Rehabilitation Considerations Following Ankle Fracture: Impact on Gait & Closed Kinetic Chain Function

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Objectives

- Describe selected kinetics & kinematics of the ankle complex
- Develop evidence-based therapeutic exercise program to maximize closed kinetic chain function following ankle fracture
- Discuss manual therapy interventions aimed at maximizing mobility of the ankle complex

Biokinesiology of the Ankle Complex

Talocrural Joint

- Mortise Joint
- 3 Articulations
  - Tibia – Fibula
  - Tibia – Talus
  - Fibula - Talus

Talocrural Joint

- Pitch of Axis
  - Average
    - 8° to transverse plane
  - Range
    - Up to 23° to transverse plane

- Pitch of Axis
  - Average
    - 20° to frontal plane
  - Range
    - 20°–30° to frontal plane
Tri-Plane Motion
- Pronation
  - Dorsiflexion
    • Sagittal
  - Abduction
    • Transverse
  - Eversion
    • Frontal
- Supination
  - Plantarflexion
    • Sagittal
  - Adduction
    • Transverse
  - Inversion
    • Frontal

Talocrural Joint
- Components of motion
  - OKC Pronation
    • DORSIFLEXION
    • ABDUCTION
    • Eversion
  - OKC Supination
    • PLANTARFLEXION
    • ADDUCTION
    • Inversion

Normal Gait: Ankle Kinetics & Kinematics

Gait Terminology

Gait Cycle Analysis: Ankle
- Loading Response:
  - Slight DF due to anterior tibialis working in swing phase for clearance
  - Plantarflexion (passive)
    • GRF vertical on heel
  - Rapid PF decelerated by:
    • Tibialis anterior
    • Extensor digitorum longus
    • Extensor hallucis longus

Gait Cycle Analysis: Ankle
- Mid-Stance:
  - Dorsiflexion (passive)
    • Tibia advances over fixed foot
  - Decelerated by gastroc and soleus
Gait Cycle Analysis: Ankle

- Terminal Stance – Pre-Swing (Propulsion)
  - Plantarflexion (passive)
    - Active for accelerated gait
  - Accelerated by gastroc and soleus
    - Resists DF during heel lift
    - Controls high GRF

Ankle Fracture

- Bimalleolar
  - Medial & lateral malleolus
- Trimalleolar
  - Medial & lateral malleolus
  - Posterior tibial malleolus
- Syndesmotic
  - Ligamentous complex of tibiofibular joint
  - High ankle sprain

Ankle Fracture

- Lateral Malleolus
  - Weight bearing varies
- Medial Malleolus
  - Management determined by displacement
  - Restricted weight bearing
- Posterior Malleolus
  - Common with lateral malleolus fracture
  - Shared ligamentous attachment
  - Posterior-inferior tibiofibular ligament

Immobilization & Weight Bearing

- Lin CWC et al. Cochrane Review 2012
  - “Rehabilitation for Ankle Fractures in Adults”
  - Removable immobilization & exercise
    - ↓ activity limitation
    - ↓ pain
    - ↑ dorsiflexion ROM
  - (+) Weight bearing with immobilization
    - ↑ dorsiflexion ROM

Immobilization & Weight Bearing

- Following ankle surgery
  - Active exercises accelerated return to work & ADL
  - Early weight bearing accelerated return to work & ADL
  - No difference in complication rates
    - Between exercise & immobilization
    - Between early & late weight bearing

Rehabilitation

- Pfeifer CG et al. Injury 2015
  - 209 Rehabilitation Protocols for ankle fractures
  - No consistency across rehab programs
- Moseley AM et al. JAMA 2015
  - Advice Group: OKC ankle ROM
  - Rehab Group: Ankle mobility & strengthening, Stepping exercises, Weight bearing & balancing
  - No difference between groups
  - **Limited PT (Week 1 = 2 visits, Weeks 2-4 = 1x/week)**
  - **1/3 advice group received out of trial PT**
Rehabilitation

  - Gait analysis
    - (1) immobilization removed
    - (2) 12 weeks after exercise-based rehab program
  - Significant improvements
    - Temporal and spatial gait parameters
    - Functional outcome (Olerud-Molander Ankle Score)

- Beckenkamp PR et al. JOSPT 2016
  - Following ankle fracture
    - ↓ Physical activity
    - ↑ time sitting
  - Long term health implications: ↑ risk (WHO)
    - Cardiovascular disease
    - Diabetes
    - Cancer
    - Depression

- Beckenkamp PR et al. JOSPT 2014
  - Reviewed 37 articles and converted outcomes to 100 point scale
    - Short term (1 month) 31.9
    - Short to medium term (6 months) 78.3
    - Long term (24 months) 86.6
  - Pain, stiffness & weakness present
  - Activity limitation was worse in older subjects & males

