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
Pathoanatomic diagnoses (nerve, disc, joint) are straightforward. Provide therapy to the source and its 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)
What's the plan?

- Rehab Fundamentals
- Body Design
- Movement & Training Considerations
- Screenings & Assessments
- Regional Implementation
- Spine
- Upper
- Lower
POLITE POLICE
Prevent, Proprioception
Optimal Loading
Instrumentation, Ice
Taping, Tech
Education, Ergonomics, Eat

Protect
Optimal Loading
Ice
Compression
Elevation
Rehab Pyramid
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
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

“Stiffness hides a stability problem and causes a mobility problem.”
- Gray Cook

[Image of a person performing a push-up on a balance board]
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?

- 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
  - Sacrotuberos lig.
- Sacrum
  - Sacrolumbar fascia, erector spinae
- Occipital ridge
Deep Front Line

Start at the Lowest Common:
- Lower Posterior
- Lower Anterior

Then:
- Lsp Vertebral Bodies (TPs)
- Upper Posterior
- Upper Middle
- Upper Anterior
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
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 between 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
What's the Basis of Prescription?

Slow Hold

Stretch

High Rep

1RM

Strength

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...
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
Fix yourself

- Remember how Rehab works

- Anything can be a screen (“Mechanical Sensitivity”)

- Take cues from your body
Integration

- Spine Integration (15 min)
  - What specific anatomy, assessment, lines are we observing?
  - Planes of Motion, DTA (Deceleration, Transition, Acceleration)

- Video/Demo (15 min)
  - Showing of the assessments and discussion of functional integration.

- Spine Cases (25 min)
  - NASM progression
Spine Motion

- Facet Orientation
Muscles
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- (-osis, -lothisthesis, etc)

- Improve engagement in direction of benefit
Lower Crossed

- Thoracolumbar hyperkyphosis
- Lumbar hyperlordosis
- Anterior pelvic tilt
- Slight hip flexion
- Slight knee flexion
- Head protraction
- Thoracic hyperkyphosis
- Lumbar hypolordosis
- Knee recurvatum
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 T spine. 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, bruegggers,
- 1RM rows, push, pulls
Preguntas?
ROUND 2
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

IT'S ALL CONNECTED!
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

What’s the Basis of Prescription?

High Rep

Endurance

1RM

Strength

Stretch

Strength
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
Muscles
Muscles

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

Legend:
- Brachioradialis
- Extensor carpi radialis longus and brevis
- Extensor digitorum
- Extensor digit minimi
- Extensor carpi ulnaris
- Anconeus
Motions
Elastic potential energy is the energy stored as a result of deformation of an elastic object, for example the stretching of a spring.

\[ E_e = \frac{1}{2} k e^2 \]

\[ k = \text{spring constant (N/m)} \]
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

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

Adhesive capsulitis, degeneration, bursitis (subacromial), biceps tendinopathy
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!
Adhesive Casulitis

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

- Squat
- Push-Up
- Apley’s
- Wall Angel
- Birddog
- Respiration
UE Stretches
UE Strengthening
Muscles

- Gluteus Medius (A)
- Gluteus Maximus (B)
- Gluteus Minimus (C)
- Piriformis

- Iliopsoas
- Psoas major
- Iliacus
- Obturator internus
- Piriformis
- Sartorius
- Adductor brevis
- Adductor longus
- Adductor magnus
- Gracilis

(a) Anterior view
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 $\rightarrow$ Maintained dorsiflexion
  - Tib Ant - Peroneal Stirrup - Spiral Line
  - Tx

- Posterior
  - Tibialis Posterior
  - Dropped arch $\rightarrow$ 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

INVERSION  TOE IN  BACKWARD ON TOES

VERSION  TOE OUT  WALK ON HEELS
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
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
Thanks!

Where else to look?
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