Musculoskeletal Management of The Foot / Ankle From “Inside to Outside the BOX”: A Functional Examination and Intervention Model

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Educational Objectives
1. Identify the pathomechanics of common musculoskeletal foot/ankle pathologies.
2. Demonstrate specific examination procedures that can be integrated into your clinical toolbox.
3. Present clinical decision making tools that can enhance clinical practice patterns.
4. Explore regional interdependence applications to select pathologies, and identify the meaningful impairments that contribute to movement dysfunction.
5. Demonstrate specific manual and neuromuscular skilled interventions that can be integrated into your clinical practice.
6. Discuss current best evidence for physical therapy interventions for selected foot and ankle pathologies.
7. Identify potential “red flags” in patients with foot and ankle pathology who require referral to a physician in a direct access.

Background

Current Appointment:
Clinical Assistant Professor
Lebanon Valley College
– DPT Program
Orthopedic Specialization Academy of Content Experts (SACE)

Major League Baseball
– Spring Training 2012
Staff PT: 84 Lumber PGA Event
Staff PT: LPGA Betsy King Classic
Mentor Orthopedic Residency

Course Overview Part I:
Examination “Inside the Box”

Medical Screening
Differential Dx
Key Findings / Clinically Meaningful Impairments

Clinical Presentation
Pathomechanics / CDM

Course Overview Part II:
Examination “Inside the Box”

Medical Screening
Differential Dx
Key Findings / Clinically Meaningful Impairments

Clinical Presentation
Pathomechanics / CDM
Course Overview Part I: Examination “Outside the Box”

Core Stability Testing
Key Movement Patterns Assessment
Balance Testing

“The whole of science is nothing more than the refinement of everyday thinking”
- Albert Einstein

The New York Times

“There is a growing body of evidence that supports what physical therapists do but there is a lot of voodoo out there too”  James Irrgang, PhD, PT

PARADIGM SHIFT

- Traditional “Root” classification of foot type falling out of favor
  - Poor inter-rater reliability for identification of STJ neutral
  - Traditional measurements used in a biomechanical evaluation have poor inter-tester reliability
- Foot Posture Index
  - Quantify observed foot posture
    1. Supinated
    2. Pronated
    3. “normal”
- Mild PRONATION is “normal”

Originally Describe: THE FOOT POSTURE INDEX® (FPI-6)
Quick FPI Score

NOT SHOWN
1. Talar Head Prominence: +2 (Medial Prominent not Lateral)
2. Arch Height: Severely Flat: +2

Do We Observe Common Themes ???

“Intrinsic risk factors that have been associated with Achilles tendon disorders include abnormal ankle dorsiflexion range of motion, abnormal subtalar joint range of motion, decreased ankle plantar flexion strength, increased foot pronation, and associated diseases. It is theorized that the etiology of chronic tendon disorders results from an interaction of both intrinsic and extrinsic factors.”

Heel Pain—Plantar Fasciitis:
Clinical Practice Guidelines
Linked to the International Classification of Function, Disability, and Health from the Orthopaedic Section of the American Physical Therapy Association.

“Ankle dorsiflexion, obesity, and work-related weight bearing were reported to be independent risk factors, reduced ankle dorsiflexion appeared to be the most important.”


……“During subsequent heel-rise, the midfoot remains unlocked and flexible. The plantar ligaments of the midfoot then are subjected to the forces generated by the gastrocnemius-soleus complex and body weight. Over time, these medial soft-tissue longitudinal arch restraints become attenuated”……“Loss of the longitudinal arch results in a fixed equinus deformity of the hindfoot and contracture of the Achilles tendon.”
EQUINUS: The Root of all EVIL

Outcomes Measurement Tools

Foot Function Index
- Commonly though as disease specific to RA
- NOTHING is specific to RA in the tool
- 23 total items / 3 subscales
  - Activity limits
  - Disability
  - Pain
- VAS used to score
- Lower score equates to a higher level of function

Foot and Ankle Ability Measure
- 2 separately scored subscales
  - 21 item ADL
  - 8 item Sports
- Higher Score represents higher level of ability

