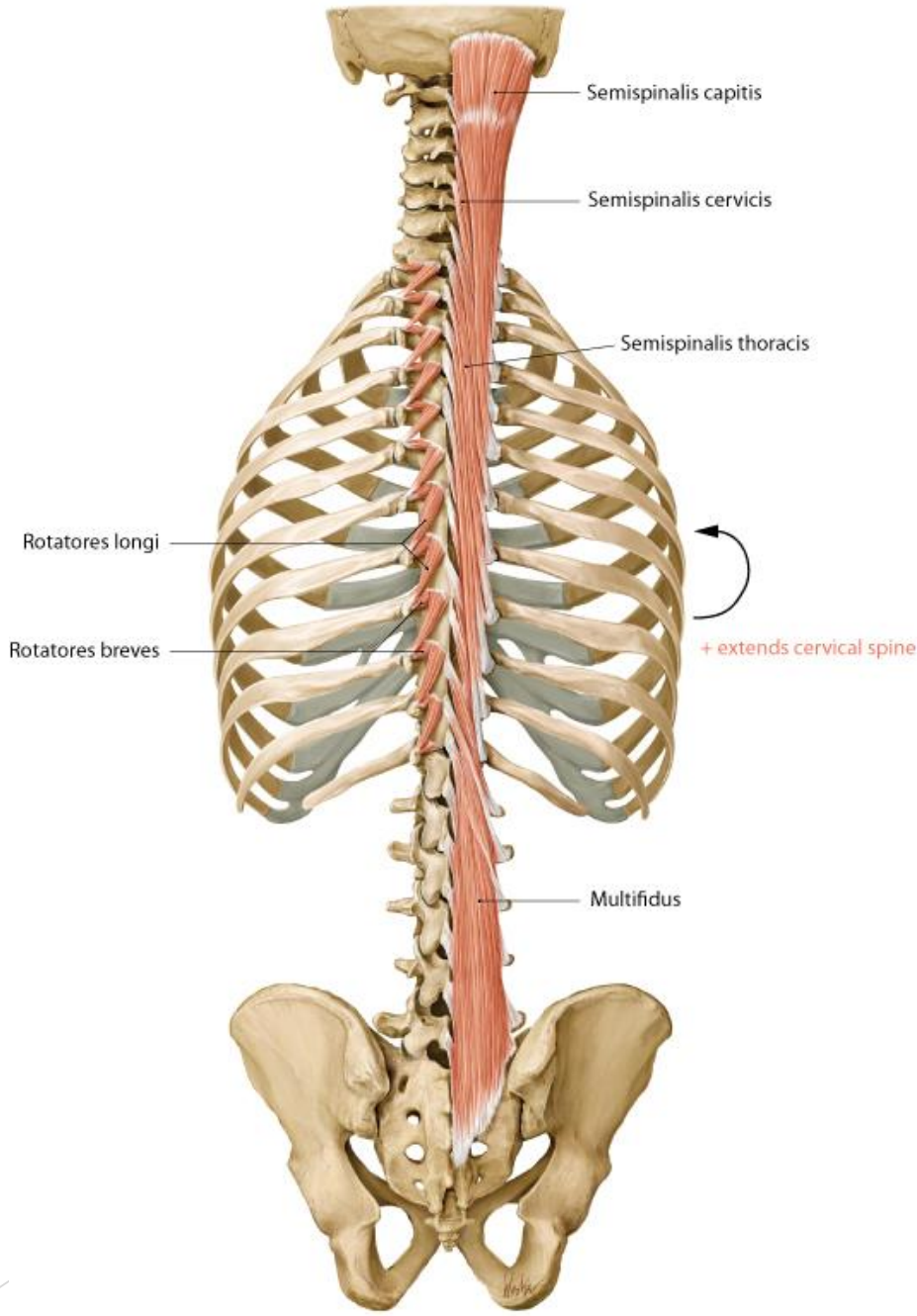
Spine Motion

- Facet Orientation


Iliocostalis cervicis
Iliocostalis thoracis
Iliocostalis lumborum

Muscles


Longissimus capitis
Spinalis cervicis
Iliocostalis cervicis
Longissimus cervicis
Spinalis thoracis
Iliocostalis thoracis
Longissimus thoracis
Iliocostalis lumborum


Semispinalis capitis
Semispinalis cervicis
Semispinalis thoracis
Rotatores longi
Rotatores breves
+ extends cervical spine
Multifidus

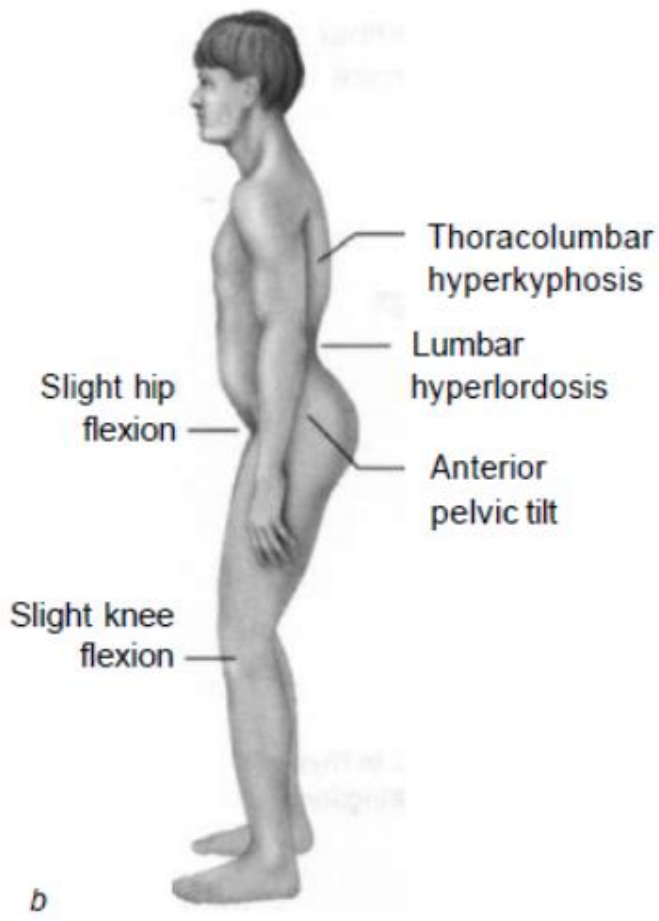
Lumbar

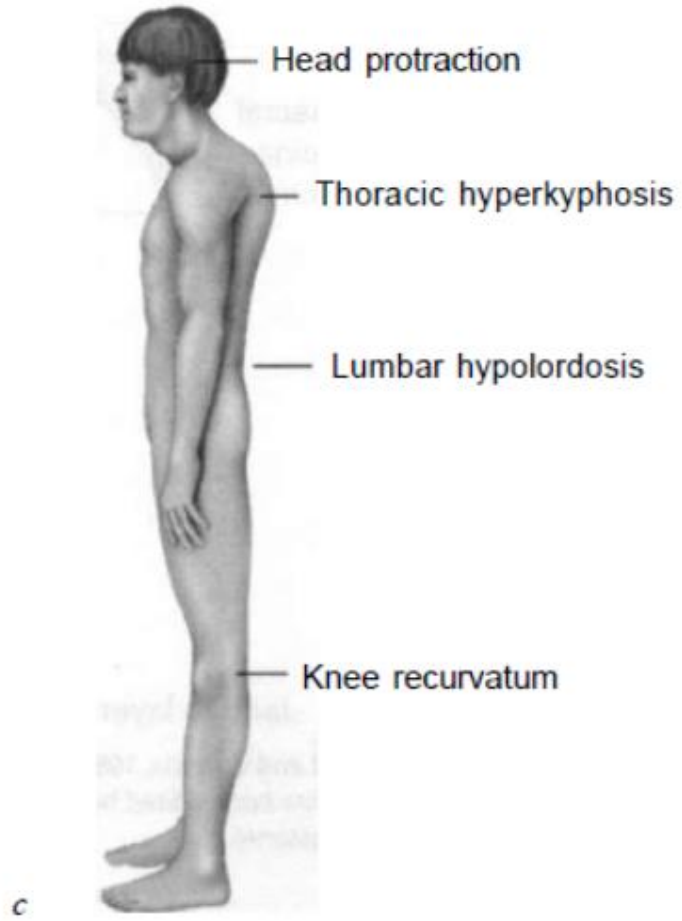
- Posture:
- Gait:
  - Spinal flexion at left heel strike in the sagittal plane
  - Spinal extension in relation to an extended hip in the sagittal plane prior to the right foot swinging through during the gait cycle
  - Spinal rotation to the left in the transverse plane at left heel strike and mid-stance
  - Lateral flexion to the left in the frontal plane during the right leg swing phase
- ROM:
  - Ipsilateral Rotators
  - Contralateral Rotators
  - Sagital Plane (next slide)
- Orthos:
  - Evaluates other structures (Disc, Nerve, Vascular)

Lumbar Sagittal Plane R/O

- Flexion Bias (think McKenzie)
  - Discogenic pain/Discopathies
  - Ligamentous Sprain
  - Radicular Symptoms (Centralization)
  - Compression Fractures
- Extension Bias (think Williams)
  - Stenosis
  - Facetogenic Pain
  - Spondy- (-losis, -lothisthesis, etc)
- Improve engagement in direction of benefit

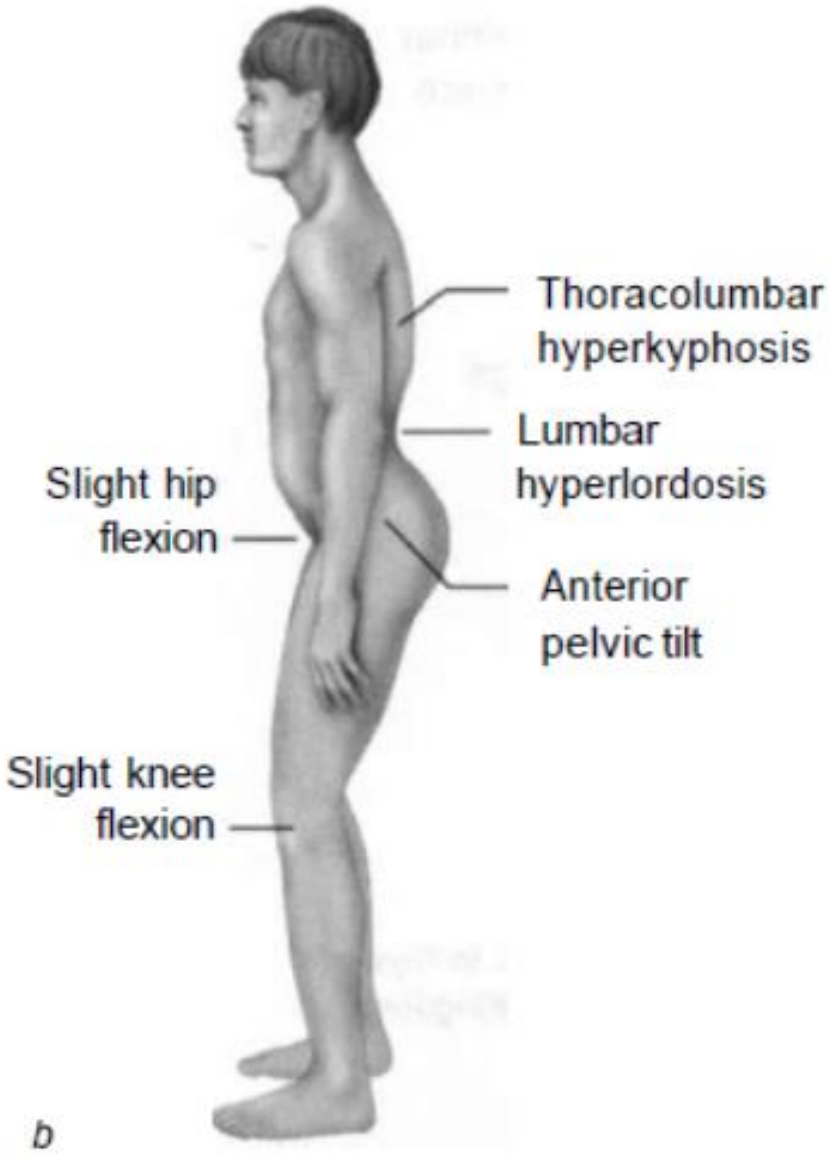
Lower Crossed





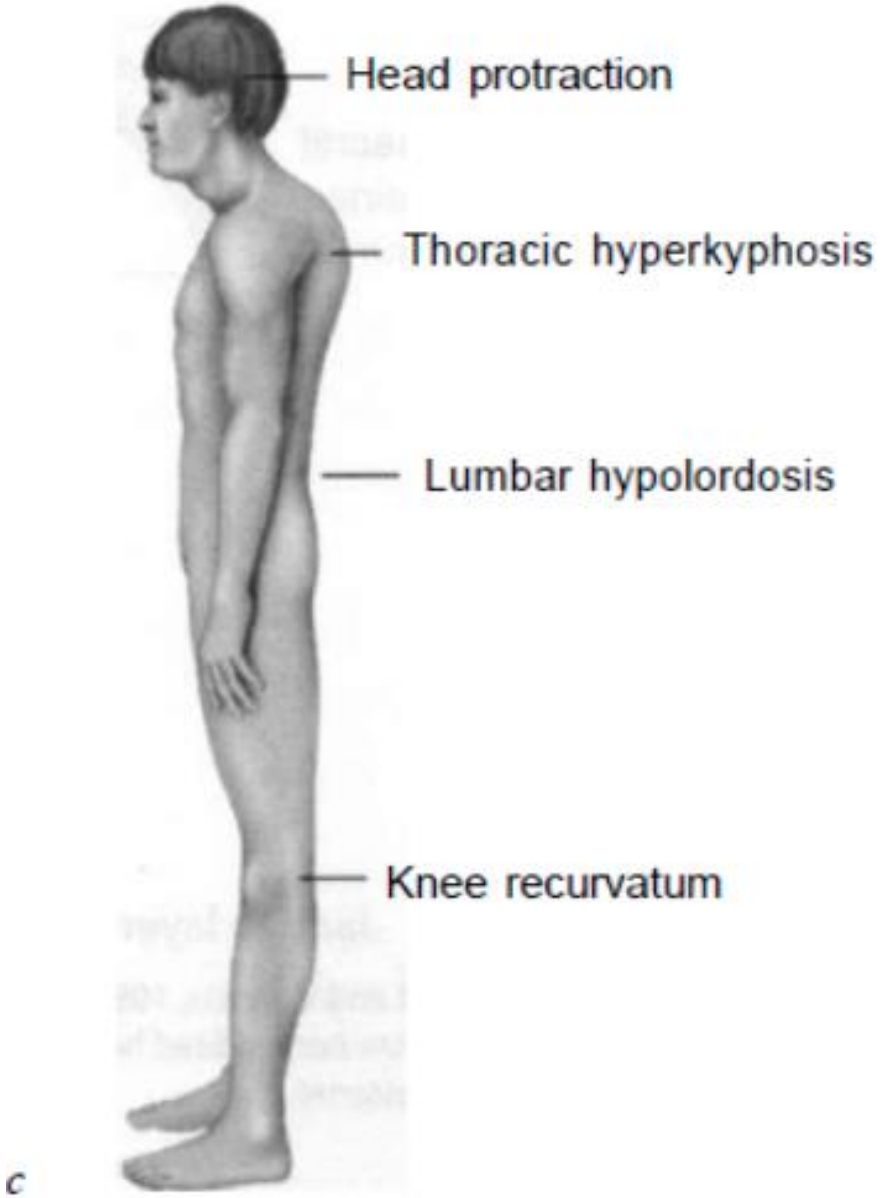
Lower Crossed - A

- Increased Lordosis
- Anterior Pelvic Tilt
- Static Hip Flexion
- Knee Flexion
- Inhibited Core
- Inhibited Gluteal
- Overactive Erectors
- Overactive Hip Flexors



Lower Crossed - B

- Hypolordosis
- Posterior Pelvic Tilt
- Knee Extension
- Overactive Hip External Rotators
- Rigid Weak Core
- Tight Hamstrings
- Lack of Post Hip Translation



Lumbar

- Squat
- Single-Leg Stance
- Push-Up
- Wall Angel
- Birddog
- Respiration

- Others?

