Gait Analysis After Orthopaedic Surgery

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Schedule

✓ History
✓ Definitions
✓ Phases of gait
✓ Clinical methods of gait analysis
✓ Clinical applications of gait analysis
History of gait analysis

✓ Aristotales
✓ Borelli – 15th century
✓ Eadweard Muybridge - 1878
Definitions

- Normal gait
- Gait cycle
- Step length
- Stride length
- Walking base
- Cadance
- Velocity
- Comfortable walking speed
Normal gait

- Series of rhythmical, alternating movements of the trunk & limbs which result in the forward progression of the center of gravity
- Series of “controlled falls”
Gait cycle

- Single sequence of functions by one limb
- Begins when reference foot contacts the ground
- Ends with subsequent floor contact of the same foot
Step length

- Distance between corresponding successive points of heel contact of the opposite feet
- Rt step length = Lt step length (in normal gait)
Stride length

- Distance between successive points of heel contact of the same foot
- Double the step length (in normal gait)
Walking base

- Side-to-side distance between the line of two feet
- Also known as “stride width”
Cadance

✓ Number of steps per unit time
✓ Normal: 100 – 115 steps/min
✓ Cultural/social variations
Velocity

✓ Distance covered by the body in unit time
✓ Usually measured in m/s or m/min
✓ Instantaneous velocity varies during the gait cycle

Average velocity (m/min) = step length (m) x cadence (steps/min)
**Comfortable walking speed**

- Least energy consumption per unit distance
- Average = 80 m/min (~ 5 km/h, ~ 3 mph)

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step length (cm)</td>
<td>79</td>
<td>66</td>
</tr>
<tr>
<td>Stride length (cm)</td>
<td>158</td>
<td>132</td>
</tr>
<tr>
<td>Cadance (steps/min)</td>
<td>117 (60 – 132)</td>
<td>117 (60 – 132)</td>
</tr>
<tr>
<td>Velocity (m/s)</td>
<td>1.54</td>
<td>1.31</td>
</tr>
<tr>
<td>Stride width (cm)</td>
<td>8.1</td>
<td>7.1</td>
</tr>
<tr>
<td>Foot progression angle</td>
<td>7°</td>
<td>6°</td>
</tr>
</tbody>
</table>
Phases of gait

✓ Stance phase
✓ Swing phase
Stance (Support) Phase

Reference limb in contact with the floor
Stance (Support) Phase

- Past terminology
  - Heel contact
  - Foot flat
  - Midstance
  - Heel-off
  - Toe-off

- Current terminology
  - Initial contact
  - Loading response
  - Midstance
  - Terminal stance
  - Preswing
Swing (Recovery) Phase

Reference limb not in contact with the floor
Swing (Recovery) Phase

- Past terminology
  - Acceleration
  - Midswing
  - Deceleration

- Current terminology
  - Initial swing
  - Midswing
  - Terminal swing
Stance – Swing phase

✓ Time Frame:

A. Stance vs. Swing:

✓ Stance phase = 62% of gait cycle
✓ Swing phase = 38% of gait cycle

B. Single vs. Double support:

✓ Single support = 42% of gait cycle
✓ Double support = 20% of gait cycle
Clinical applications of gait analysis

 ✓ Assess the degree and extent of departure from the normal
 ✓ Design an appropriate treatment plan
 ✓ Evaluate the effectiveness of treatment
 ✓ Document the results of therapeutic interventions
 ✓ Make scientific studies
 ✓ Educational
Clinical methods of gait analysis

✓ Qualitative analysis
✓ Quantitative analysis
Clinical methods of gait analysis

✓ Qualitative analysis
✓ Observational analysis

- Head vertically aligned
- Head inclined forward (flexion)
- Head inclined backward (extension)
- Head tilted to side (from front view)
- Trunk vertically aligned
- Kyphosis
- Lordosis
- Trunk flexion
- Scoliosis (from front view)
- Arm swing in opposition to legs
- Arm swing less than 45°
- Arm swing greater than 45°
- Rigid arm swing
- Kinematic chain-type arm swing
- Hands held in fists
- Equal range of motion (ROM) for both arms
- Hip remains relatively at the same height (height)
- Hip bobs up and down (head may be viewed)
- Knee vertical at initial contact
- Knee inclined backward at initial contact
- Knee off with shank vertical
- Knee off with shank inclined forward
- ROM for both legs
- Leg remains below horizontal
- Leg becomes horizontal
- Leg at knee less than 45°
- Leg at knee greater than 45°
- Leg held rigid
- Leg held in equinos
- Leg turned outward excessively
- Leg turned inward excessively
- Leg stuck-kneed
- Leg stuck-kneeged
- Contact with heel of foot
- Contact with flat foot
- Contact with ball of foot
- Weight borne on medial part of foot
- Weight borne on lateral part of foot
- Weight shifts borne effectively on foot
Clinical methods of gait analysis

- Quantitative analysis
  - Kinematic analysis
  - Kinetic analysis
  - Combined kinematic and kinetic analyses
  - Dynamic pedobarography
  - Electromyography (EMG)
  - Energy measurements
Clinical methods of gait analysis

✓ Motion capture systems
Clinical methods of gait analysis

✓ Force plates and pressure sensors
Clinical methods of gait analysis

✓ Electromyography (EMG)
Clinical methods of gait analysis

✔ Energy measurements
Clinical applications of gait analysis

- Neuromuscular disorders
- Congenital and developmental deformities
- Inflammatory and degenerative joint diseases
- Spine injuries
- Musculoskeletal injuries
- Sports medicine and related injuries
- Orthosis and prosthesis
Why do we need gait analysis?

- Aids in surgical planning
- Assessing the efficacy of surgical intervention
- Evaluation of the rate of deterioration in progressive disorders that affect gait can also aid in understanding a patient's abilities and directing care
- Bracing issues and medication efficacy can be addressed using gait analysis techniques
- Quantification for clinical and research
Thank you ...