Outcomes Measurement Tools

PTTD: Posterior Tibialis Tendon Dysfunction
- Progressive collapse of medial arch, calcaneal valgus and forefoot abduction
- Similar to Achilles and Plantar fascia, histologically we see alteration of normal parallel collagen bundles
- Typically Classified in 3 stages: what to look for
  1. Pain and tenderness along PT and at navicular. Normal alignment of forefoot and rearfoot
  2. Enlarged and elongated Post. Tib. Foot deformity present (but is flexible). Painful/weak inversion contraction. Poor function
  3. Fixed Pes Planus. Heel does not invert with heel raise. Weak or NO Inversion / Post tib. contraction

Posterior Tibialis Tendinopathy
Achilles Tendinopathy
Plantar fascitis
Ankle Sprains

MARTIN RL, IRIGANG JJ. A SURVEY OF SELF-REPORTED OUTCOME INSTRUMENTS FOR THE FOOT AND ANKLE. JOSPT 2007,37:72-84

Table: Self-reported outcome instruments with evidence to support their use for assessing the effects of treatments and conditions in the foot and ankle related to foot and ankle, lower extremity, and related disorders.

PTTD: Posterior Tibialis Tendon Dysfunction

Proper collapse of medial arch, calcaneal valgus and forefoot abduction
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Foot Function Index
Lower score equates to a higher level of function

Foot and Ankle Ability Measure
Higher Score represents higher level of ability
Key Examination Components

- t.t.p along post-tibialis and/or navicular / Swelling
- Painful resisted inversion contraction
- Assess medial arch collapse / “too many toes sign”
  - Foot Posture Index Score- Baseline
- Single leg heel raise test
  - Able /unable
  - Does the heel invert
  - Is substitution present
- STJ mobility Assessment
  - Flexible vs. Rigid deformity
- Lack of DF mobility leads to mid-tarsal collapse

Assessing Strength and Function

Women With Posterior Tibial Tendon Dysfunction Have Diminished Ankle and Hip Muscle Performance

Reduced Peak Hip Abductor (34%) and Hip Adductor (30%) strength in women with PTTD
compared to age-matched Controls!!

Evaluation should include assessment of hip strength!!
Achilles Tendinopathy
Key Exam Components

- Central 1/3 vs insertion
  - Implications
  - Diabetes history
  - Tendon enlargement
  - Haglund's deformity present?
- Dorsiflexion mobility
  - Gastrocnemius vs. Gastrosoleus
  - Posterior capsule tightness
  - Closed chain Assessment / Lunge test
- Objectively Quantify Strength
  - Single foot heel raise test for gastro/soleus strength 20=N, 15=G, 10=F, 5=P, 1=T, 0=0
  - Must consider age and sex. Older patients and Females do not score as well on this functional measure (Mei-Hwa et al., 2005 PT Journal)
- Gait
  - Lack of tibial advancement / poor push off

Lunge Test

Provides reliable measure of ankle DF mobility in closed chain using any of 3 methods

Plantar Fasciitis

- Largest predictive factors for plantar fasciitis:
  - Lack of DF and Obesity
  - Limited Evidence to support “foot type as a predictor for Plantar fascitis
  - Lack of ankle DF mobility = Increased mid-tarsal pronation / “pronatory Stress”
  - “Fasciosis” probably a better term
  - 50 samples following following plantar fascia surgery
  - ZERO showed evidence of inflammatory process

Plantar Fasciitis Examination

Heel Pain Guidelines JOSPT 2008

- DF ROM
- Windlass
- DF–Exursion Test (to/r/o Tarsal Tunnel
- Longitudinal Arch Angle (LAA)

R/O: Tarsal Tunnel or Baxters neuritis
- Less complaints of post static pain
- Increased pain as day and WB stress progresses
- Often have persistent pain at rest

- Measure DF ROM mobility
- Assessment of posterior capsule mobility
- Palpation at medial calcaneal tubercle as well as along fascia
- BEWARE: High Arch with Full DF mobility!!!!

