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Gait Examination and Evaluation in Patients with Neurological Disorder

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Learning Objectives

The participant will be able to:
• Accurately describe at least two examples normal gait kinematics in adults.
• Correctly identify three key components of a comprehensive pathological gait analysis for patients with neurological disorders.
• Discuss the concept of a hypothesis drive gait examination and evaluation.
• Independently identify at least two appropriate gait specific outcome measures for use in patients with neurological disorders.
• Formulate a hypothesis driven gait analysis of patients (video cases) with neurological disorders.
Quick Review of Normal Gait

• Why?
  – A thorough understanding of normal gait is absolutely essential in order to understand pathological gait.
  – Understanding the pathological gait and how it deviates from normal is critical in establishing a plan of care, selecting treatments, and/or prescribing appropriate orthotics to correct this pathology

Goals of Normal Gait

• Movement along desired path
• Maintaining weight bearing stability
• Conserving energy
• Absorbing shock
Norms

- Cadence: steps per minute (113-116)
- Velocity: 82 m/min or 1.37 m/sec
- BOS: 2-4”
- Toe out: 7°
- Stance phase: 62% of gait cycle
- Swing phase: 38% of gait cycle
- Single limb support: 80% of time
- Double limb support: 20% of time

Lavangie and Norkin, Joint structure and function. A comprehensive analysis. 4th edition, 2005
3 Functional Tasks of Normal Gait

• Weight acceptance
  – Forward progression, shock absorption, stability
• Single limb support
  – Stability, forward progression
• Swing limb advancement
  – Foot clearance
  – Limb advancement

**Weight Acceptance**

• Forward progression
• Stability
• Shock absorption

  – Initial Contact and Loading Response
Single Limb Support

- Stability
- Forward progression

- Mid stance and terminal stance

Swing Limb Advancement

- Foot clearance
- Limb advancement

- PSw, ISw, MSw, TSw
What is the common factor???

Forward Progression

Lavangie and Norkin, Joint structure and function. A comprehensive analysis. 4th edition, 2005
Above, a **flexion moment or torque** is being generated at the knee because the body weight line (vector) is **behind** the knee joint.

An **equal and opposite** muscle action (of the quads) is necessary to keep knee from collapsing into greater flexion. Muscle action greater than the flexion torque is necessary to move knee toward extension.

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**Stance versus Swing**
Examine Both Sub Phases

- SINGLE LIMB INSTABILITY IN STANCE
- IMPAIRED LIMB CLEARANCE IN SWING

Initial Contact (IC)

- **Hip**
  - 20° flexion
  - Hamstrings on to slow limb, other extensors turning on
- **Knee**
  - Neutral
  - Quadriceps
- **Ankle**
  - Neutral
  - Pretibials
Loading Response (LR)

- Hip
  - Still at 20°
  - Extensors and abductors
- Knee
  - 15° flexion
  - Quadriceps
- Ankle
  - 5° PF
  - Pretibials
  - Heel Rocker

Mid stance (MS)

- Hip
  - Neutral
  - Abductors
- Knee
  - Neutral
  - Quads initially, then no muscle activity
- Ankle
  - 5° DF
  - Calf
  - Ankle Rocker
Terminal Stance (TS)

- Hip
  - 20° hyperextension
  - No muscle activity
- Knee
  - Neutral
  - No muscle activity
- Ankle
  - 10° DF
  - Calf
  - Forefoot Rocker
- Toes
  - 20-30° extension

Pre Swing (PSw)

- Hip
  - 10° hyperextension
  - Adductors
- Knee
  - 40° flexion
  - No muscle activity
- Ankle
  - 15° PF
  - No muscle activity
- Toes
  - 55-60° extension
Updates on Rockers

You may have learned of only 3 rockers. In Dr. Perry and Burnfield’s most recent edition of *Gait Analysis*, they discuss a 4 rocker system.

**Initial Swing (Isw)**

- **Hip**
  - 15° flexion
  - Flexors
- **Knee**
  - 60° flexion
  - Flexors
- **Ankle**
  - 5° PF
  - Pretibials
Mid Swing (MSw)

- Hip
  - 25° flexion
  - Flexors initially, then hams
- Knee
  - 25° flexion
  - Flexors
- Ankle
  - Neutral
  - Pretibials

Terminal Swing (TSw)

- Hip
  - 20° flexion
  - Hamstrings
- Knee
  - Neutral
  - Quads
- Ankle
  - Neutral
  - Pretibials
Pathological Gait Analysis

• Compare patient to normal
• Segmental
• Start distal, work proximal
• ID major problems that prevent accomplishment of 3 functional tasks (what were these?)
• Major versus minor deviations

Various conditions of gait

• Environment
• Multi tasking
• Varying load
• Speed demands
Hypothesis Drive Examination and Evaluation

- Distinguishing major from minor deviations
- Prioritizing problems
- Hypothesize the causative factors for each major gait deviation
- Test those hypothesis
- Re-assess post intervention and repeat process as necessary

Problem Solving Approach

- Problem identification
  1. Observational gait analysis and impairment testing
  2. Determine significant deviations for each functional task
     - Think about critical events
  3. List major problems interfering with 3 functional tasks
Problem Solving Approach

• Cause identification
  1. Consider all possible causes contributing to major problems (what were these?)
  2. Determine likely causes by referring to torque demands, muscle activity and joint positions
  3. Narrow list of possible causes and determine MOST LIKELY CAUSE

How do we assess gait across the ICF?
Observational analysis

• Advantages
• Disadvantages
• How do we maximize accuracy?

Gait Analysis:
Right | Left
--- | ---
Stance Phase |  
Swing Phase |  

An example....

- Billy Bob has left hemiplegia and has impaired swing limb clearance.
- His MD says he has “drop foot”
- You prescribe an AFO that limits plantarflexion to neutral (ie substitutes for the dorsiflexors)
- Unfortunately, Billy Bob walks essentially the same, with or without the AFO
- What’s the problem?
Instrumented Analysis

- Gait Lab
  - GAITRite
  - Stop Watch

Temporal and Spatial Measures

- Gait Speed
  - 10 m walk
- Cadence
- Endurance Measures
  - 2, 6, 12 minute walk
- Gait Symmetry
- Combination Measures
  - TUG
  - Berg Balance Test
  - DGI or FGA
  - Tinetti Gait and Balance Scale
Other Instrument Measures

- GAITRite
- Shoe Inserts
- Step activity monitor/pedometer
- Motion Analysis
- Forceplate Analysis
- EMG Analysis

What about Measures of Participation?

- QOL improves with increases in gait speed
- Relationships between QOL and gait parameters
- Determinants of Community Ambulator
- Link to cost and caregiver burden
How do we improve our gait assessment?

Video Case 1
Video Case 1

- ID major gait deviations
- Hypothesize causative factors
- Examine potential causative factors
- Identify potential outcome measures

Video Case 2
Video Case 2

• ID major gait deviations
• Hypothesize causative factors
• Examine potential causative factors
• Identify potential outcome measures

Video Case 3
Video Case 3

• ID major gait deviations
• Hypothesize causative factors
• Examine potential causative factors
• Identify potential outcome measures

Questions?

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