Introduction to Human Walking & Clinical Gait Analysis

Jessica Rose, Ph.D.
Associate Professor, Department of Orthopaedic Surgery
Stanford University School of Medicine

Motion & Gait Analysis Lab
Lucile Packard Children’s Hospital
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Motion Analysis at Stanford
Edweard Muybridge & Leland Stanford 1878
Muscle Activity During Gait
Gait Analysis

• Video
• Kinematics and Kinetics
• Dynamic EMG
• Postural Balance
• Energy Expenditure
Kinematics & Kinetics

• Kinematics: 3-D Joint Motion
  8 Digital Motion Capture Cameras Record
  Position of Light Reflective Markers

• Kinetics: Forces Passing Through the Joints
  Force Plate Embedded in the Floor Records
  Ground Reaction Force Vectors
Musculoskeletal Computer Models of Gait

Computer models are generated from gait kinematics (joint motion) and kinetics (joint forces) and reveal the biomechanical features that influence gait.

The changing muscle lengths during gait are calculated using the computer model. Muscles that are too short and limit gait can be identified and selected for treatment.
Kinematics & Kinetics
Kinematics

• Nearly normal hip motion

• Increased knee flexion at IC and stance

• Reduced peak knee flexion in swing

• Increased plantar flexion in terminal stance

• Internally rotated foot progression
Kinetics

- Toe Walking “Double-Bump” Ankle Plantarflexor Moment Pattern

- Increased plantar flexor moment in loading response associated with increased plantar flexion at IC

- Decreased moment in terminal stance associated with a reduced forefoot rocker
Dynamic EMG & Kinematics

Equinus Gait
Postural Balance

- Force Plate Center of Pressure
- Postural Sway with Eyes Open / Closed
Energy Expenditure Index

EEI = \frac{\text{Walking Heart Rate} - \text{Resting Heart Rate}}{\text{Walking Speed}}
Pathologic Gait

Neuromuscular Conditions
_Cerebral Palsy, Stroke, Traumatic Head Injury_

- Equinus
- Equinovarus
- Pseudo equinus (knees bent, ankles at neutral, forefoot contact)
- Jumped (knees bent, ankles true equinus)
- Crouch (knees bent, ankles dorsiflexed)
- Stiff–knee gait
Motion & Gait Analysis Lab
Research
Thank You