Atypical Heel Pain

What about a spur???
- Psychological implications
- Are X-rays necessary??

No significant difference in Ankle Dorsiflexion ROM gains when stretching with foot in supination or pronation

…..Investigators did not attempt to investigate the effects of STJ position and “stress” or joint reaction forces at other joints—clinical judgment should prevail

Subtalar Joint Position During Gastrocnemius Stretching and Ankle Dorsiflexion Range of Motion

Marie Johnson, PhD, PT, OCS; Jennifer Baer, MPT; Holley Hovermale, DPT; Phouvy Phouhavong, MPT

Georgia University School of Medicine, Athens, GA

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Plantar Fasciitis

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ANKE SPRAINS
EXAM

ANKLE SPRAINS
EXAM

R/O : High Ankle (Syndesmotic)
Sprain

Ankle Sprain Exam Concepts

- **Delayed Physical Examination >48 hrs more sensitive**
  - Hematoma w/ positive laxity tests increases likelihood of a tear
- **Limited DF mobility?**
  - Predictive factor for injury
- **Impaired balance and proprioception**
  - Predictive factor for injury
  - SLS time, Biodex Balance test, Hop test
    - MUST be performed with respect to tissue healing
- **Medial Sided pain**
  - Bone Compression / Impact
- **Peroneals**
  - Strength, endurance and reaction/response time

Movement Quantity vs QUALITY

- **What is the better question?**
Neuro-Developmental Perspective

- The Neuro-Developmental Perspective has taught us that movement was developed in patterns not in individual muscles.

Regional Interdependence

- Biomedical model of managing impairments may not be adequate for most common non-operative musculoskeletal disorders
- Regional interdependence
  - Concept that seemingly unrelated impairments in a remote anatomical region may contribute to, or be associated with, the patient’s primary complaint

Operational Definitions

- **MOBILITY** (b710):
  - is the creation of unrestricted active functional movement in the presence of normal muscular strength and joint stability.
  - *Gray Cook 1999*
### Operational Definitions

**STABILITY (b715):**
- Is the active muscular control exerted on a joint to redirect force and control movement in the presence of normal muscular flexibility and joint mobility.

  — Gray Cook 1999

### Mobility / Stability Paradigm:
**Formula for Optimal Movement for Lower Quarter**

<table>
<thead>
<tr>
<th>CKC Dorsiflexion Mobility</th>
<th>Core/Gluteal Stability</th>
<th>Lower Extremity Dynamic Balance/Stability</th>
</tr>
</thead>
</table>

### Meaningful Impairments and Movement Dysfunctions

**Paradigm Shift**

**Historical Perspective…………….Why Movement?**

- “The motor system functions as an entity, it is in principle a wrong approach to try to understand impairments of different parts of the motor system separately, without understanding the function of the motor system as a whole.”

  — Janda ’64

“Consistent with the identification of changes in motor planning, there is compelling evidence that pain has strong effects at the supraspinal level. Both short- and long-term changes are thought to occur with pain in the activity of the supraspinal structures including the cortex”.

  — Richardson and Hodges ’04

Injury \[\rightarrow\] Pain

Altered Motor Control
“Learned” Movement Patterns

- In May 2008, Farquhar et al: Subjects with TKA’s showed improved quadriceps strength from 3 months to 1 year - however continued to demonstrate a compensatory movement pattern with the sit to stand task.
- The compensatory movement pattern included increased weight bearing on the uninvolved limb and relied more on increased hip flexion and hip extensor moment to perform the sit to stand task.

Meaningful Impairments and Movement Dysfunctions

Additionally, if normal dorsiflexion range of motion is not available at the talocrural joint, it will be gained at the subtalar joint during weight bearing (17). This excess dorsiflexion at the subtalar joint simultaneously yields compensatory pronation of the subtalar joint, resulting in medial rotation of the tibia and the requisite medial rotation of the femur. As a result, lateral patella dislocation is a concern.