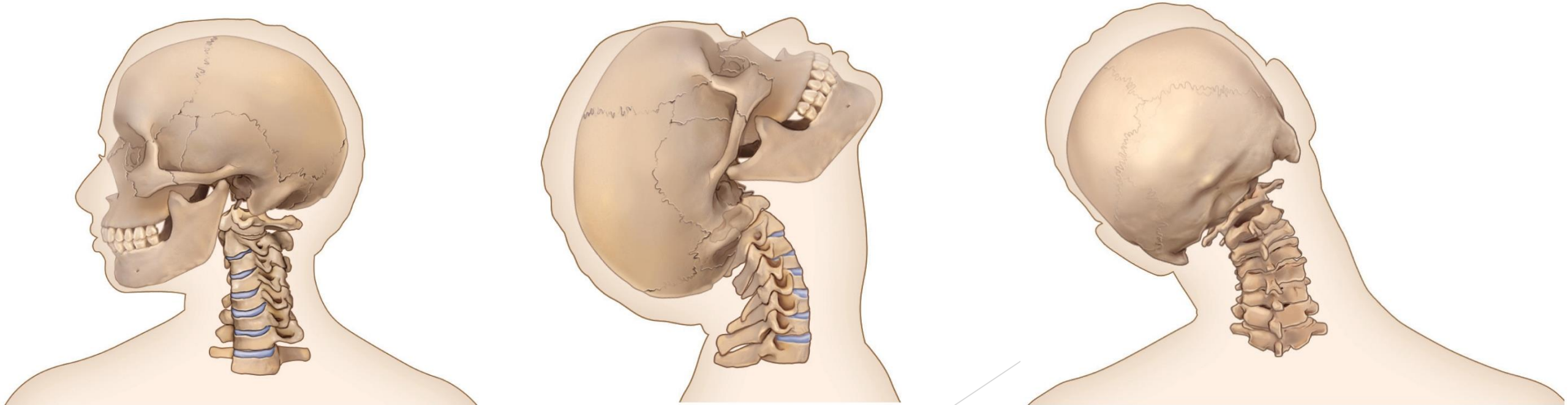
Lumbar Stretches

- ERL
- QL Stretch (Hurdler-type stretch)
- Knee to Chest
- Psoas (tri-planer)

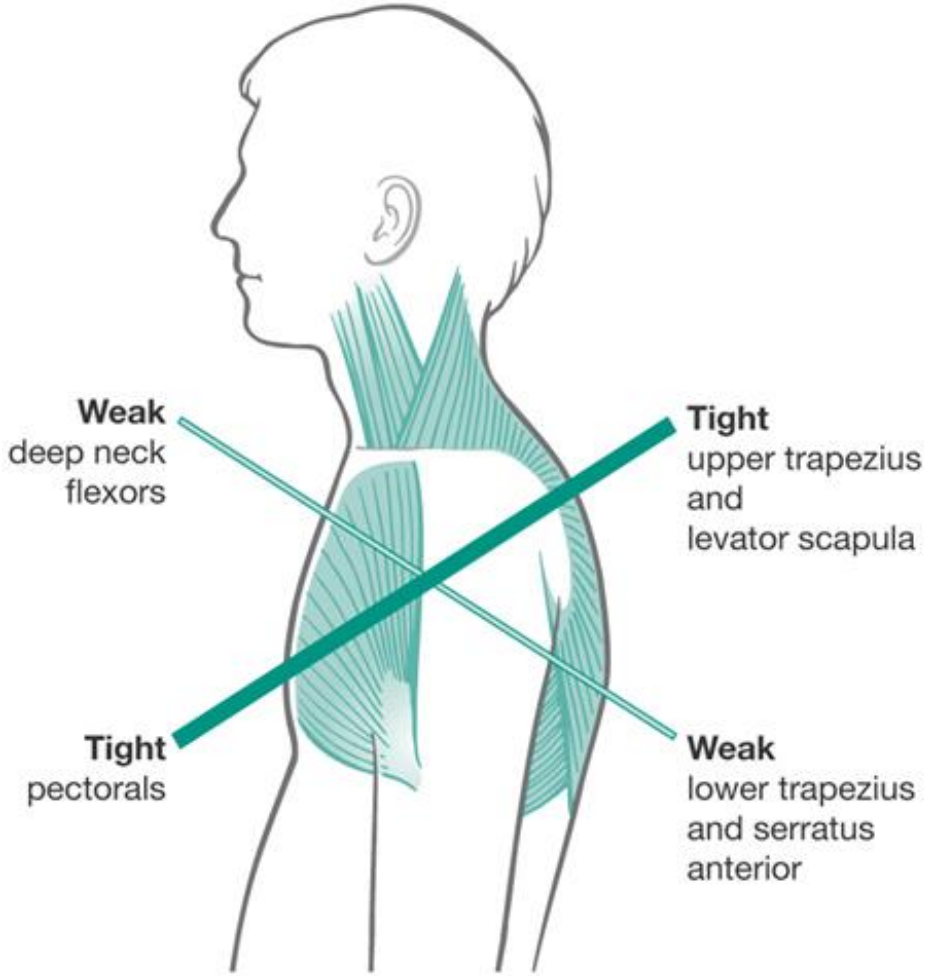
Lumbar Strengthening

Cervical

- Movement involves all three planes of motion
- When movement occurs, there is a translation of the vertebral segments over the center of rotation
- Look for adequate motion within the thoracic spine for successful cervical movement



Upper Crossed



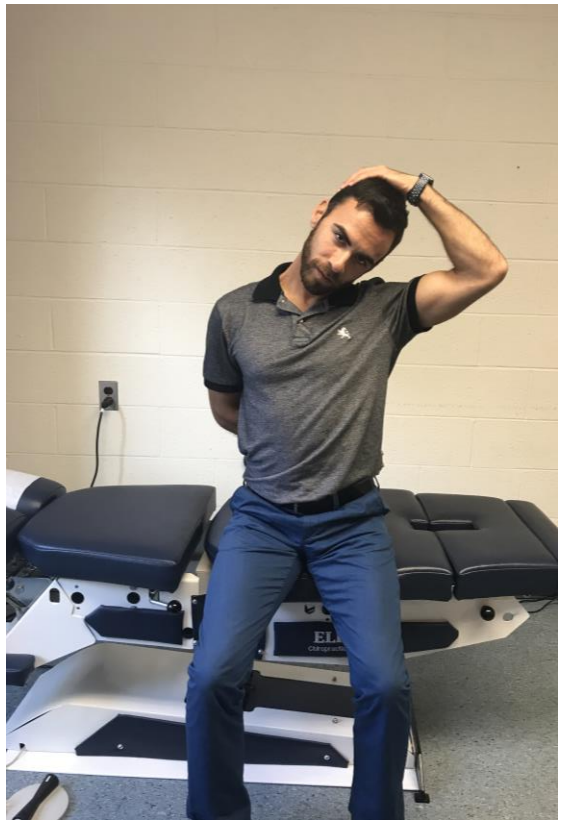
Also:

- Longus Coli/Capiltus
- Suboccipitals

Cervical

- Squat
- Single-Leg Stance
- Push-Up
- Apley’s
- Wall Angel
- Birddog
- Respiration

Cervical Stretches



Cervical Strengthening

Thoracic

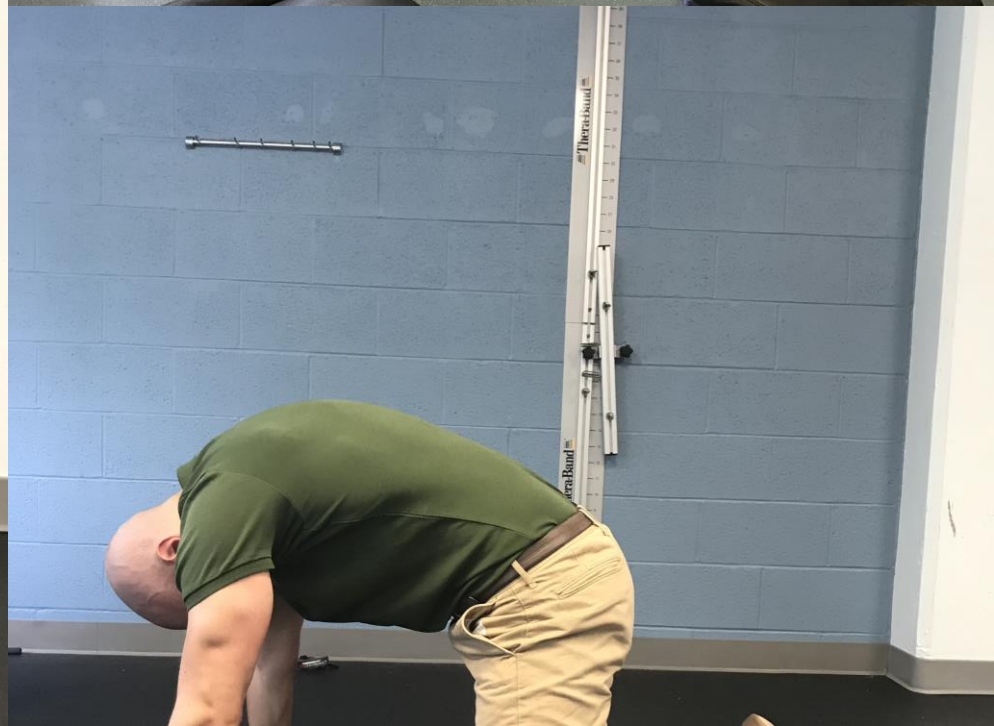
- Combined ROM of Tspine. Greater than Lumbar, Less than Cervical
- Necessary for cervical, shoulder, lumbar mechanics

- Serratus Anterior & Posterior Sup/Inf
- Rhomboids

Thoracic Stretches & Strength

Blends neck and low back concepts

- Stretch with cat-camel, Tsp rot openers, foam roll
- Endurance with anti-rotation pallof press, brueggers,
- 1RM rows, push, pulls



Preguntas?


ROUND
2

Journal Manual & Manip Therapy 2019 Rosedale

- Study exploring prevalence of extremity pain of spinal source (EXPOSS)
- “44% had spinal source of symptoms”
  - Extremity pain relieved with spinal treatments
- assess spine in extremity pain!
- …Quick Review

Stages & Rehab Pyramid

As said another way… a la Janda

- Normalize joint function [MOBILIZE]
- Relax and/or stretch hypertonic muscles [MOBILIZE]
- Facilitate and/or strengthen inhibited muscles [STRENGTHEN]
- Reprogram co-ordinated movement subcortically [NEURO ENGAGE]

- Metrics for LONGEVITY
- Attitudes

Body Design – Regional Interdependence

- Coined by **Wainner et al** in 2007 [Cleland was an author too!!!]
- Seemingly unrelated impairments in a remote anatomical region may contribute to, or be associated with, the patient's primary complaint
- Today we're riding the Anatomy Trains!

