# Gait disorders

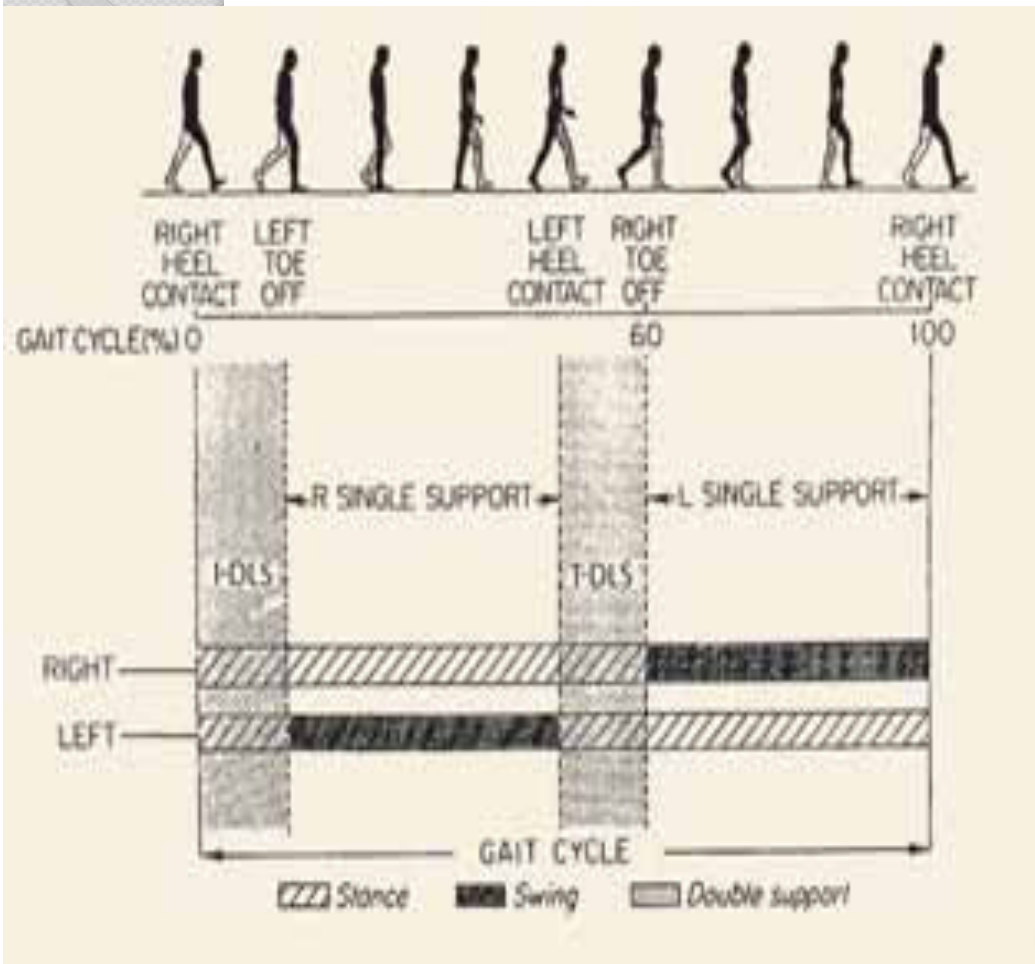## Amr Hasan, M.D.

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# Normal Gait Cycle



- **I-DLS** = initial double leg support
  - **T-DLS**= terminal double leg support
    - **Stance**: interval for foot of reference to be in contact with ground
- **Swing**: interval foot is off ground
- **Stride:** distance of a full gait cycle (heel strike of one foot to point of heel strike of same foot)
- **Step:** distance from heel strike of one foot to that of other foot
- **Speed:** Stride length and cadence

- *Rubenstein, Annals Long Term Care Feb 2004*

# Normal Gait

- Locomotion
  - Nervous system initiates and stops stepping

- Balance
  - Static postural reflex: standing
  - Anticipatory postural reflex: feed forward response
  - Reactive postural reflex: Feedback

- Adaptation:  Needs-
  - Information about environment/body position from proprioceptive, vestibular, and visual pathways
  - Ability to interpret/integrate information
  - Ability to produce force for muscle action
  - Ability to modulate force for optimal performance
  - Ability to select/adapt based upon person and environment