Farquhar SJ, Reisman, DS, Snyder-Mackler Lynn (2008); Persistence of Altered Movement Patterns During a Sit to Stand Task 1 year Following Bilateral Total Knee Arthroplasty Phys Ther Vol 88, Number 5 567–579

Impairments, Regional Interdependence, & Movement Dysfunction

1. Less Hip ER strength (stability) & Less Dorsiflexion ROM (mobility) resulted in an increase in Frontal plane excursion of the knee
2. Altered transverse plane knee mechanics in Runners with Achilles tendonopathy

Proximal Muscle Timing in CAI

Significant EMG latency differences were found in gluteus medius with inversion perturbation

Significantly delayed onset times for the ankle, hip, and hamstring muscles compared with control subjects

(in transition from double limb to single limb stance)

Beckman & Buchanan 1995, Van Deun 2007

Changes in Proximal Joint Motion & Strength after Ankle Sprain

- Decreased hip and knee joint angles and decreased reach distance with SEBT
- Delay in onset of activation of the gluteus maximus in previously injured subjects
- Decreased hip abduction and extension strength in CAI

Movement Assessment
“METRICS”

Building upon Fundamental Movement Patterns...exploring Functional Thresholds

Interpreting the Results

- Did it produce pain?
- Is the pattern asymmetrical?
- For unilateral active movements, if the motion is equal - is the effort or perceived exertion equal?
- Does it fall under the norms of clinical experience for your patient?

Quadruped Core Stability Screen

Advanced Basic

Squatting Pattern

The Deep Squat is used to assess bilateral, symmetrical mobility of the hips, knees, and ankles.

Combined with the hands held overhead, this test also assesses bilateral, symmetrical mobility of the shoulders as well as extension in the thoracic spine.

Squat Pattern

Squat Movement Pattern
Lunge Movement Pattern

Single Leg Stance

- Have them lift their right leg up until their hip & knee are both at 90°.
- Have them maintain good posture & balance for 10 seconds.
- Repeat on the other leg.

Look for player losing height or slumping forward when they go from double leg to single leg stance.

FN: Stable x 10" without pain
FP: Stable x 10" with pain
DP: Unstable < 10" with pain
DN: Unstable < 10" without pain

Y Balance Testing

Posterolateral

Anterior

Posteromedial

Hertel 2007 & Plisky 2006
YBT Strengths

- YBT measures a different construct of movement.
- Rather than breaking movement patterns down into components, it puts many of them together.
- This makes the YBT powerful as it measures comprehensive movement harmony.

Learn more about the Y Balance Test by taking the free home study course & certification at www.Ybalancetest.com

Power, Speed, Agility Testing for Durability

- Jump Landing Assessment
- Vertical Jump
- 40 yd Dash
- T-test, etc
- One Leg Hop Assessment
- Other??

LOCALIZED TREATMENT / INTERVENTIONS

Achilles Tendinopathy
Posterior tibialis tendon dysfunction

EdUReP

Educate
Unload
Reload
Prevention

Unloading

- Heel Lifts
- Unna Boot
- CAM Walker
- Lace-up Braces
- Tape
- Orthotics
FOOT ORTHOTICS
20-60-20 Rule

…my 2 cents. Not a Discussion for TODAY!!!!

Reloading
Kulig K, Reischl SF, Pomrantz AB, Burnfield JM, Mais-Requejo S, Thordarson DB, Smith RW. Nonsurgical management of posterior tibial tendon dysfunction with orthoses and resistive exercises: a randomized controlled trial. Phys Ther Jan 2009

Conclusion: People with early stages of tibialis posterior tendinopathy benefited from a program of orthoses wear and stretching. Eccentric and concentric progressive resistive exercises further reduced pain and improved perceptions of function.

