Gait Disorders

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Outline

• What is Required for Normal Gait
  – Anatomy / Physiology
• Epidemiology and Consequences on Gait Disorders
• Assessment of Gait
• General Gait Pathophysiology / Classification
• Specific Gait Pathologies
  – Videos!
Requirements for Gait

• Motor strength and engine
• Sensory input
• Vestibular reflexes
• Visual clues
• Spinal and anti-gravity reflexes
• Coordination of associated movements
  – (super learned)
• Structural support
Neuroanatomy for Gait

- Cortex
- Vestibular system
- Cerebellar output
- Extra-pyramidal output
- Pyramidal (motor)
- Visual system
- Autonomic nervous system
- Spinal rhythmic centers
- Reticulospinal anti-gravity centers
- Sensory (proprioceptive)
Gait Physiology

• Gait rhythmic and interlimb coordination located in spinal cord, in animals
• Subserved by rostral midbrain and diencephalon via medial tracts: reticulospinal, tectospinal, vestibulospinal
• Balance and gait compensation requires higher centers
Why we don’t fall

- **Equilibrium**: vestibular, proprioception, visual
- **Support structure**: elasticity of musculoskeletal
- **Anticipatory**: preprogrammed feed forward
- **Reactive**: short and long loop stretch reflex
- **Rescue**: partially voluntary
- **Protection**: protect face
Reduced Gait/Balance Strongly Associated with Other Problems

• Falls!
• Dementia
• Quality of Life
• Overall disease burden
• White matter changes on MRI
Gait and Falls

• Sequelae of falls are 5th leading cause of death
  – 60,000/year
• Falls increase markedly with age
  – 40% annual incidence at 65
  – Nursing home patients 3 falls/year
• Falls correlate with: death, dementia, NHP, reduced QoL
“Normal” Affects of Aging on Gait

• Gait mechanic changes with aging
  – Speed slows due to reduced stride length
  – Mildly wider base
  – Less flexion at hip and knee
  – Less arm swing

• Gait abnormality
  – 20% at age 65
  – 60% at age 85

Gait Initiation

1. shift weight to one side
2. lift opposite leg
3. let torso fall forward (weight shift)
4. move leg forward
Leg Stages During Gait

(a)

(b)
Clinical Assessment of Stance

• Base
• Sway
• Romberg (eyes closed)
• Palpate legs for tremor
• Tandem / One Leg
• Head Turning
• Orthostatic BP
Clinical Assessment of Gait

- Speed
- Step Length
- Limp / Orthopedic / Antalgia
- Regularity / Variance
- Posture
- Arm Swing
- Patterns
- Gait scenarios: turns, backwards, stairs, toes
Formal Clinical Assessments of Gait/Balance

- Speed and stride length
  - “Get up and Go” sit/3 meters/turn/ 3 meters/sit
- Tinetti -Performance-Oriented Mobility Assessment (POMA)
- Modified Gait Efficacy Scale (mGES)

Falls Correlate Well with Speed

- Community dwelling >65
- Average: 1m/second over 4 meters
- Falls: <0.8 m/sec (indoors)
- Falls: >1.3 m/sec (outdoors)
- Slower speed associated with many problems including death
Pitfall: Compensation

• Primary pathology (deviation)
• Secondary deviations (compensations)
  – Passive: follow as a physical effect “necessary”
  – Active: true volitional or super-learned compensation
• Tertiary deviations

Schmid S. *Gait and Posture*  2012
## Common Gait Compensations

<table>
<thead>
<tr>
<th>Biomechanical constraints, primary pathology</th>
<th>Compensatory mechanisms</th>
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</thead>
<tbody>
<tr>
<td>Hip extensor weakness</td>
<td>Posterior trunk extension</td>
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<tr>
<td>Hip abductor weakness</td>
<td>Duchenne limp</td>
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<tr>
<td>Knee extensor weakness</td>
<td>Hip extensors (hamstrings) for knee extensors</td>
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<tr>
<td>Quadriceps avoidance</td>
<td>Center of mass anterior of knee joint by:</td>
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<td>Increased activity of plantarflexion/knee extension couple</td>
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<tr>
<td></td>
<td>Hip flexion, Ant pelvic tilt</td>
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<tr>
<td>Ankle plantarflexor weakness</td>
<td>Eccentric work of hip flexors for progression in stance</td>
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<td>Hip and knee extensors in stance</td>
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<tr>
<td></td>
<td>Hip flexors (pulling) in pre-swing</td>
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<td>Internal rotation of trunk and pelvis on contralateral side</td>
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<td></td>
<td>Larger symmetrical hip power generation</td>
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<tr>
<td>General leg weakness</td>
<td>Hyperactivity ankle plantarflexors</td>
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<td></td>
<td>Co-contraction around knee</td>
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<td></td>
<td>prolonged activity of contralateral hip abductors</td>
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<tr>
<td>Reduced foot clearance</td>
<td>Pelvic up tilt on unaffected side</td>
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<tr>
<td></td>
<td>Pelvic hike</td>
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<tr>
<td></td>
<td>Circumduction, hip abduction, hip external rotation</td>
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<td></td>
<td>Hip flexion and/or knee flexion</td>
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<tr>
<td></td>
<td>Increased plantarflexion on unaffected side (vaulting)</td>
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<tr>
<td>Limited hip extension</td>
<td>Lumbar lordosis</td>
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<tr>
<td></td>
<td>Knee flexion to allow the pelvis to progress forward</td>
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<tr>
<td>Loss of lumbar lordosis (center of mass anterior)</td>
<td>Hip hyperextension, Crouch gait</td>
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<tr>
<td>Rotational knee instability/increased medial knee load</td>
<td>Lateral shift of center of mass (pelvic hike)</td>
</tr>
<tr>
<td>Patella &quot;out of line&quot; Q-angle increased</td>
<td>Reduced hip internal rotation</td>
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<tr>
<td>Leg length discrepancy</td>
<td>Hip/knee flexion and ankle dorsiflexion on unaffected side</td>
</tr>
<tr>
<td>Initial toe-contact</td>
<td>Early onset plantarflexors, reduced dorsiflexor activity</td>
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</tbody>
</table>
Gait Laboratory Assessments

