The Ankle and Foot Joint

- Walking & running
  - Stance phase
    - Heel-strike
      - foot should be in supination
    - Midstance immediately follows with foot moving into pronation
    - Toe-off follows midstance, foot returns to supination prior to and during push off

- Swing phase
  - occurs when foot leaves ground & leg moves forward to another point of contact
LOCOMOTION

• The act or power of moving from place to place by means of one’s own mechanisms or power
• In human beings, this is the result of the action of body levers propelling the body
  – Ordinarily is by the lower extremities
  – Occasionally by all four extremities
  – Sometimes by upper extremities alone

Purpose and Basic Function of Gait

• Purpose
  – Transport the body safely and efficiently across the ground (Winter, 1991)

Main Functions of Gait

• Support of the upper body during stance to prevent collapse
• Maintenance of upright posture and balance of total body when walking
  – Dynamic stability
• Control of foot trajectory to achieve safe ground clearance (minimum foot clearance) and gentle landing (GRF)
Main Functions of Gait

• Generation of mechanical energy to maintain the present forward velocity or to increase the forward velocity
• Absorption of mechanical energy for shock absorption and stability or to decrease the forward velocity of the body

Main Functions of Gait

• 5 functions must be performed within the anatomical constraints of the body
• Must be efficient
  • Mechanisms to reduce COM displacement
    – Increases in COM displacement means it is a less efficient gait cycle
    – Mainly in the frontal and transverse plane

Main Functions of Gait

• CNS must integrate efferent (motor) commands with peripheral feedback, vestibular and visual inputs
  – Uses this info to generate correct patterns of joint moments (forces)
Functions of Gait

- Impairments of:
  - ROM
  - Muscle activity (weakness, spasticity, timing)
  - Pain
  - Sensation
- Can limit a person’s ability to:
  - Maintain stability against gravity and inertial forces
  - Propel the body forward
  - Minimize costly changes in energy

WALKING
Description

- Alternating action of the two lower extremities
- Translatory motion of the body brought about by rotary motion of the some of its parts
- Two Phases:
  - Swing & Support

Phases of the Gait Cycle
Stance Phase

Weight Acceptance = GC – max knee flexion
- 0-15% of stride
Mid-stance = FF – HO (15-40%)
Push-off/Terminal stance = 40% - 60% of stride

Swing Phase

Distance Measures

- Height dependent
- Stride Length
  - 1.33 – 1.63 ± 1 m
- Step Length
  - 0.7 – 0.81 ± 0.03 m
- Step Width
  - 0.6 – 9.0 cm
- Foot Angle
  - ~5-7
Temporal Measures

\[ \text{Velocity} = \frac{\text{Stride Length} \times \text{Cadence}}{60} \text{ m/s} \]

- Cadence = steps/min
  - 100-120 steps/min on average
- Velocity
  - 0.8 – 1.6 m/s

WALKING

Anatomical Analysis: Stance Phase

Hip:

- Gluteus Medius
  - Hip abductor to control drop of pelvis
- Gluteus Maximus
  - Hip extensor to control hip extension during weight acceptance
  - Stabilizes pelvis for trunk control
Hip: Hamstrings

- Medial hamstrings
  - Major burst serves to decelerate the lower leg
  - After contact, serve as hip extensors
- Lateral Hamstrings
  - Similar to medial

Hip: Adductors

- First peak
  - Co-contraction to hip abductors
- Second peak
  - Keep limb in line for foot placement

WALKING
Anatomical Analysis: Stance Phase

Knee:
Knee: Quadriceps
- Extend leg and foot prior to heel contact
- Control amount of knee flexion

WALKING
Anatomical Analysis: Stance Phase
Ankle and Foot:

Foot and Ankle: Dorsiflexors
- Controlled lowering of foot during weight acceptance
Foot and Ankle: Plantarflexors

- mid-stance
  - Controls forward tilt
- Active plantarflexion at push-off

---

WALKING
Anatomical Analysis: Swing Phase

Hip:

2. Muscles: iliopsoas prime mover of hip at this point
   - assisted by: rectus femoris, sartorius, gracilis,
WALKING
Anatomical Analysis: Swing Phase

Knee:


Ankle and Foot:

1. Movements: Dorsiflexion; prevention of plantar flexion to clear the floor.
Anatomical Analysis: Swing Phase

11

WALKING
Anatomical Analysis: Swing Phase

Ankle and Foot:
2. Muscles: Tibialis anterior, extensor digitorum longus, extensor hallucis longus, and peroneus tertius contract with slight to moderate intensity at the beginning of swing phase and taper off during middle portion of this phase
   - Contract again to prepare for heel strike

![Graph showing muscle activity during swing phase](image-url)