# Changes with Aging

- Slowing in average speed
  - Shorter stride length due to instability or muscle weakness
  - May compensate with increased cadence
- Increased step width
  - Compensation for problems with strength or balance (normal gait "on ice")

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# Changes with Age

- Romberg quotient:
  - Ratio of body sway values with eyes open and closed
  - Effect of visual stabilization on posture
  - Decreases with age
  - Suggests vision becomes more important for balance

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# Changes with Aging

- 15-20% elderly will have abnormal proprioception
- Decrease in vibratory and tactile sense
- Changes to vestibular system and slower postural support responses
- Sensory changes lead to more cautious, watching feet type gait

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# Abnormal Gait

- Pain
- Impaired Joint Mobility (arthritis, contractures)
- Weakness ( Myopathy, Neuropathy)
- Spasticity (stroke, cord lesion)
- Sensory/balance deficit (neuropathy, stroke)
- Impaired central processing (dementia, stroke, delirium, drugs)

- Rubentstein, Annals Long Term Care 2004

# Abnormal Gait: Pain

- Antalgic Gait: Painful hip
- Gonalgic Gait: painful knee
- Podalgic Gait: painful foot
- Decrease single limb support period (less time on bad leg)
- Shorter stride on opposite side
- Limp
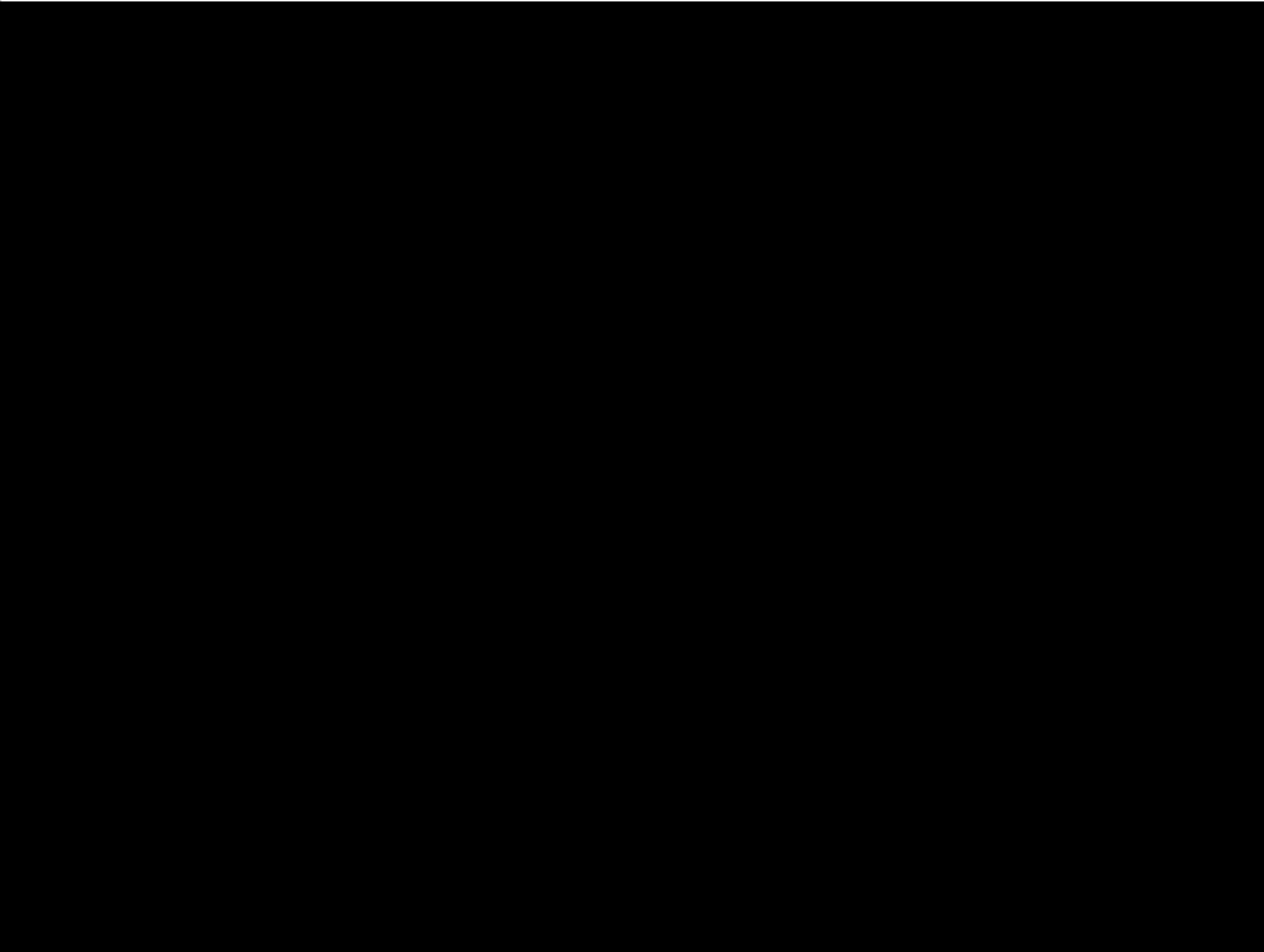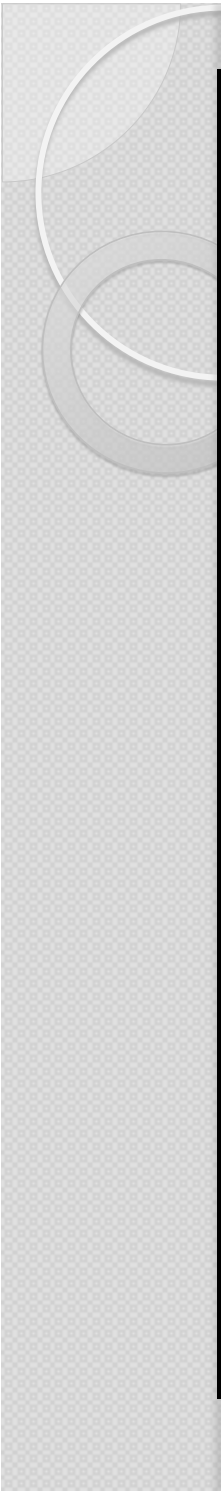
# Weakness