- "after an injury tissues heal, but muscles learn, they readily develop habits of guarding that outlast the injury"

  ~Janet Travell

Anatomy Trains

- Body held together by balance of rigid structures (bones) and movable parts (muscles/ligaments) = **Tensegrity**
- Joint position important for stability and efficiency of movement = **Centration**
- Location of maximum insult, culmination of pattern breakdown = Site
- Assessments expose deficiencies in movement mechanics which may be the precursor for breakdown = Source

Posture Aware - Dominant Patterns

Cannot manage asymmetries (for example)

- Cerebral hemisphere dominance
- Eye dominance/Hand/Foot
- Lungs/Liver/Lymph Drainage
- Bigger, stronger diaphragm/crura on right than left

→Will develop system inadequacies or reciprocal weaknesses

- Right Diaphragm stronger
  - Larger and shape supported by liver
- Compromised breathing on left
  - Elevated anterior ribs on left
- Reciprocal inhibited left obliques/TVA
- Left pelvis (unsupported) ant tipped/forward rotated
  - Lower spine orients to right, upper spine to the left
- Favorable standing on right leg
  - Upper body shifted left & left leg likely turned out
- Lowered, depressed shoulder & chest on right
- Other overdeveloped compensatory muscles

Reciprocal Inhibition

- Inhibition of the antagonist muscle when isometric contraction occurs in the agonist.
- This happens due to stretch receptors within the agonist muscle fibers – *muscle spindles*.
- The spindles discharge impulses which excite the afferent nerve fibers or the agonist muscle
- They meet with the excitatory motor neuron of the agonist muscle (in the spinal cord) and at the same time inhibit the motor neuron of the antagonist muscle which prevents it from contracting.
- **THE PHYSIOLOGY AND APPLICATION OF MUSCLE ENERGY TECHNIQUES**
- ***by Gill Webster DARM RMT SMTO***


Functional Assessments

Considering full body mechanics during assessments exposes patterns which can serve as the basis for exercise prescription

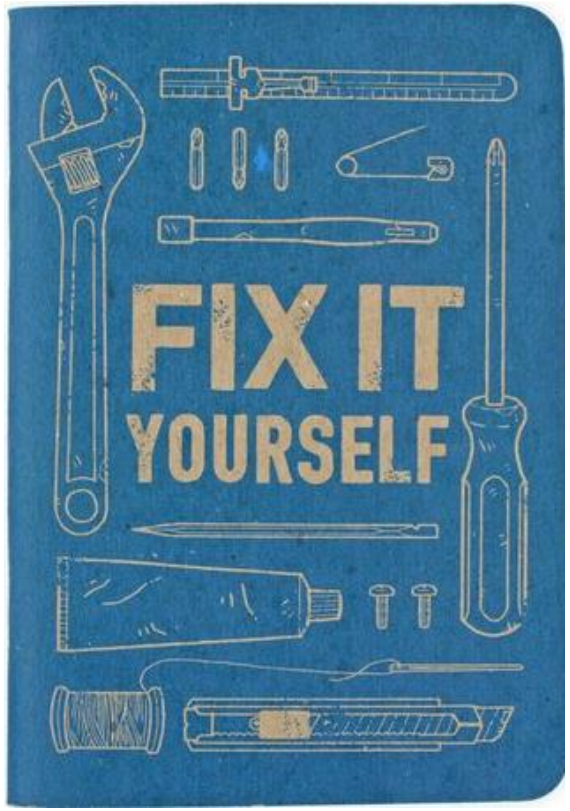
Pick the assessment

Find the pattern

Provide intervention

Fix yourself

- Remember how Rehab works
  - POLITE POLICE
- Anything can be a screen
  - (“Mechanical Sensitivity”)
- Take cues from your body



Slow Hold

1RM

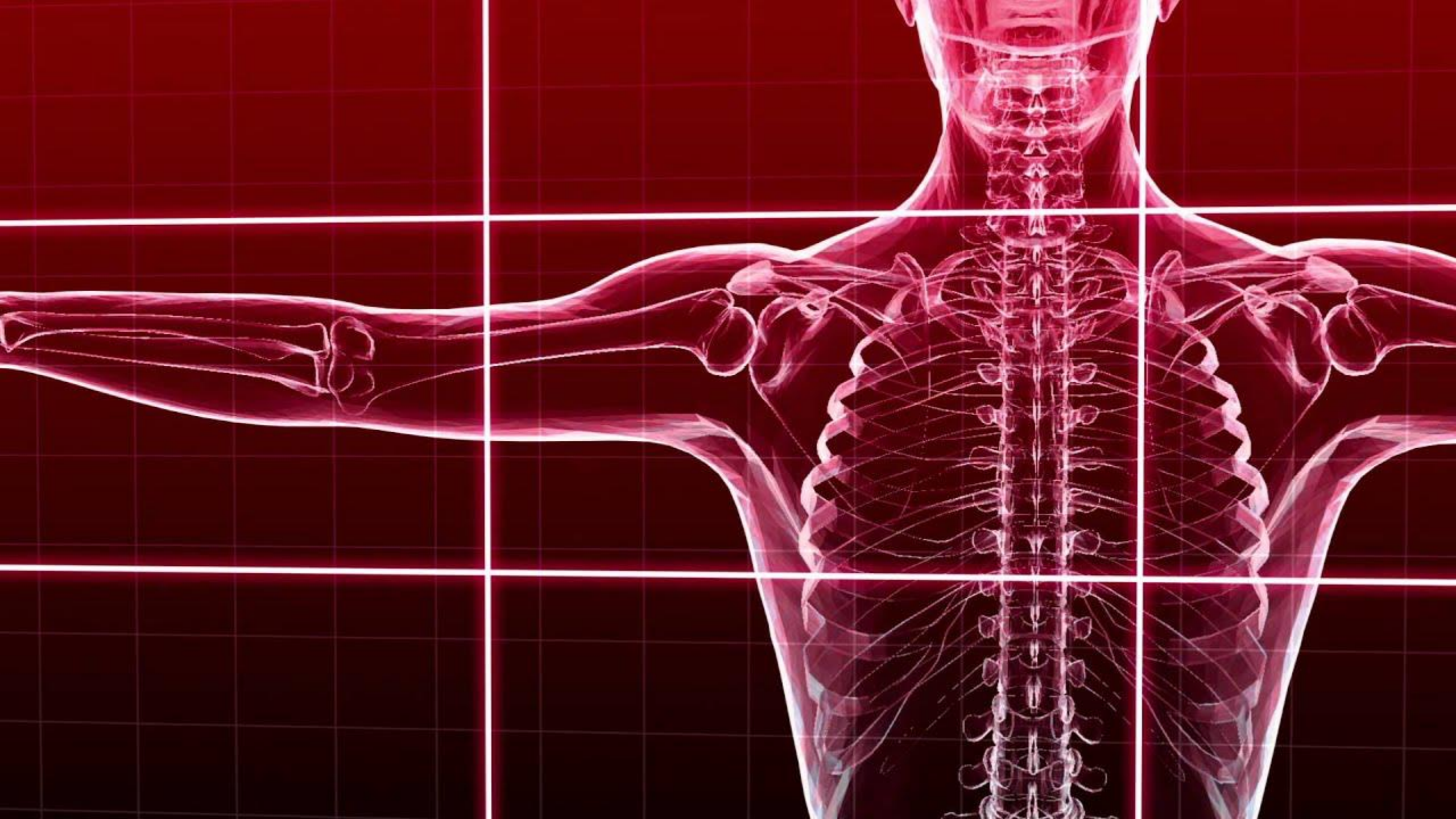
What's the Basis of Prescription?