- Rehabilitation
  - Treatment
    - Impairment focused
      - Limited ankle dorsiflexion ROM
        - Hancock MJ et al. JOSPT. 2005
      - Weakness (approximately 60%)
        - Shaffer MA et al. Phys Ther. 2000
      - Uninvolved side is benchmark

Manual Therapy

- Manual Therapy ↑ DF ROM
  - Hoch MC & McKeon PO J Orthop Res. 2011
  - Vicenzino B et al. JOSPT. 2006

  - Manual therapy did not improve clinical or economic outcomes
    - Standard treatment of a single joint mobilization technique
      - Gr III AP glide of talus in DF
**Painter EE et al. JOSPT 2015**

- Case series of 11 patients (2 male) mean age 39.6 (18-64)
- Impairment based manual PT with targeted exercise
- Outcomes @ 4 & 12 weeks compared to baseline
  - LEFS ↑ 21.9 (p = .001)
  - Ankle Lunge Test ↑ 7.8cm (p = .001)

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**Talocrural Joint**

- Distraction
  - Neutral calcaneus
  - Force at dorsal surface of talus
  - Force: Gentle → Manipulation

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**Talocrural Joint**

- Posterior Glide
  - Stabilize tibia-fibula
  - Control DF-PF
  - Posterior force through talus
  - Consider plane of joint axis

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**Talocrural Joint**

- Weight-Bearing Progression
  - Mobilization with Movement (MWM)
  - Posterior glide at talus
  - Control limb rotation with target

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**Gastrocnemius / Soleus**

- Gait function
  - Gastrocnemius
    - Decelerate/control forward progression of tibia on talus
  - Soleus
    - Active around the time of heel strike
- Rehab focus
  - Flexibility
    - Prevent compensatory pronation at midfoot
  - Strength
    - Eccentric contraction key
    - Respect stage of healing / reactivity of tissue

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**Therapeutic Exercise Following Ankle Fracture**

- Mobilization with Movement (MWM)
- Posterior glide at talus
- Control limb rotation with target

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Gastrocnemius / Soleus

- **Flexibility**
  - Maintain supinatory bias
  - Inverted calcaneus
  - Prevent oblique midtarsal compensation

- **Strength**
  - Eccentric is key
  - Manual resistance
  - Resisted band
  - Weight bearing

Tibialis Posterior

- **Anatomical Function**
  - Inverter, adductor, plantar flexor of foot
- **Gait function**
  - Decelerate/control GRF moving foot into eversion & abduction
  - Greater activation in low arch foot types
- **Rehab focus**
  - **Strength**
    - Eccentric contraction key
    - Works in concert with peroneus longus

- **Strength**
  - TB resistance
  - Manual resistance
  - CKC progression

FDL / FHL

- **Anatomical Function**
  - Strong toe flexors
- **Gait function**
  - Stabilize the foot during midstance and late stance
- **Rehab focus**
  - **Strength**
    - Resist the distal phalanx with toe curl exercises

- **Strength**
  - Toe curls
  - “Short Foot” or “Cupping” exercises
  - CKC / Balance
Tibialis Anterior

• Anatomical Function
  – Strong ankle dorsiflexor
  – Prevents posterior sway during standing balance
• Gait function
  – Prevent foot slap after heel strike (eccentric)
  – Clear foot during swing phase (concentric)
• Rehab focus
  – Strength
    • Concentric & Eccentric important

Tibialis Anterior

• Strength
  – TB Resistance
  – Manual Resistance
  – CKC:
    • Squatting: Control DF (Eccentric) and prevent posterior body sway (Concentric)

EDL / EHL

• Anatomical Function
  – EDL: Evertor
    • Balances inversion of tibialis anterior
  – EHL: Extends proximal phalanx of great toe
• Gait function
  – Decelerate foot slap after heel strike (eccentric)
  – Clear foot during swing phase (concentric)
• Rehab focus
  – Strength
    • Location of resistance will determine muscle activation

EDL / EHL

• Strength
  – TB Resistance
  – Manual Resistance

Peroneals

• Anatomical Function
  – Abduct & evert the foot in OKC
• Gait function
  – Brevis
    • Stabilizes calcaneocuboid joint
  – Longus
    • Stabilize first ray as weight transfers from lateral to medial
• Rehab focus
  – Strength focus is OKC & CKC

Peroneals

• Strength
  – OKC:
    • TB Resistance
    • Manual Resistance
  – CKC:
    • Weight shift control
    • 1st ray vs ground
**Plantar Intrinsic Group**

- Anatomical Function
  - Individual origin / insertion but function as group
- Gait function
  - Flexibility
    - Shock absorption & balance
  - Rigidity
    - Propulsion
- Rehab focus
  - Midfoot control

**Summary**

- Prolonged functional limitation is common in patients with ankle fracture
- Consider mobility demands of gait and a kinetic chain approach to maximize ROM early in rehab course
- Integrate targeted therapeutic exercise to improve muscle activation and strength

**THANK YOU**