- Muscle
- Neuropathy
- Cardiac or pulmonary
- Anemia or other medical conditions
- Medications
- Orthostasis
- Metabolic

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# Weakness: Steppage Gait

- Foot Drop/ Dorsiflexor weakness
- Either drag feet or lift high (compensation with increased hip flexion = steppage gait)
- Appear to be walking up stairs
- Unable to walk on heels
- Circumduction if hip flexor muscles cannot compensate

# Weakness: myopathic Gait

- Hip girdle muscles are responsible for keeping the pelvis level when walking.

- If you have weakness on one side, this will lead to a drop in the pelvis on the contralateral side of the pelvis while walking (Trendelenburg sign).

- With bilateral weakness, you will have dropping of the pelvis on both sides during walking leading to waddling.

# Weak Hip Abductor

- The contralateral side of the pelvis drops b/c the weak glut. med. is unable to stabilize the pelvis
- The trunk leans over the ipsilateral side during stance phase

- This is referred to as a "Trendelenburg gait"

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Weak Gluteus Medius

Normal

Trendelenburg Sign
Drop of pelvis when lifting leg
opposite to weak gluteus medius

Stanford Medicine 25

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# Spasticity

- Resistance to joint movement in one direction.
- Hypertonicity, hyperreflexia, clonus
- Spinal cord or cerebral (upper neuron)
- Synergies: mass movement of group of muscles (flexion or extension)

# Spastic Hemiparesis

- Stroke/corticospinal tract lesion
- Description: one arm immobile and close to side with mass muscle group flexion; leg extended with plantar flexion of foot;  With walking, foot drags or circles outward and forward
- Circumduction

- Generally, with spasticity, there is an extension synergy in the LE (hip add, ext, IR & ankle PF, inv).

- Usually no reciprocal arm swing.

- Step length tends to be lengthened on involved side and shortened on uninvolved side.