Stretch

Strength

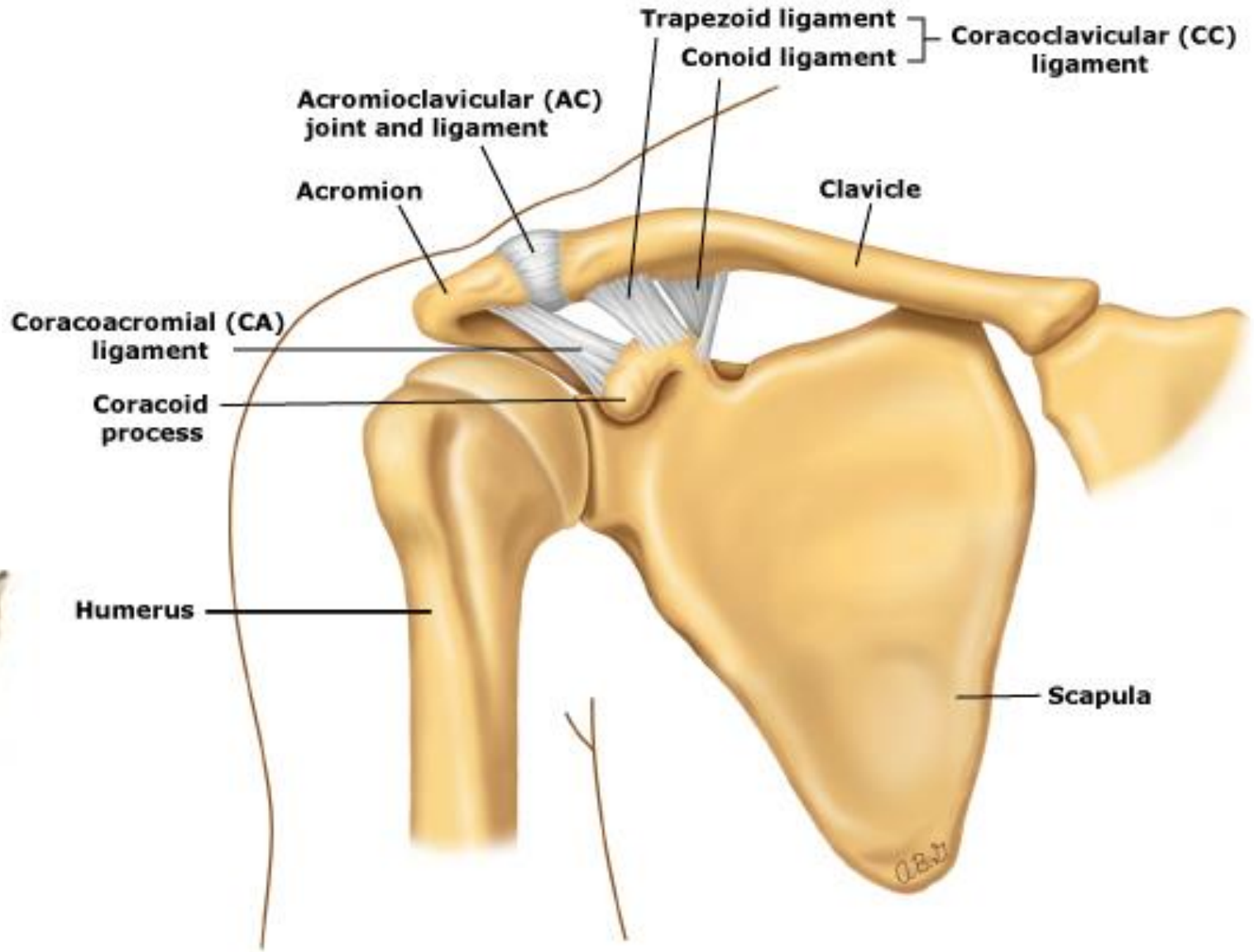
High Rep

Endurance

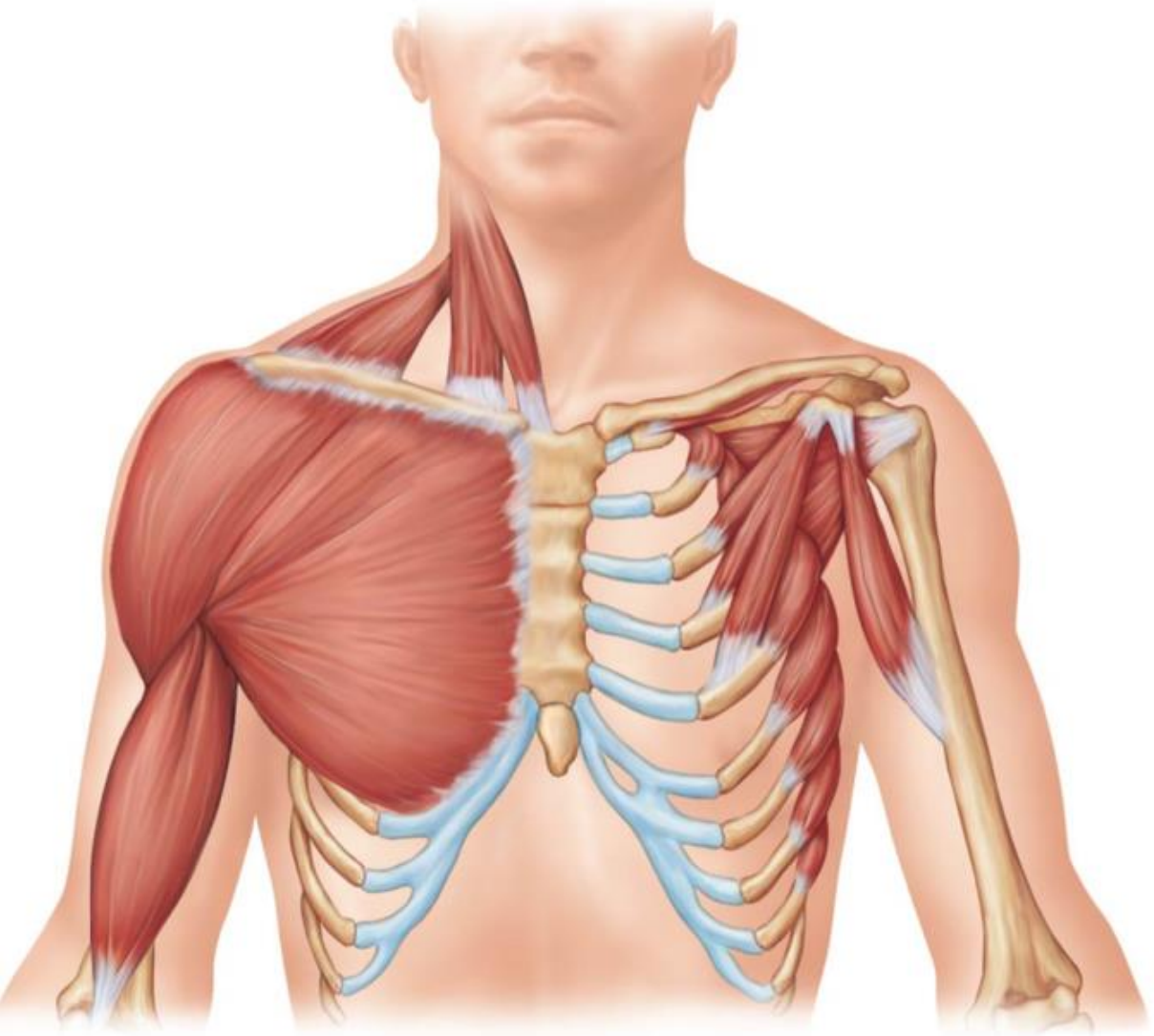


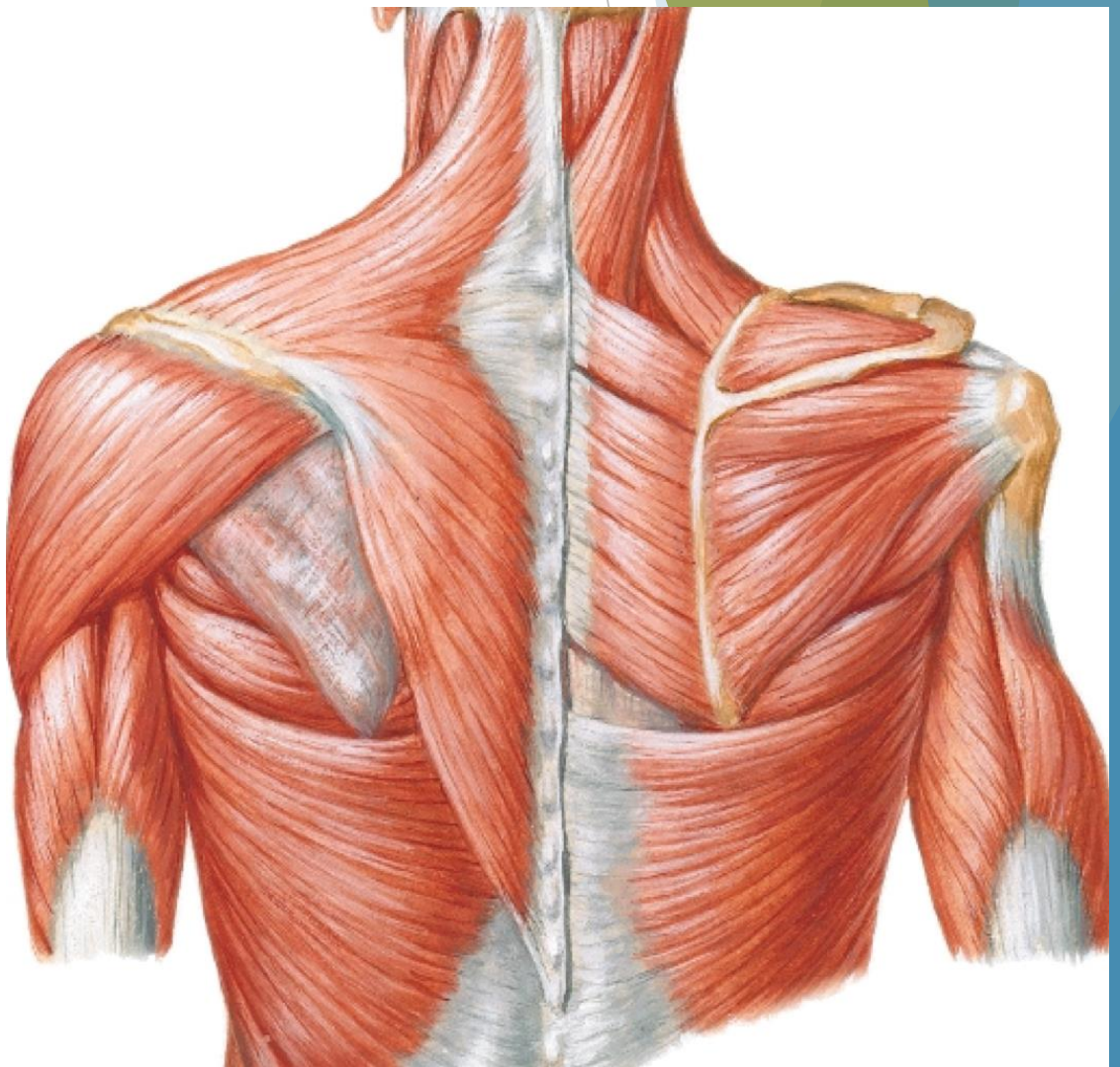
Arm Lines

- Deep Front Arm Line (DFAL)
  - Pectoralis minor, Biceps brachii, Thenar muscles
- Superficial Front Arm Line (SFAL)
  - Pectorals major, Latissimus dorsi, Flexor group
- Deep Back Arm Line (DBAL)
  - Rhomboids, Rotator cuff muscles, Triceps brachii
- Superficial Back Arm Line (SBAL)
  - Trapezius, Deltoid, Extensor group

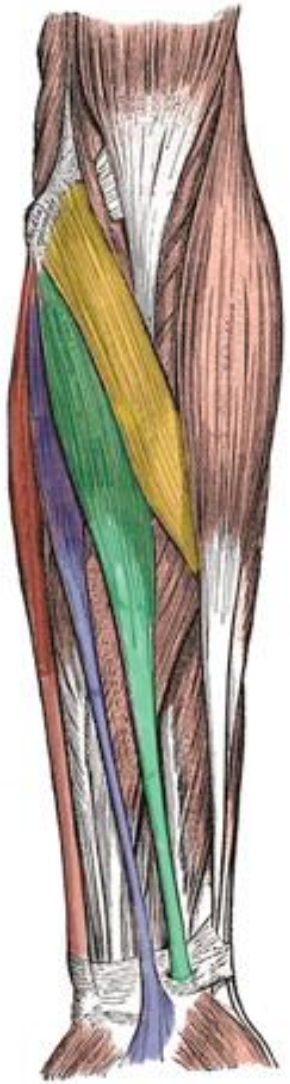

Trapezoid ligament
Conoid ligament
Coracoclavicular (CC) ligament
Acromioclavicular (AC) joint and ligament
Acromion
Clavicle
Coracoacromial (CA) ligament
Coracoid process
Humerus
Scapula

Muscles

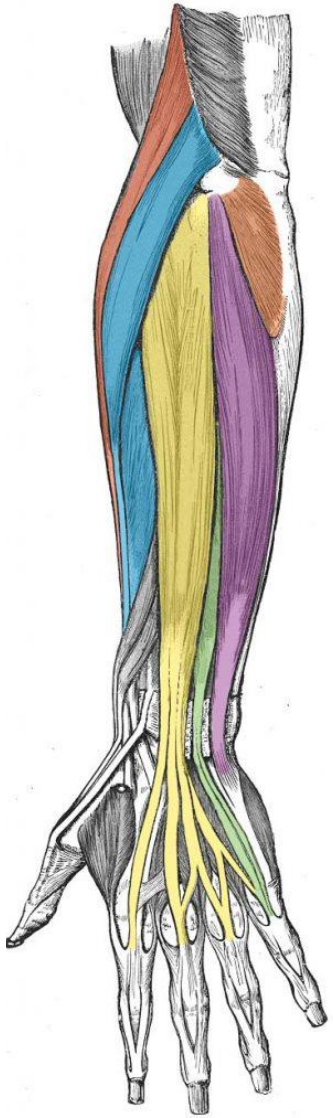




Muscles

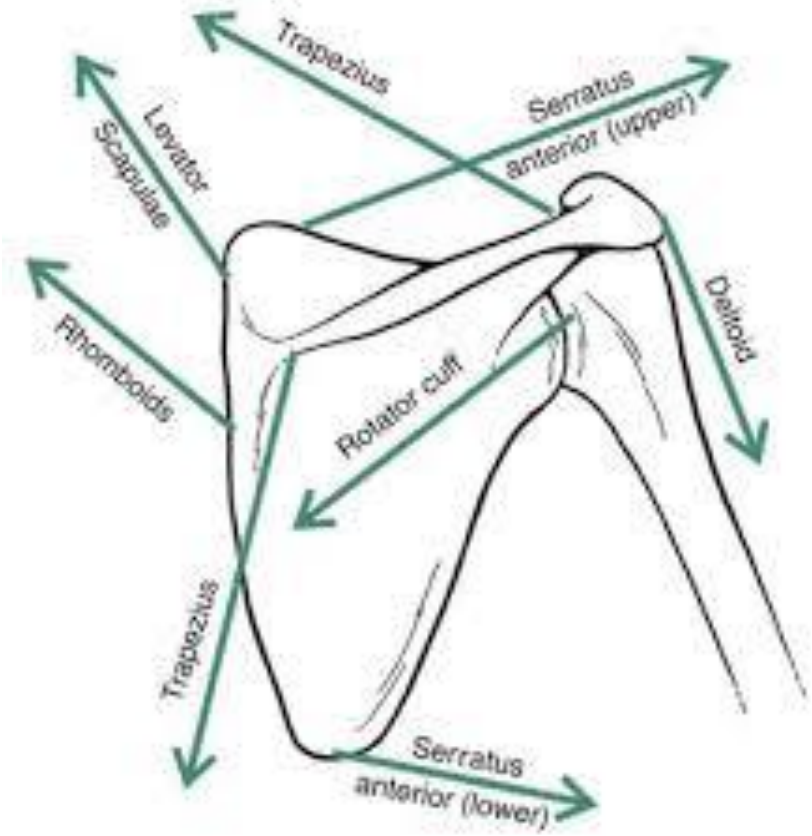


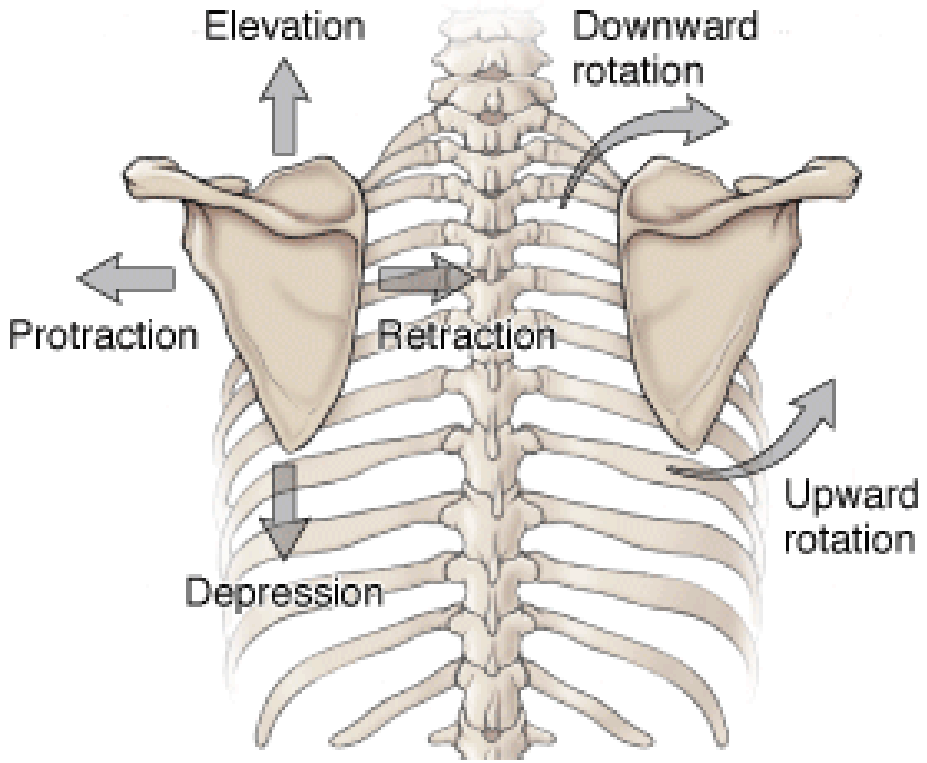
- Flexor carpi ulnaris
- Palmaris longus
- Flexor carpi radialis
- Pronator teres

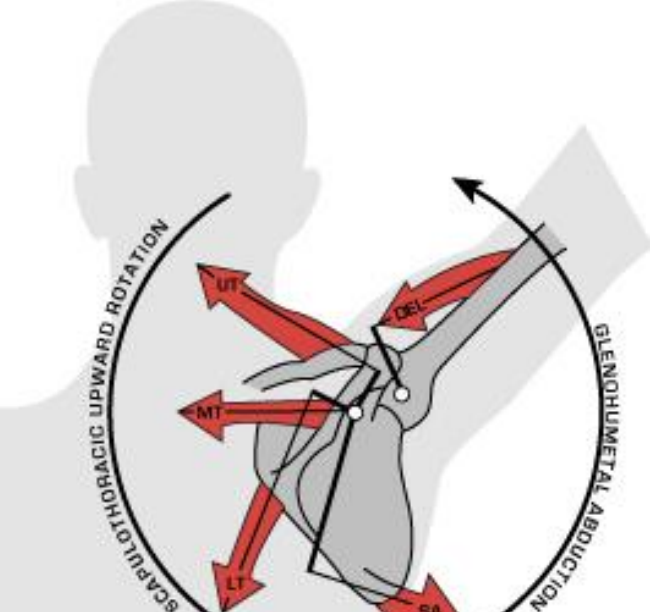


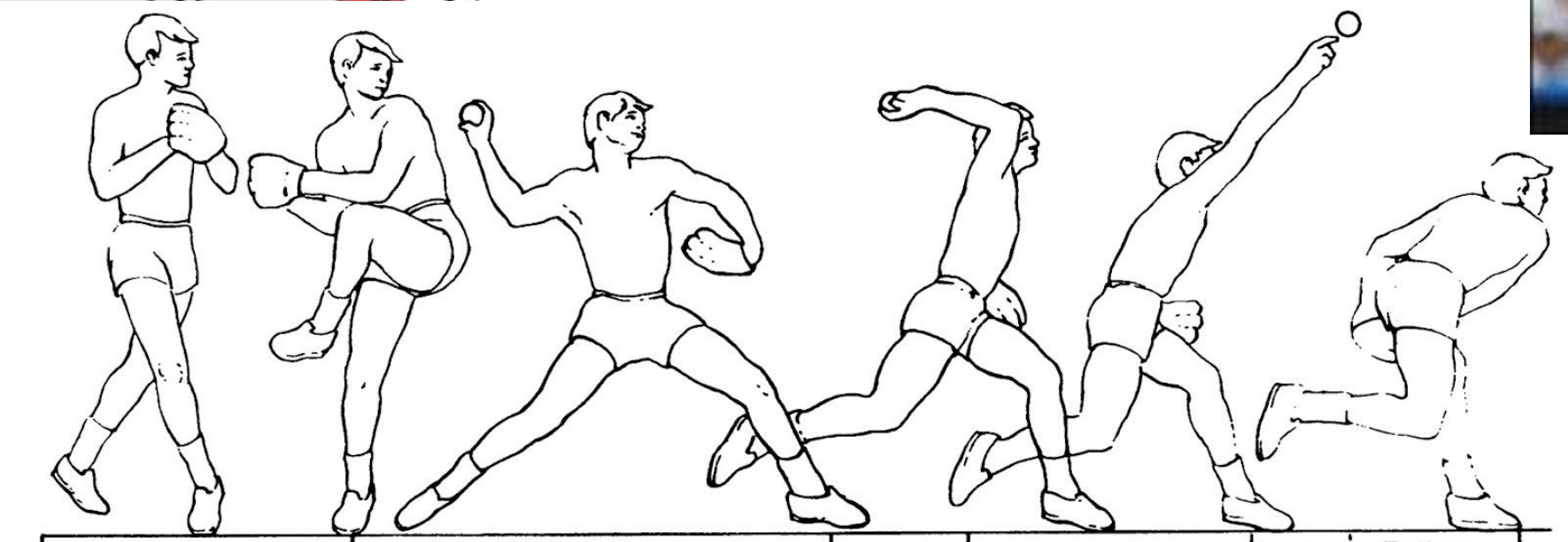
- Brachioradialis
- Extensor carpi radialis longus and brevis
- Extensor digitorum
- Extensor digit minimi
- Extensor carpi ulnaris
- Anconeus