➢ Eccentric group had the most improvement in each outcomes measure (FFI, 5 min walk distance and pain)

INCREASED POST. TIB. EMG ACTIVITY
UNPUBLISHED FINE WIRE EMG DATA KORNELIA KULIG, PhD, PT
Alfredson’s protocol

- Eccentric Gastroc and soleus only
- 3 sets of 15 reps twice daily, 7 days/week
- Essentially ignores pain: patient MUST buy in !!!!
  - Add resistance once exercise becomes easy
- Eccentric Strain helps to remodel the degenerative portion of the tendon

Insertional Achilles pain Vs. Central 1/3

- INSERTIONAL Achilles tendinopathy MUCH harder to manage
  - Eccentrics NOT as Effective
  - Less-Aggressive DF stretching early on (may irritate Bursae)
  - Mobilizations: MWM, Posterior glides, fibular mobs
  - Posterior heel spur / Haglunds deformity
  - Longer Immobilization period???
  - Iontophoresis with dexamethasone
    - Dosing: Not defined in the literature

- Central 1/3: Use the Evidence!!!!
  - Eccentric resistance
  - Restore DF Mobility
    - Posterior talur glides, Fibular mobilization (anterior glides), Mulligan MWM
Potentially NOT a good Candidate !!!!!

Who is most likely to “buy in”

High rate of recurrent problems in pt’s with tendinopathy

Optimal preventions programs have not been described in the literature

-MODIFY Training if appropriate

-Must continue Flexibility and Resistance TE’s.

-ORTHOTICS??

Manual therapy and exercise is a superior management approach over electrophysical agents (US, Iontophoresis and Ice) and exercise in management of patients with plantar heel pain (4 week and 6 month follow-up)

Summary: Plantar Fascitis

1) Control Pronation with taping and Orthotics
2) Restore DF mobility to decrease mid tarsal pronatory stress
3) Incorporate manual techniques of lateral STJ glides, STM gastroc and Cross Friction to fascia
4) Improve Eccentric strength of the Post tib if pronation is a concern!!!!

INTERVENTION Model:
Governing Principles

1. Isolate the Meaningful Impairment (RESET)
   - Ex: Manual Techniques
2. Integrate (Reinforce)
   - Taping / Strapping / Orthotic
   - Patient Education
3. Functional Pattern (RELOAD)
   - Corrective Exercise
   - RNT / Functional Exercise Progression

Treatment Progression for Optimal Movement Re-education

Isolate/Reset
Integrate/Reinforce
Functional Pattern/Reload
CKC Dorsiflexion MWM

• Isolation (M)
  – DF Mobilization

Mulligan Taping Technique

• Isolation (M)
  – DF Mobilization

Heel Pain: Patient Perspectives

Gluteal / Core Stability

Electromyographic Analysis of Core Trunk, Hip, and Thigh Muscles During 9 Rehabilitation Exercises

Which Exercises Target the Gluteal Muscles While Minimizing Activation of the Tensor Fascia Lata? Electromyographic Assessment Using Fine-Wire Electrodes
The Chop

The Lift

Half Kneeling Valgus Stress

OTIS Technique

ITIS Technique
Dead Lift Progressions

1. ASIS & Knee positioned over the second toe
2. Hip positioned in approximately 10 deg of External Rotation

Assisted Squatting

Corrective Weight Shift Squat

Unilateral Valgus Corrective Exercise

Bilateral Valgus Corrective Exercise
Assisted Lunging

RNT Lunge

Side Lunge Progression

Acceleration / Deceleration

Power, Speed, Agility Development for Durability

- Plyometrics
- Speed Development
- Agility Drills
- Skill Acquisition
- ...Many more (Goal-Oriented Creativity)

Course Objectives!!! Revisited...

- 1. Identify the pathomechanics of common musculoskeletal foot/ankle pathologies.
- 2. Demonstrate specific examination procedures that can be integrated into your clinical toolbox.
- 3. Present clinical decision making tools that can enhance clinical practice patterns.
- 4. Explore regional interdependence applications to select pathologies, and identify the meaningful impairments that contribute to movement dysfunction.
- 5. Demonstrate specific manual and neuromuscular skilled interventions that can be integrated into your clinical practice.
- 6. Discuss current best evidence for physical therapy interventions for selected foot and ankle pathologies.
- 7. Identify potential "red-flags" in patients with foot and ankle pathology who require referral to a physician in a direct access setting.
Closing

• Summary...
• Questions...
• THANK YOU!!!!