Gait Analysis: Qualitative vs Quantitative
What are the advantages and disadvantages of qualitative and quantitative gait analyses?

Walking gait analysis
Note the toeing in during left foot contact and how he walks on the lateral aspect of the foot

Basics of Gait Analysis
• Gait cycle: heel strike to subsequent heel strike, for the same heel
• Phases:
  1. stance (0-60%)
  2. swing (60-100%)
• Tasks:
  1. weight acceptance (0-10%)
  2. single limb support (10-50%)
  3. double-limb support (50-60%)
  4. swing (60-100%)
• Strides and steps...

Basics of Gait Analysis
• Hip, knee, and ankle sagittal-plane kinematics
• Hip, knee, and ankle sagittal-plane kinetics
• Corresponding electromyography

Common Gait Pathologies
1. Hip abductor weakness (Trendelenburg)
2. Lack of terminal knee extension
3. Lack of dorsiflexion
4. Hyperpronation

Impairment #1: Trendelenburg Gait

Trendelenburg: Related Impairments/Pathologies
• Hip Musculature Weakness
• Hip Osteoarthritis
• Overuse:
  – IT Band Friction Syndrome
  – PF Pain
  – Bursitis
• Low Back Pain
• Knee Injury/Surgery
• Lateral Ankle Sprains
Trendelenburg Gait: Possible Effects
Observations: Pelvic tilt, adducted femur, valgus knee...

Trendelenburg

Trendelenburg

AROM Hip Abductor Exercise

Functional Closed-Chain Exercises
- Functional closed-chain exercises for the hip (University of Kentucky Athletic Training)
Functional Closed-Chain Exercises

- Lateral step-ups

Functional Balance Exercises

- Other progressions:
  - Flex hip
  - Lean anteriorly

Functional Closed-Chain Exercises

- Cone Drills: Intermediate. Implement a ball for the advanced phase of progression

Impairment #2: A Lack of Terminal Knee Extension (TKE)

What is normal knee motion during gait?

- Begins at ~5° flexion at initial contact, and flexes to ~20° through single limb stance
- Returns to ~5° prior to swing
- Begins to flex prior to swing; maximal flexion is ~70° through swing

TKE: Related Impairments/Pathologies

- Stiff Hamstrings or Plantarflexors
- Weak Quads
- ACL Injury
- Meniscal Damage
- Inflammation
- Pain

Does it really matter? What are the implications?
Experimentally Induced Knee Pain

Does knee pain alter joint mechanics in a way that may promote osteoarthritis?

Lack of Terminal Knee Extension

Lack of Terminal Knee Extension

- Sagittal-plane Net Knee Torque
- Sagittal-plane Knee Angle

Hypomobile Hamstrings or Gastrocnemius

- What can be done?
- What are the stretch choices?
- Which is the best choice?
- What actually happens to a stretched muscle?
**AROM for Knee Flexors and Extensors**

PROM exercises can be performed using similar motion; patient can use a towel or theraband to move the joint through the complete ROM.

**Quad Weakness: Strengthening Exercises**

Open-chain, isotonic knee extensions focusing on the end of the ROM

Open-chain, isotonic knee extensions focusing on the full ROM

**Quad Weakness: Strengthening Exercises**

Open-chain, isokinetic knee extensions are helpful; exercises can be practiced at angular velocities and ROMs representative of gait

**More Strengthening Exercises**

A closed-chain strength exercise for terminal extension

(University of Kentucky Athletic Training)
Quad Weakness: Functional Closed-Chain

Standing Mini Squats

Quad Weakness: Functional Closed-Chain

Step up progression
(University of Kentucky Athletic Training)

Quad Weakness: Functional Closed-Chain

Resistive reverse walking

Forward and rearward treadmill walking, progress by increasing speed and decreasing upper-extremity support

Quad Weakness: Functional Closed-Chain

Reverse stair climbing

Star exercise is an activity that allows the patient to objectively observe improvements
(University of Kentucky Athletic Training)
Quad Weakness: Functional Closed-Chain

Lunges

Impairment #3: A Lack of Dorsi or Plantarflexion (DPF)

What is normal?
- 5-10° plantarflexion, immediately following initial contact
- 10° dorsiflexion, at weightbearing
- 20° plantarflexion, at pushoff
- Neutral position, throughout swing

DPF: Why does it occur?
- Ankle Sprain
- Achilles Tendinitis
- Various Fractures of the shank
- Shortened Achilles/Gastroc Complex
- Plantar Fasciitis can be related

What might it cause?
- Compensation at the hip and knee can lead to additional chronic injuries
- A lack of toe clearance may cause additional ankle injuries

DPF: AROM Exercises for the Gastroc and Soleus

PROM exercises can be performed using similar motion; patient can use a towel or theraband to move the joint through complete ROM.
DPF: AROM Exercises for the Dorsi Flexors

PROM exercises can be performed using similar motion; patient can use a towel or theraband to move the joint through the complete ROM.

DPF: Functional Balance Exercise

- Heel raises, progress from no perturbation and upper-extremity support on a rail or table to no upper-extremity support and perturbation

DPF: Functional Balance Exercise

Toe walking (University of Kentucky Athletic Training)

DPF: Functional Balance Exercises

- Walk a narrow line, slowly placing one foot in front of the other; focus upon a proper heel strike, stance phase, and toe-off

DPF: Functional Balance Exercises

Controlled sway forward and backward, progress with perturbations and implementing heel raises

Impairment #4: Hyperpronation
What is normal, and why does it occur?
- ~ 5-10° of pronation at weightbearing; for shock absorption purposes
- ~ 10° of supination at pushoff; for torque production purposes

Why does the impairment occur?
- Flat feet
- Overly compliant feet
- Weak supinators: soleus, plantaris, gastroc, tibialis posterior
- Lower-limb malalignment

What might it cause?
- Various pathologies including,
  - Chronic, varied tendinitis
  - Abnormal wear at the ankle and knee
  - Stress fractures at the shank

Muscle Strengthening for Hyperpronation
- Strengthen the “supinators” and tibialis anterior:
  - ankle inversion (theraband)
  - side-lying inversion, using ankle weight
  - single-leg stance, balance progressions
  - toe raises

Mechanical Means
- Orthotics are also effective
- Shoe characteristics for overpronators:
  - Straight-shaped outer sole
  - Board construction of the inner sole
  - Firm Heel
  - Firm Midsole