Motions


Trapezius
Levator Scapulae
Serratus anterior (upper)
Rhomboids
Rotator cuff
Deltoid
Trapezius
Serratus anterior (lower)


Elevation
Downward rotation
Protraction
Retraction
Upward rotation
Depression


SCAPULOTHORACIC UPWARD ROTATION
GLENOHUMETAL ABDUCTION
UT
DEL
MT
LT

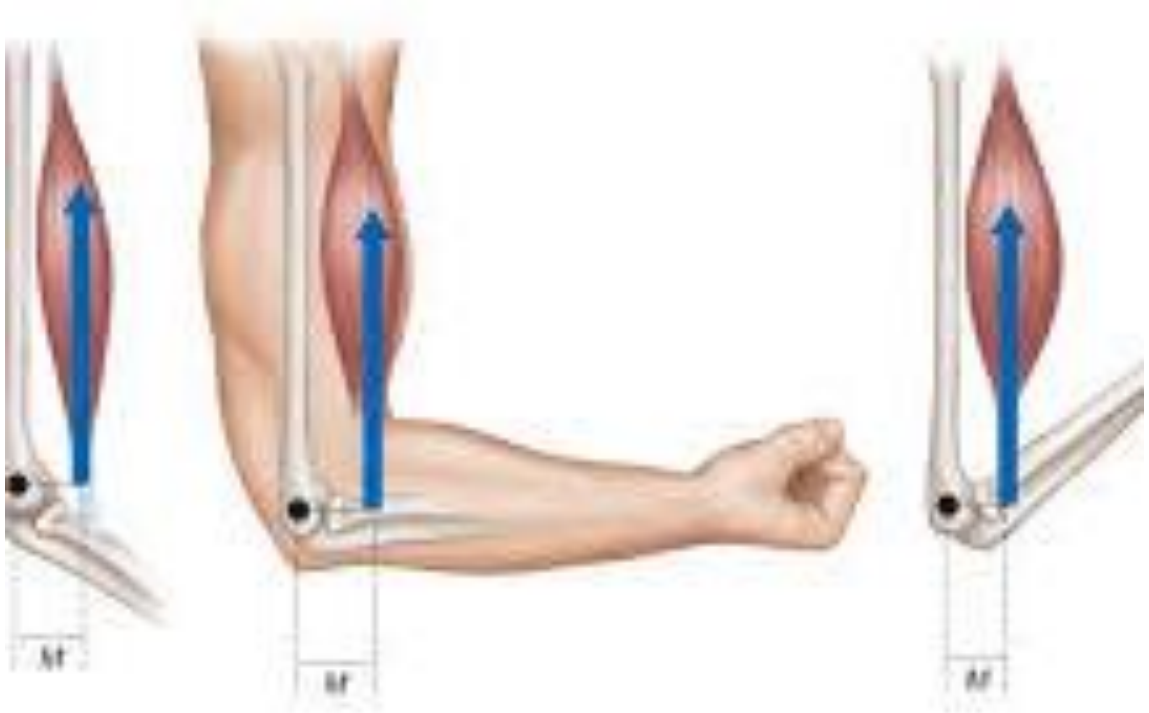

Wind-up
Early cocking
Late cocking
Acceleration
Deceler-ation
Follow-through
Start
Hands apart
Foot down
Maximum external rotation
Ball release
Finish

Elastic potential energy is the energy stored as a result of deformation of an elastic object, for example the stretching of a spring.

$$E_e = \frac{1}{2}ke^2$$

k = spring constant (N/m)

Remember that neural drive…?



- Centration (balance between force and form closure)
  - Tensegrity
  - “Centration is in the brain, not in the joint” ~Pavel Kolar (DNS)
- Stabilization
  - Maximize joint surface contact with muscular fiber overlap
- Efficiency

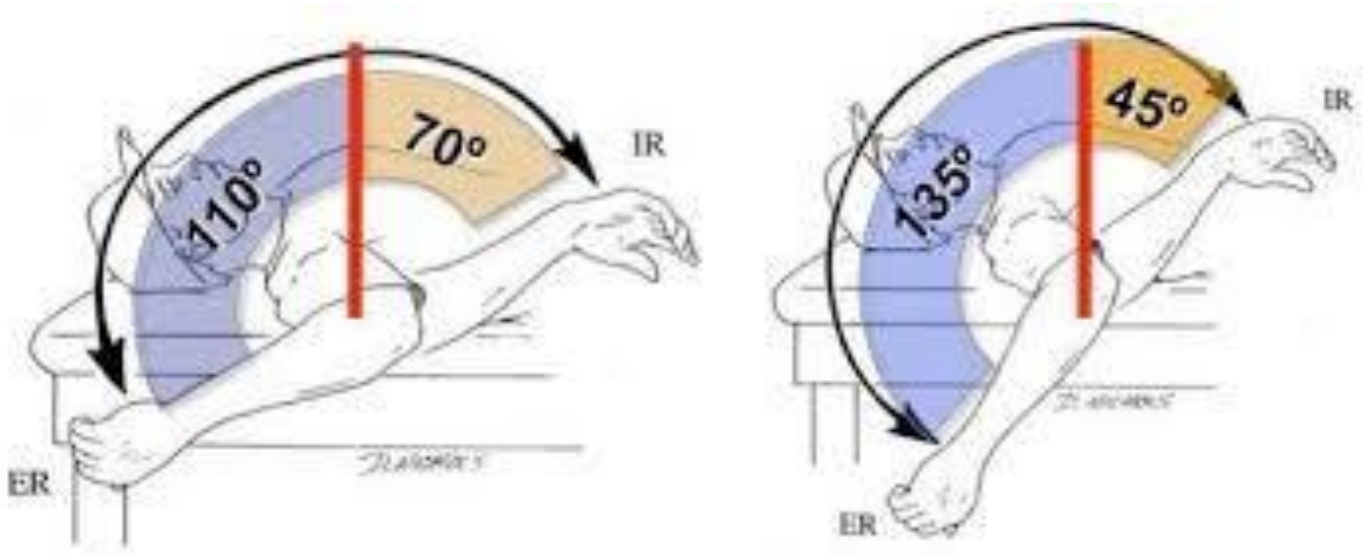
Upper Extremity

- Posture: Supination/Pronation, shoulder height, humeral int/ext rotation
- Gait:
  - Arm swing (lack thereof)
- ROM:
  - Scapulothoracic Motion
  - Glenohumeral Motion
  - Wrist motion & Palp
- Orthos:
  - Shoulder R/O – Hawkin-Kennedy, O'Brien, Codman,
  - Elbow R/O – Varus/Valgus, Cozen, Mills
  - Wrist R/O – Phalen/Prayer, Varus/Valgus

GIRD

- Adaptation to throwing – “Normal” in throwing sports
- Total loss of ROM in dominant arm

- **GIRD is a loss of internal rotation ROM in the presence of a loss of total rotational motion**



Shoulder Dysfunction Continuum

Adhesive capsulitis, degeneration, bursitis (subacromial), biceps tendinopthy

Road to Surgery

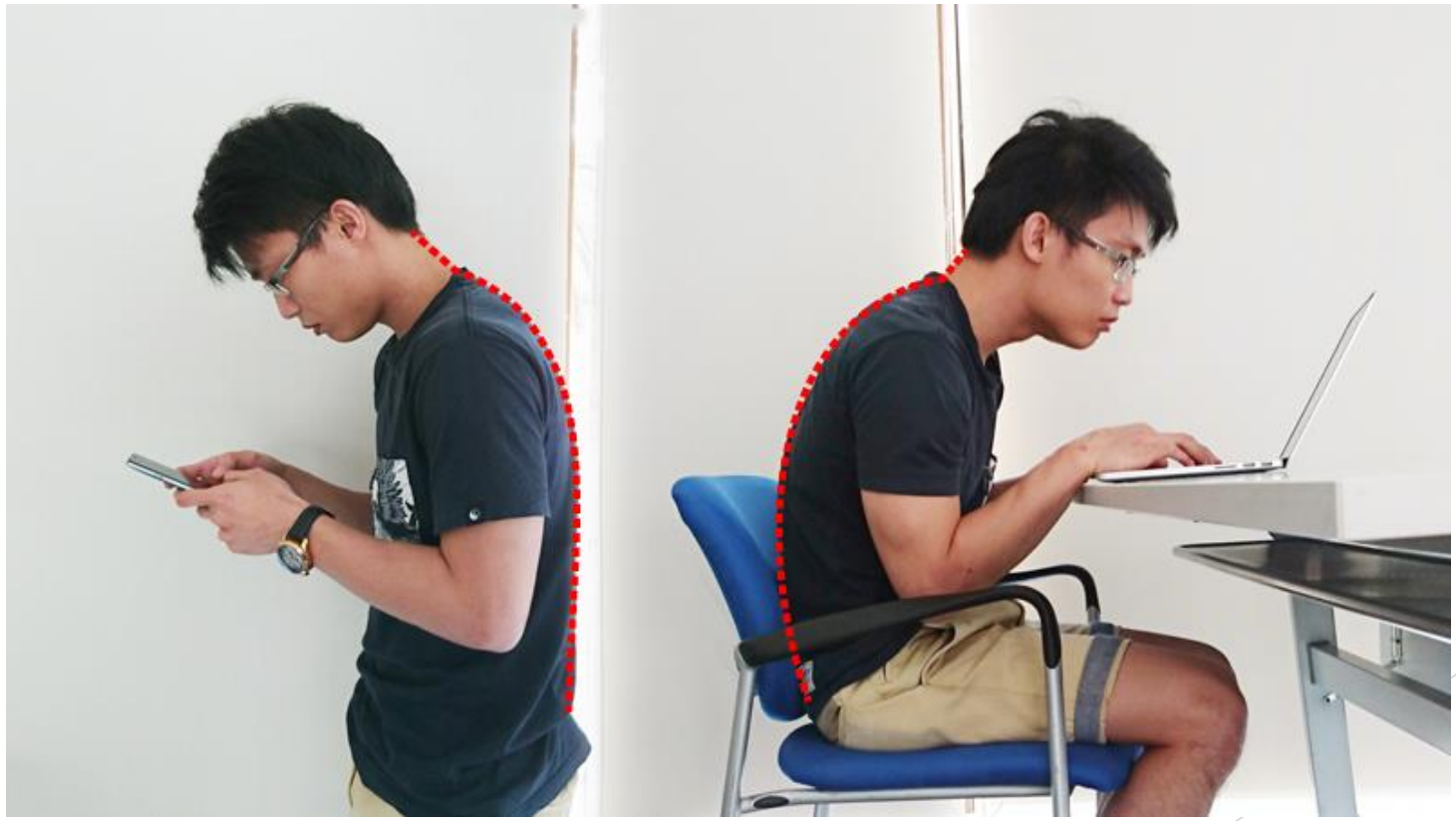
- Rotator Cuff Rupture
- Rotator Cuff Tear
- Anterior Impingement Syndrome
- SICK
- Scapular Dyskinesis

SICK scapula

- Scapula malposition
- Inferior angle prominence
- Coracoid tenderness
- dysKinesis

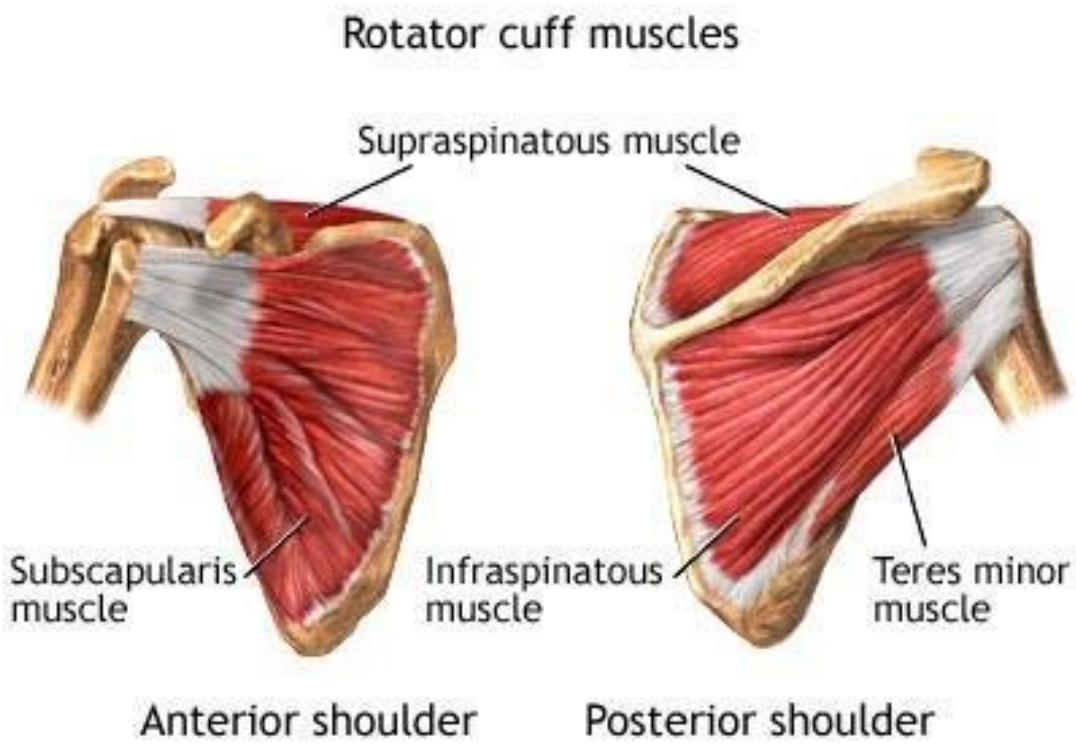
- Pain?

Upper Crossed Syndrome (again)
Anterior Impingement



RTC – Strains & Tears

- Impingement → irritation/inflammation RTC
- Start breaking down → Tears
- Training as Stabilizes… not ER!
- Get the earlier stuff moving!



