Normal Gait

Heikki Uustal, MD
Medical Director, Prosthetic/Orthotic Team
JFK-Johnson Rehab Institute
Edison, NJ
Critical Gait Parameters

- Average walking speed = 2-3 mph (60-80 m/min)
- Average cadence = 80-110 steps/min
- Average step length = 60 cm
- Stance/swing = 60/40
- Single/double limb support = 80/20
- Running has no double limb support
Step or Stride?

- a) L step
- d) R step
- c) R stride
- b) L stride
- g) L toe out 7°
- e) Width of base support
- f) R toe out 7°
Phases of the Gait Cycle

Stance Phase Phase – 60%

Swing Phase Phrase – 40%
Comparison of Right Leg to Left Leg Phases

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<tbody>
<tr>
<td>Phase</td>
<td>0–10%</td>
<td>10–30%</td>
<td>0–10%</td>
<td>10–23%</td>
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<tr>
<td>Initial &amp; loading</td>
<td>Midstance</td>
<td>Terminal stance</td>
<td>Initial swing</td>
<td>Midstance</td>
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<tr>
<td>Preswing</td>
<td>Initial swing</td>
<td>Midswing</td>
<td>Terminal swing</td>
<td>Stance</td>
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<tr>
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<td>50–60%</td>
<td>30–50%</td>
<td>50–60%</td>
<td>37–50%</td>
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<td>Initial swing</td>
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<td>Terminal swing</td>
<td>Midswing</td>
<td>Terminal stance</td>
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<td>60–73%</td>
<td>73–87%</td>
<td>87–100%</td>
<td>60–80%</td>
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<td>(13%)</td>
<td>(14%)</td>
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Key: Swing | Stance
Three Important Gait Factors

- Forward Progression
- Stance Stability
- Conservation of Energy
Methods of Analyzing Gait

- **Kinematics** is the method of observing or measuring the position of joints and segments through each phase of gait (visual gait analysis).

- **Kinetics** is the method of measuring the Ground Reaction Force at each joint and then calculating the muscle activity or soft tissue resistance present to stabilize the joint.
Gait Analysis Basic Training

- Assess only one joint at a time
- Look at early stance, late stance, then swing
- Separate kinetics from kinematics
- KEEP IT SIMPLE!
Normal Human Locomotion: Sagittal Plane Gait Kinematics
STANCE PHASE
SWING PHASE

INITIAL SWING  MIDSWING  TERMINAL SWING
Rockers or Pivot Points in Stance

A Heel rocker
B Ankle rocker
C Forefoot rocker
Initial Contact:

- Double Support
- Hip = Flexed 30°
- Knee = Extended
- Ankle = Neutral
- Goal = Begin Stance
Loading Response:

- Double Support
- Hip = Flexed
- Knee = Flexing 5-10*
- Ankle = Plantarflexing to 20*
- Goals = Weight Acceptance, Shock Absorption, Advance body over Heel Rocker
Mid Stance:

- **Single Support**
- **Hip** = Extending
- **Knee** = Extending but not to 0°
- **Ankle** = Dorsiflexing
- **Goal** = Advance body over stationary foot, ankle rocker
Terminal Stance:

- Single Support
- Hip = Extending 15-30°
- Knee = Extend, then Flex
- Ankle = 15° DF to Neutral
- Goal = Advance body over forefoot rocker
Pre Swing:

- Double Support

- Hip = Flexing

- Knee = Flexing 30-40*

- Ankle = Plantarflexing 20-30*

- Goal = Prepare for Swing, transfer load to other limb
Initial Swing:

- **Single Support**
- Hip = Flexing
- Knee = Flexing up to 65°
- Ankle = Dorsiflexing to 0°
- Goal = Clear foot and advance limb
Mid Swing:

- Single Support

- Hip = Flexing to 30°
- Knee = Extending
- Ankle = Dorsiflexing to 0°

- Goal = Advance limb and clear foot
Terminal Swing:

- Single Support
- Hip = Flexed 30°
- Knee = Extending
- Ankle = Neutral
- Goal = Advance limb
Initial Contact:

- Double Support
- Hip = Flexed 30°
- Knee = Extended
- Ankle = Neutral
- Goal = Begin Stance
Kinetics of Stance Phase
Activity of All Major Muscles
Activity of All Major Muscles
Hip Abductor Activity
Determinants of Gait
Stick Figure Model
1. Pelvic Rotation
Lengthens Limb at IC and PS
2. Pelvic Tilt
Shortens Limb at MS
3. Knee Flexion in Stance
Shortens Limb at MS
4&5. Foot and Ankle Motion Lengthens and Shortens Limb
Sinusoidal Motion of the COG
6. Narrow Base of Support to Minimize Horizontal Motion
Effect of Incline on Energy
Effect of Ankle Immobilization on Gait
Effect of Knee Immobilization

![Graph showing energy expenditure during walking at different knee flexion angles for two different speeds (2.9 km/h and 4.4 km/h).]
Up and Down Stairs
Center of Gravity Line

**Figure 5-24.** Location of the COG. In the average adult, the COG lies anterior to S2.
Base of Support

Figure 5-26. Base of support. The size of the base of support varies with a change in foot position.
Base of Support

Figure 5-27. Base of support. The size of the base of support varies with the use of a cane or crutches and with placement of the assistive device.