• Common assessment devises:
  – Accelerometers / Gyroscopes
  – Photic / Computer assessment
  – Gait pad assessments
  – Computerized posturography

• Common measured variable:
  – Speed, stride length height pattern, stride variance
Gait Lab
General Treatment of Gait Problems

• Treat underlying problems
• Reduce/Eliminate culpable drugs
• Proper footwear (avoid bare feet)
• Safe fall area
• Improved lighting
• Therapy
  – Aerobic plus stretching
Pathologic Gait Classification

- Low level: physical inability (proprioception, vision, vestibular, weakness, mechanical)
- Middle level: abnormal stepping pattern (spastic, ataxic, dystonia, chorea)
- Higher level: inappropriate locomotion pattern (gait apraxia, gait freezing in parkinsonism)
Higher Center Gait Disorders

- Cautious gait
- Subcortical dysequilibrium
- Frontal dysequilibrium
- Isolated gait initiation failure
- Frontal gait disorder
Gait Disorder Classification: Anatomic

- Central Nervous Syndrome
- Perceptual Systems (vision sensation)
- Peripheral Nervous System
- Muscle
- Bone / Joints
- Energy Production (cardiovascular)
Non-Neurologic Gait Pathology

- Antalgic: shortened weight support
- Flat feet
- Abdominal problems: lordotic gait
- Orthopedic
  - Spine deformity: PD
  - Hip, knee, ankle, long bone
- Iatrogenic (many medications)
Specific Neurological Gait Pathologies

- Senile (cautious)
- hemi-paretic
- spastic paretic (bilateral)
- parkinsonian
- gait freezing (vascular parkinsonism)
- gait apraxia

- steppage gait
- foot drop gait
- myopathic gait (proximal)
- choreatic gait
- dystonic gait
- hysterical gait
Senile (Cautious) Gait

- small steps
- en bloc turns
- slow
- slightly broad base (women > men)
- No freezing or start hesitancy
- Like walking on ice!
Stasibasiphobia

• Cautious gait to the extreme
  – holding on to objects
  – very anxious
  – will improve with encouragement and token support
• a.k.a. Pseudoagorophobia
• a.k.a. Post fall syndrome
• a.k.a. Furniture Creepers
Gait Phobia
Hemi-paretic Gait

- Leg circumduction or pelvic elevation
- Can turn more easily to affected side
- Can walk more easily laterally to affected side
- Arm flexion
Spastic Paresis Gait

- Leg adduction (scissoring)
  - Obturator muscle
- Equivarous position
  - Posterior Tibialis muscle
- Short steps
Familial Spastic Paraplegia
Ataxic Gait

- Broad based
- Irregular
- Difficulty with tandem gait and stance
- Arms abducted
Ataxic Gait
Parkinson's Disease Gait

- decreased arm swing
- tremor exacerbation
- stooped posture
- en block turns
- festination
- shuffling
- preserved tandem gait
PD with Freezing and Postural Instability
Gait Freezing - PD
Vascular Parkinsonism Gait

- aka. Lower body parkinsonism
- aka. Binswanger’s disease
- aka. idiopathic NPH
- aka. “severe periventricular WMC”
- Manifest by freezing, broad based gait, decreased tandem gait, mild arm involvement
P.S.P. Gait

- Severe random, postural instability
- Freezing
- **Pivotal turns**, not en bloc
- May or may not be broad based
- Mild arm involvement
PSP
Apraxia of Gait

- Associated with frontal lobe dysfunction
  - Normal Pressure Hydrocephalus
  - Frontal lobe tumors or ischemia
- “march a petits pas”
- initiation difficulty
- small steps
- normal arm swing
- cannot walk over obstacles
Normal Pressure Hydrocephalus
Steppage Gait

- CMT, motor neuropathy
- Exaggerated hip and knee flexion
- Toes hit ground before heals
- Characteristic sound

- In S1 or Peroneal nerve injury, heals hit ground before toes
Foot Drop with S1 Radiculopathy
Proximal Myopathy Gait

- waddling due to pelvic weakness
- lordosis
- broad base
- difficulty climbing stairs
Myopathic Gait
Gait of Chorea

- Irregular, unpredictable
- Jerky
- Parakinesias
- Randomly wide based or scissoring
- May look psychogenic
Chorea Gait
Gait with Dystonia

- Task specific movements of legs
- Usually improves with other movements
  - walking backwards
  - walking up or down stairs
- Arm typically behind back
- May be bizarre
Dystonia Gait
Hysterical Gait

- variable and dramatic
- many near falls
- knee dipping
- hip and torso swaying
- often actually balancing on one leg
Psychogenic Gait
Psychogenic Gait
Miscellaneous Gaits
Manganese “Cock Walk” Severe

Cock Gait in Manganese Intoxication

Chin-Chang Huang, Nai-Shin Chu, Chin-Song Lu, and Donald B. Calne

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What Is This?
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Thank You

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