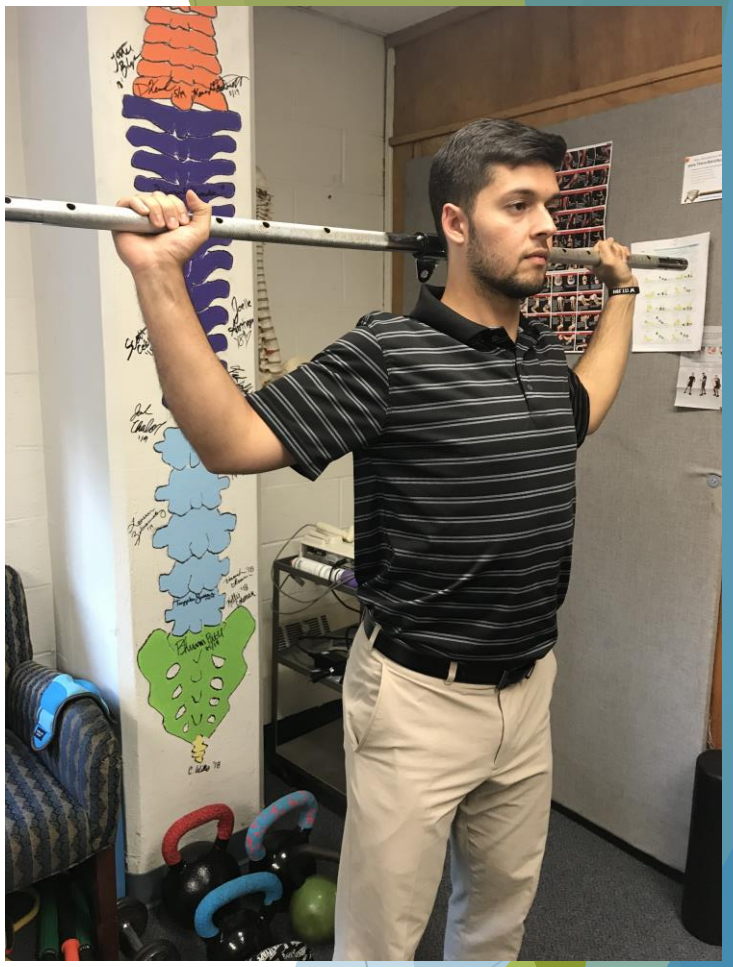
- Ongoing Rotator Cuff Pathology
- Trauma/Surgery
- Restricted Motion

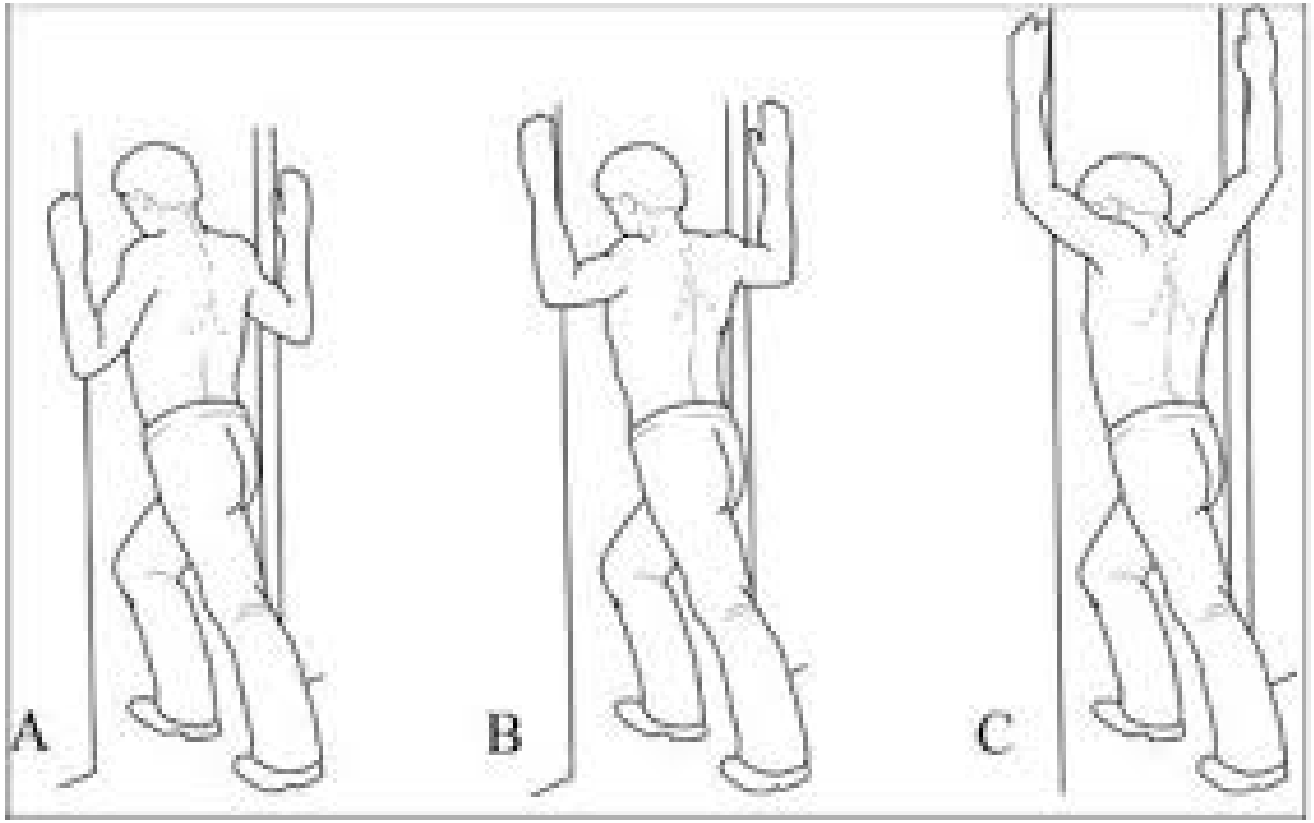
Adhesive Casulitis

Upper Extremity

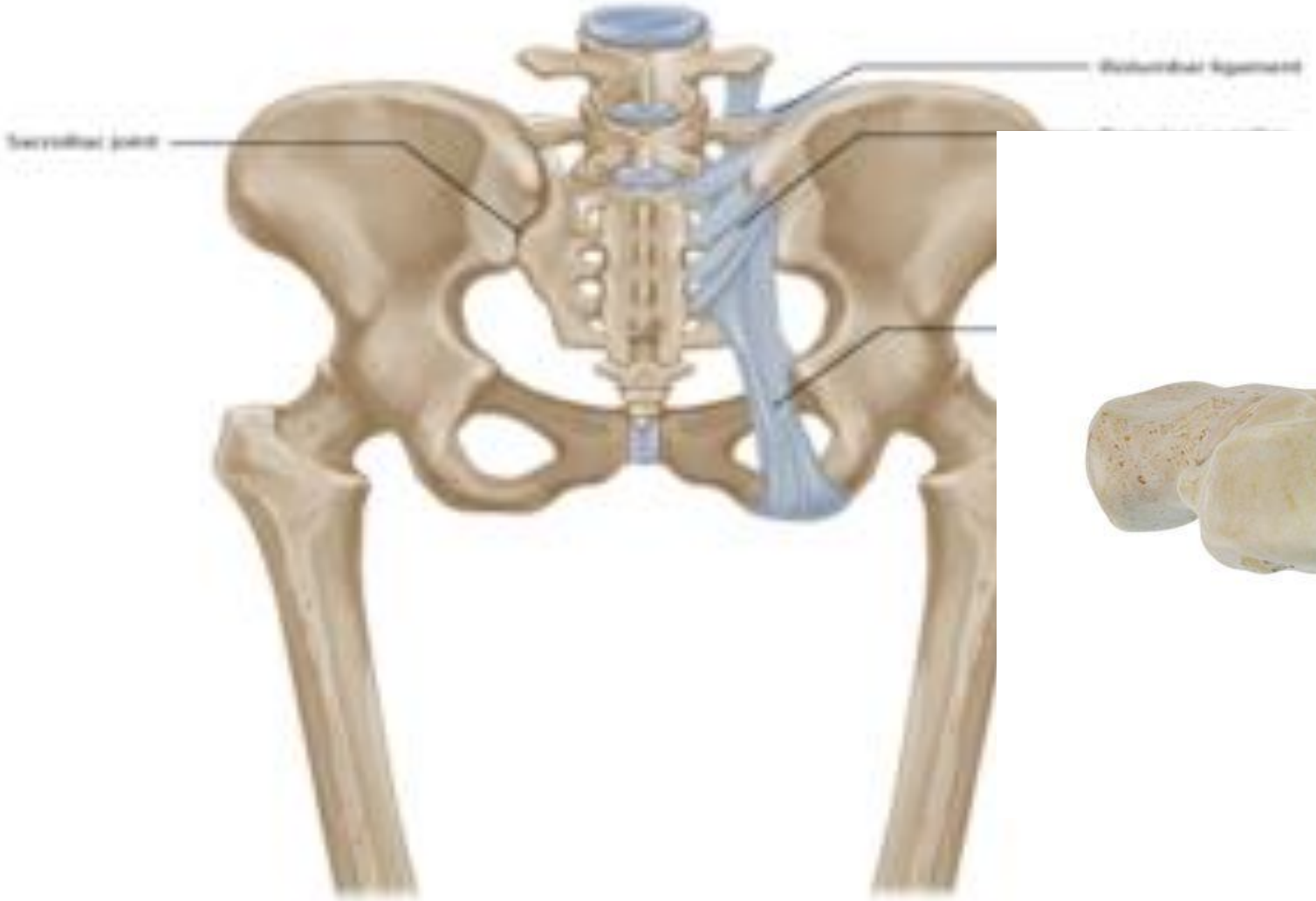
- Squat
- Push-Up
- Apley's
- Wall Angel
- Birddog
- Respiration

UE Stretches

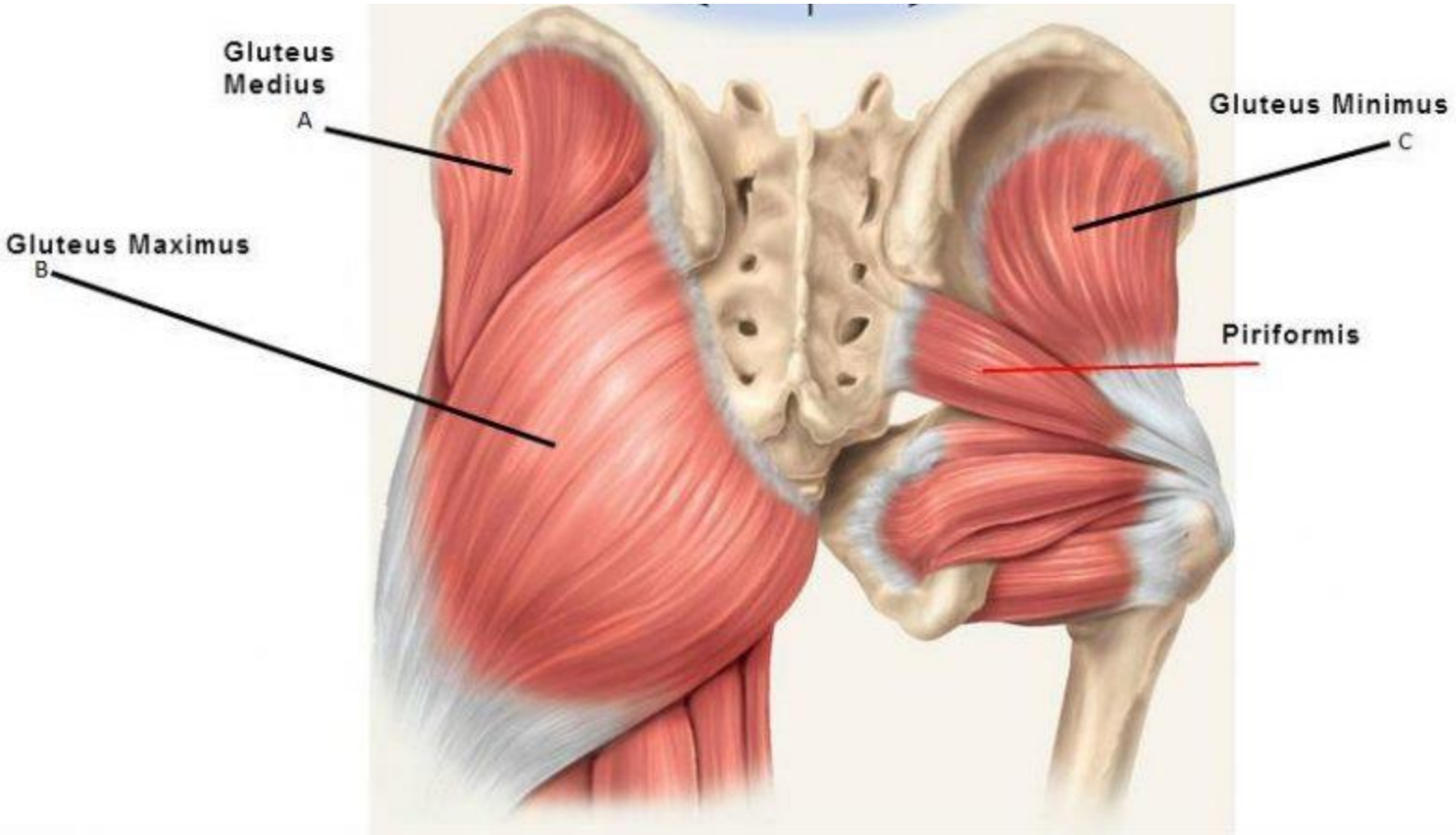


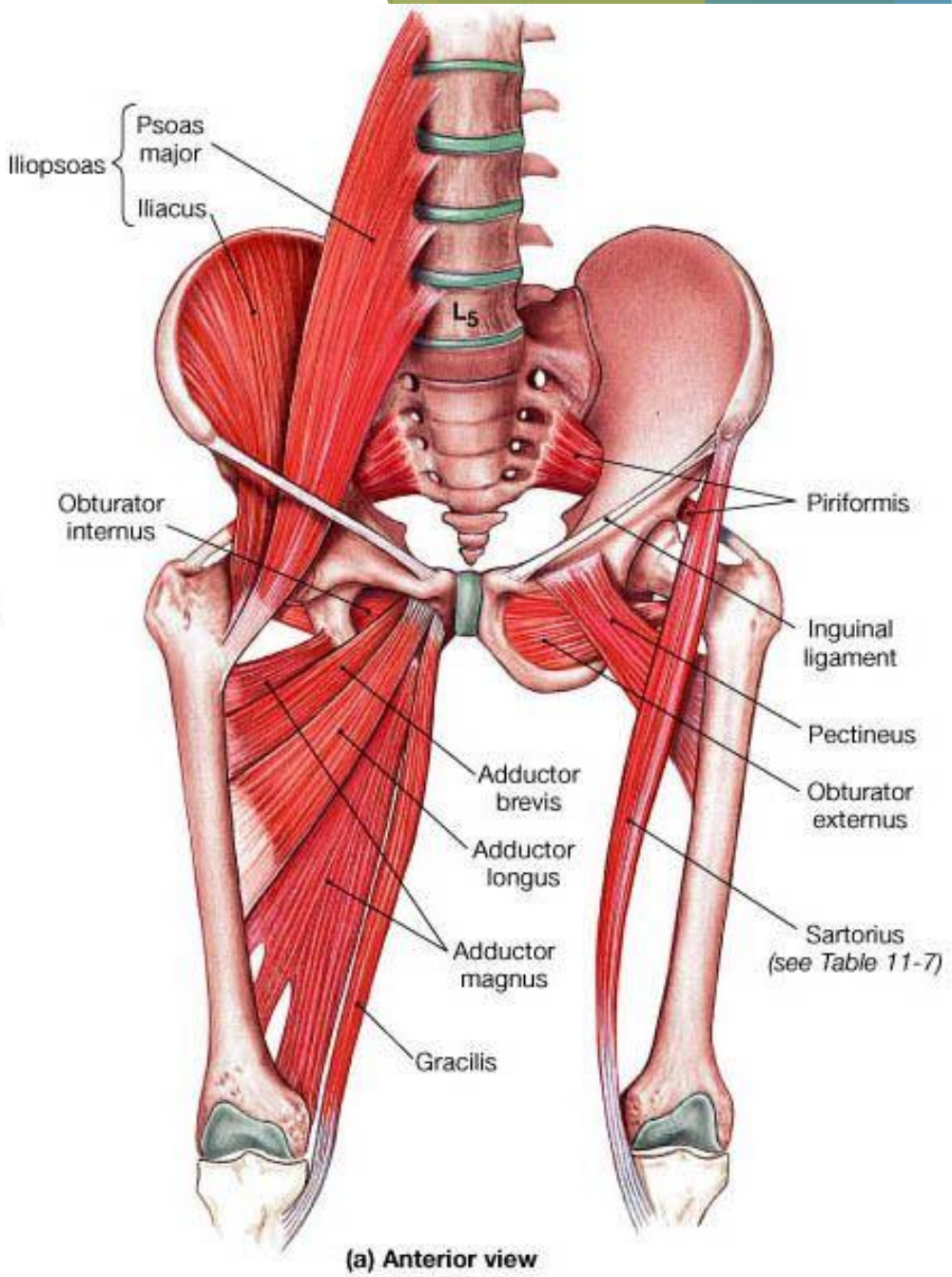


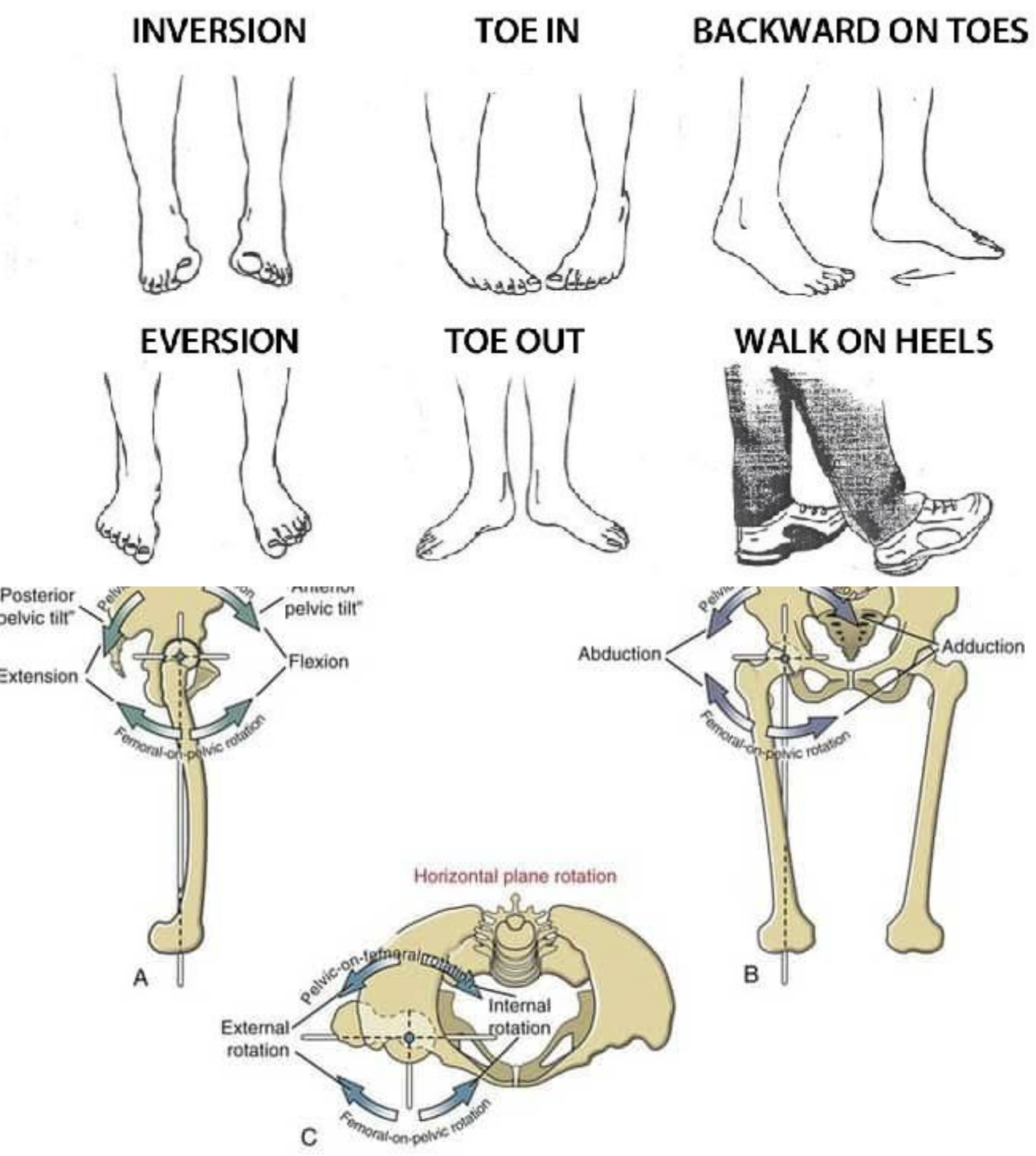
UE Strengthening



Muscles


Gluteus Medius
A
Gluteus Minimus
C
Gluteus Maximus
B
Piriformis


Iliopsoas
Psoas major
Iliacus
L5
Obturator internus
Piriformis
Inguinal ligament
Pectineus
Adductor brevis
Obturator externus
Adductor longus
Sartorius (see Table 11-7)
Adductor magnus
Gracilis
(a) Anterior view


INVERSION
TOE IN
BACKWARD ON TOES
EVERSION
TOE OUT
WALK ON HEELS
Posterior pelvic tilt"
Anterior pelvic tilt"
Extension
Flexion
Femoral-on-pelvic rotation
A
Abduction
Adduction
Femoral-on-pelvic rotation
B
Horizontal plane rotation
Pelvic-on-femoral rotation
External rotation
Internal rotation
Femoral-on-pelvic rotation
C

Motions

Lower Extremity

- Posture: Q-angle, varus/valgus, int/ext rotation, arches
- Gait:
  - Swing phase/Stance phase, pelvic motion
- ROM:
  - Hip ROM, Scour
  - Foot mechanics
- Orthos:
  - Hip R/O – SLR, Mod Thomas, FABER, FADIR
  - Knee R/O – Thessaly, Lachman, McMurray, Drawer,
  - Ankle/Foot R/O – Ottawa,

Painful SIJ?

- Typical SIJ tests?

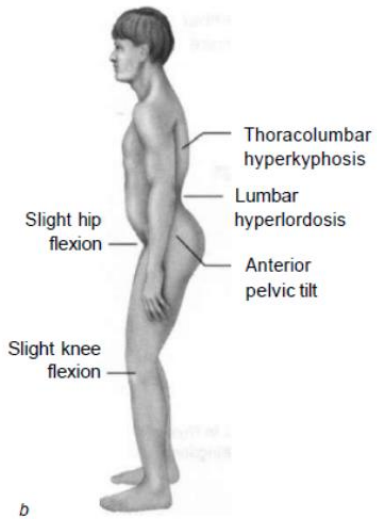
- Laslett's (2008)
  - Gaenslen*
  - Sacral Thrust
  - Thigh thrust / femoral shear test ** Kokmeyer et al
  - ASIS distraction (supine)
  - Sacral compression (sidelying)

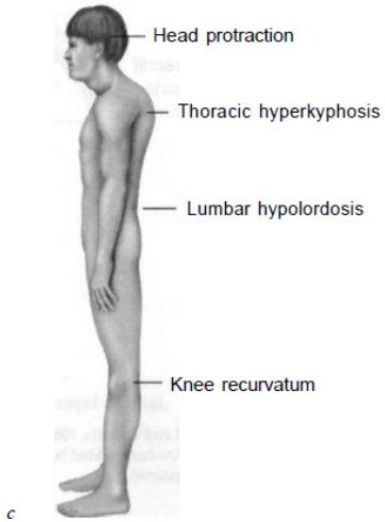
  - Van der Wurff et al report that if at least 3/5 of these tests were positive, there was 85% sensitivity and 79% specificity for detecting the SI joint as the source of pain.

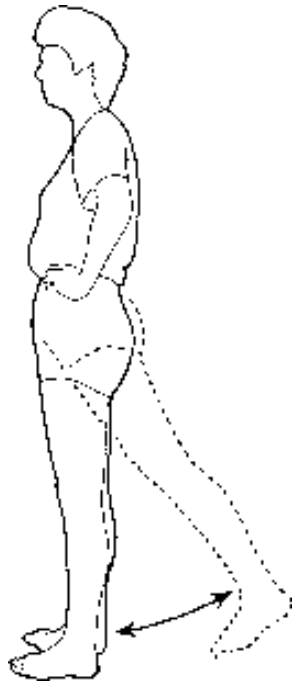
Lower Crossed Syndrome

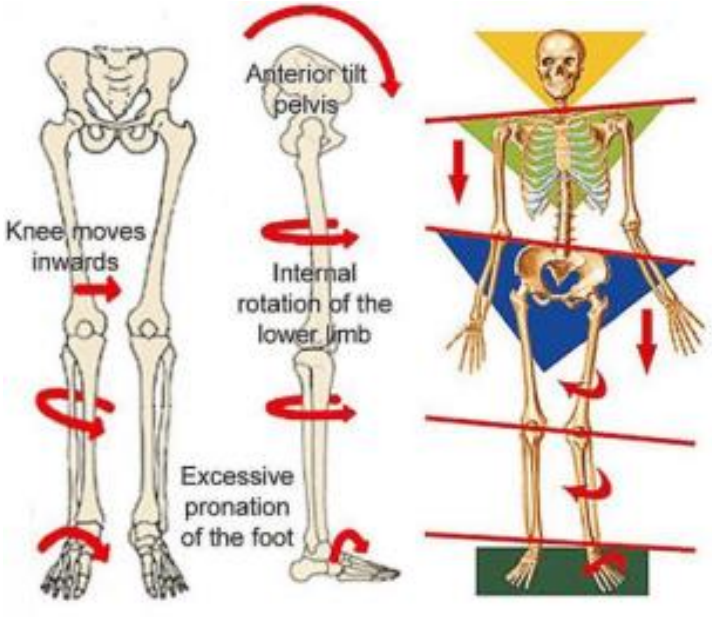
- Lumbopelvic region into lower extremity…
- Weak glutes as they relate to eccentric loading of the hip. Commonly seen with knee valgus in dynamic movement.
- Quad dominance related to function

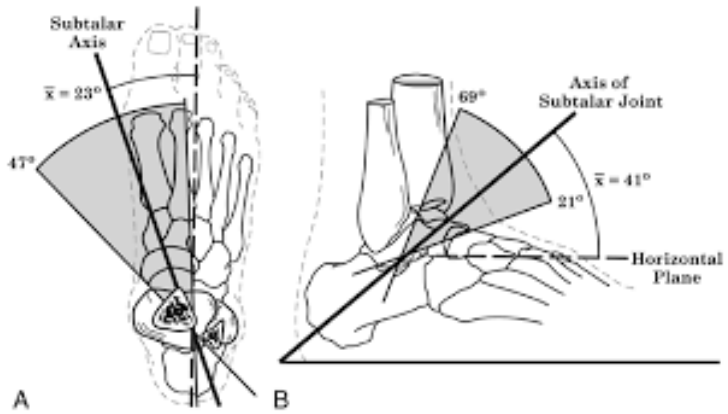
- Continuation of Pronation Distortion Syndrome?











Pronation Distortion Syndrome

Motions & Muscles

Shin Splints

- R/O Compartment Syndrome

- Anterior
  - Tibialis Anterior
  - Increased Stride → Maintained dorsiflexion
  - Tib Ant – Peroneal Stirrup – Spiral Line
  - Tx

- Posterior
  - Tibialis Posterior
  - Dropped arch → Overstretched muscles
  - Pronation Distortion Syndrome – FFL, DFL
  - Tx

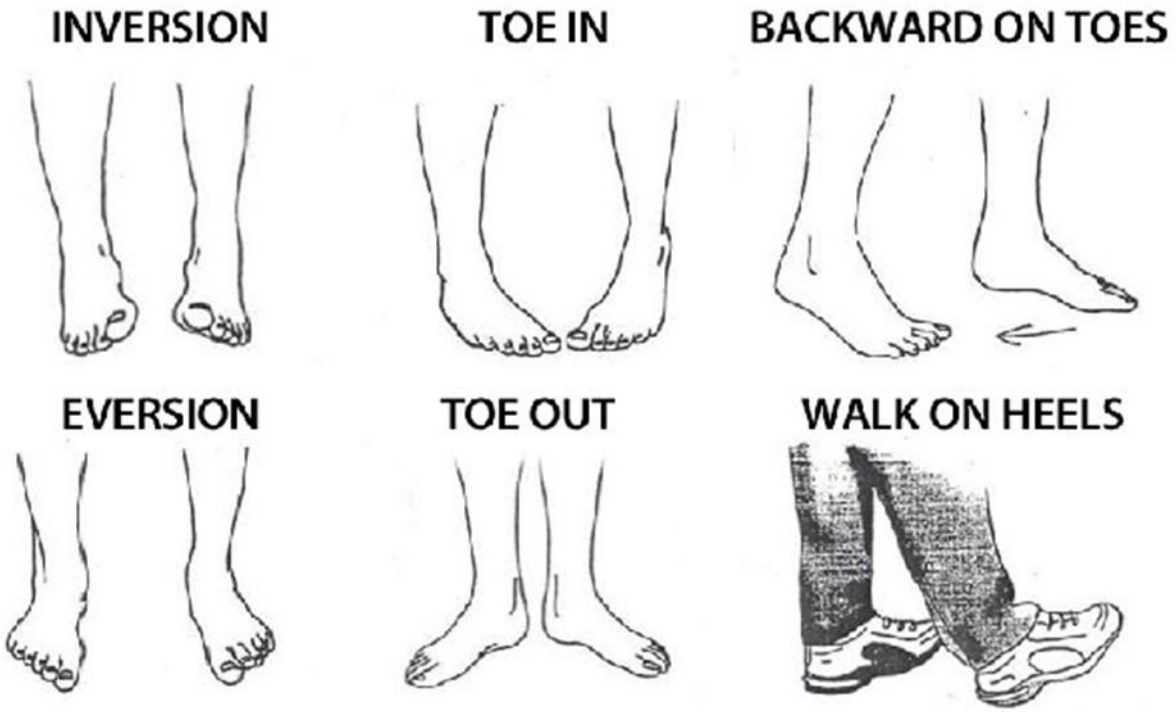
Time for Plantar Fasciitis?

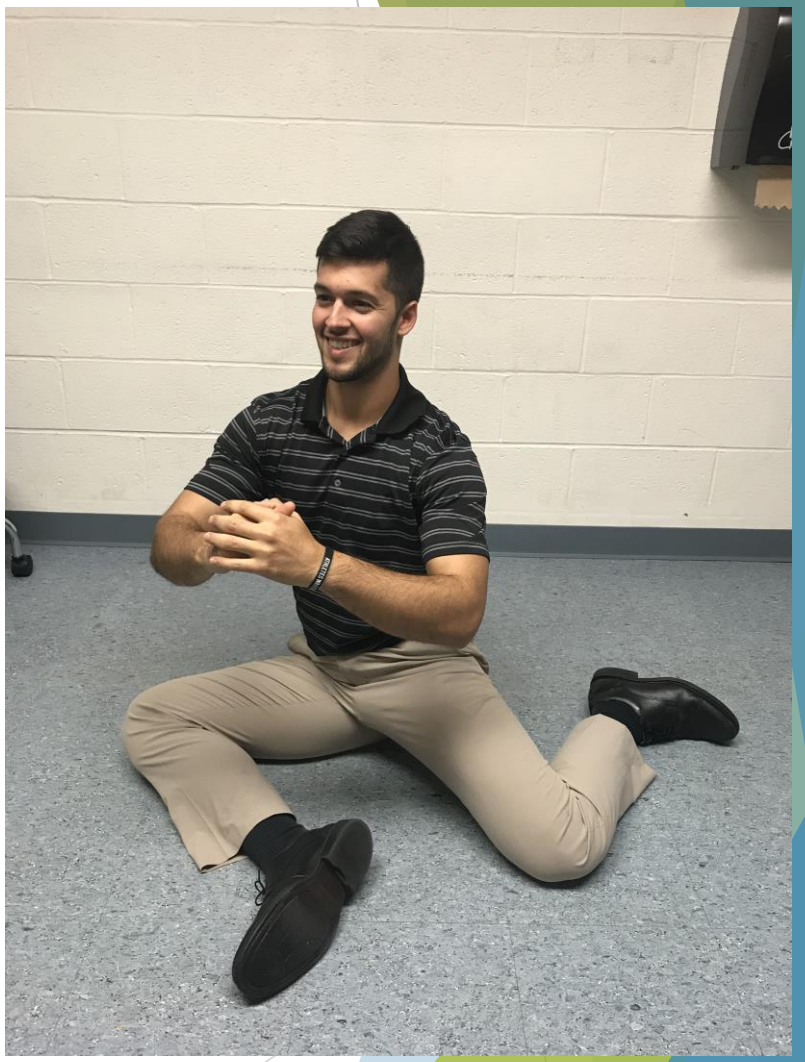
- Isn't NOT just the fascia
- Heel Spur
- Posterior Tibial Nerve/Tarsal Tunnel
  - Baxter's Neuropathy (Lateral Plantar Nerve)
  - Medial Calcaneal Nerve
- Flexor Hallicus Brevis
- Tx?

Lower Extremity

- Squat
- Single-Leg Stance
- Birddog
- Respiration
- Gait

LE Stretches



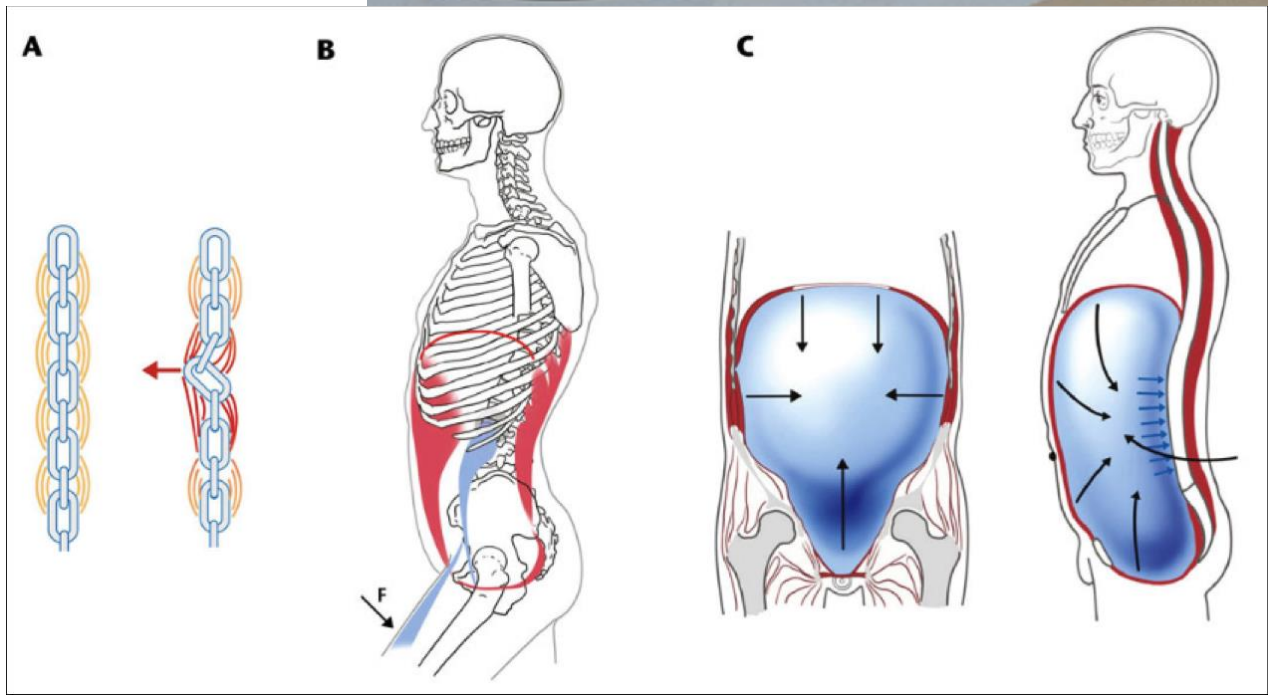


LE Strengthening

Core

- You can't fire a cannon from a canoe ~Charles Poliquin
  - Look for proximal issues as the root of distal problems
  - Will increase power of distal movements

- Stiffness appropriate to increase load bearing
- MVA & longus coli
- TVA
- Diaphragm

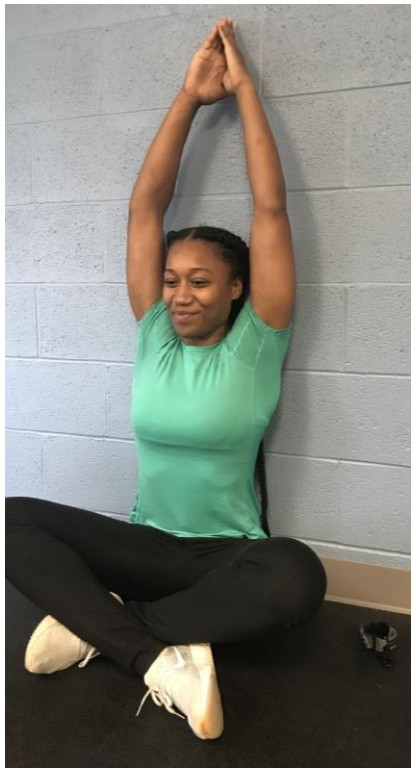
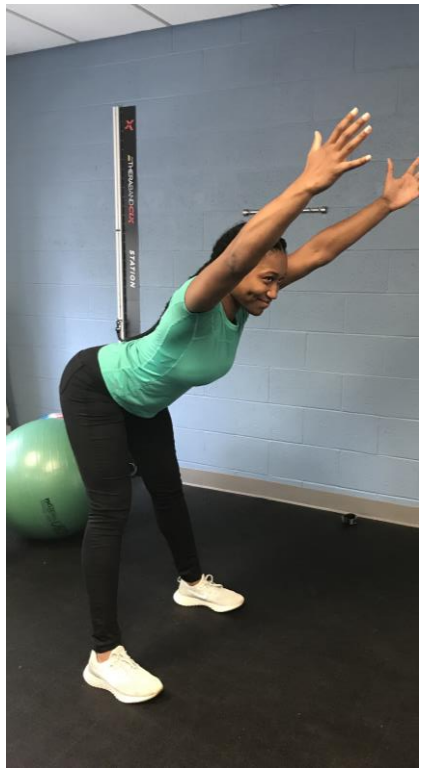


Putting it Together

- Squat Variations
- Turkish Get-Up
- Foundation Training
- ELDOA
- Yoga
- Crossfit

Rehab Club

BJJ


What happens on Monday?

Pick the assessment

- Start adding functional screens

Find the pattern

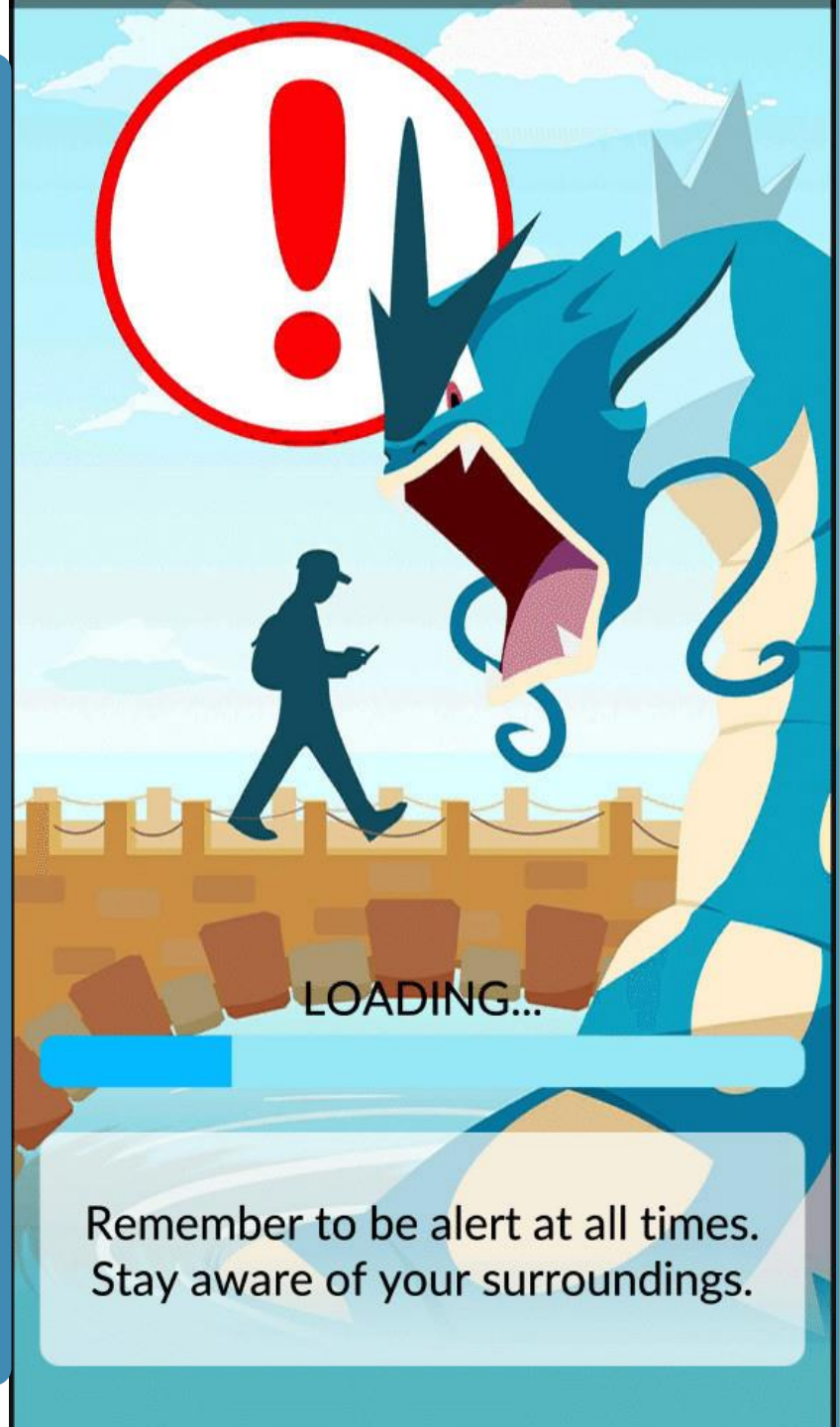
- Look at the full equation

Provide intervention

- Give 1-2 exercises addressing biggest issue!

Where observation is concerned, chance favors only the prepared mind.

~Louis Pasteur



Where else to look?

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@drdimond

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