# Scissors Gait

- Bilaterl spastic paresis of legs

- Stiff gait; each leg advances slowly, thighs cross forward with short steps

# Rigidity

- Increased resistance to joint movement in both directions
- Usually most apparent in trunk and proximal muscles
- Decreased trunk rotation
- Diminished arm swing
- Flexed posture
- Shuffling gait
- Short steps

# Parkinsonian Gait

- Stooped posture
- Head and neck forward
- Hips and knees slightly flexed
- Slow initiation of gait
- Festination: speeding up
- Propulsion: tendency to fall forward with walking)
- Short, shuffling steps (marche a petit pas)
- Decreased arm swings
- Patient turns stiffly, in "one piece" or "en bloc"

# Hyperkinetic gait

- Chorea

- Athetoid cerebral palsy

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# Proprioceptive Loss: Sensory Ataxia

- Positive Romerg with eyes closed
- Wide, irregular, uneven steps
- Unsteady, wide based gait
- Throw feet forward and out and bring them down first on heels and then toes (double tapping sound)
- Watch ground
- Positive Romberg (cannot stand with feet together and eyes closed)

# Vestibular system

- Gait unsteadiness
- Inability to walk down stairs independently
- Decreased ocular fixation during motion leading to sense that world is "jiggling"
- May be unable to drive, or need to stop walking to read a sign
- "Vestibular Ataxia"
- Vertigo or nystagmus with standing/walking

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# Balance Loss due to Cerebellar problems

- Lack of coordination of proprioceptive, vestibular, and visual information in reflex movements needed to make adjustments to changes in posture
  - Wide based
  - Unsteadiness
  - Irregularity of steps
  - Lateral veering

# Cerebellar Ataxia

- Staggering
- Wide based
- Exaggerated difficulty with turns
- Cannot stand steady with feet together (with eyes open or closed)

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# Dysfunction in Central Integration

- Gait Apraxia: Inability to process nerve impulses to walk
  - Difficulty initiating or changing direction
    - Bradykinesia
- Festination or retropulsion: involuntary acceleration
  - Shuffling
  - Wide based gait

# Dysfunction in Central Integration

- Dementia, frontal lobe disease, NPH
  - Gait hesitation
  - Freezing/abulia

# Assessment

- History and Physical
  - Neurological Exam
    - Vision
  - Orthostatics
  - Observation of Gait
- Targeted Gait and Balance Assessments

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# Neurological Exam

- Test for retropulsion
  - Examiner stands behind patient, vigorously pulls patient backward at the shoulders; normally patient will regain center of gravity with step backward and truncal flexion
  - Difficulty with compensation in Parksinsonism

# Assessment: Neurological Exam

- Romberg
  - Worse with eyes closed = sensory ataxia
    - Poorly with eyes open/closed: motor ataxia (cerebral cortex), vestibular or cerebellar
- Tandem Walking
  - Compass Test
  - Walk on heels
  - Walk on toes

# Tandem Walking

- Walk straight line heel to toe
- Exacerbates all gait problems
- Worse with vestibular and cerebellar problems
- Truncal ataxia with vermis and cerebellar disease

# Compass Test

- Have patient walk 8 steps forward and 8 steps back

- May have patient walk beside you with eyes closed to remove visual cues

- Vestibular or cerebellar disease: stray from path

# Walk on heels

- Cannot be done with motor ataxia, spastic paraplegia or foot drop

# Walk on toes

- Cannot be done with parkinson's, sensory ataxia, cerebellar disease, spastic hemiplegia

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# Get Up and Go Test

- Patient stands from chair, walks 3 meters, turns around, walks back and sits down

- Single overall judgment score: 1- 5 (normal to very abnormal)

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# Timed Up and Go Test

- High reliability
- Clinical Signficance
  ◦ Times over 10 seconds highly associated with risk for falls

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# Chair Rise

- Arms crossed, stand from chair
- If able to do this, can have patient stand from chair 5 times
  - Normal:  under 13 seconds

# Tinetti Performance-Oriented Mobility Assessment (POMA)

# Tinetti Balance Evaluation

| | | |
|---|---|---|
| 1. Sitting Balance | Leans or slides in chair<br>Steady, Safe | =0<br>=1 |
| 2. Arises | Unable<br>Able with  arms<br>Able without arms | =0<br>=1<br>=2 |
| 3. Attempts to arise | Unable<br>Able with more than one try<br>Able with one try | =0<br>=1<br>=2 |
| 4. Immediate Standing Balance (first 5 sec) | Unsteady<br>Steady with walker/cane/support<br>Narrow stance without support | =0<br>=1<br>=2 |
| 5. Standing Balance | Unsteady<br>Steady with wide stance<br>Narrow stance without support | =0<br>=1<br>=2 |
| 6.  Nudged | Begins to fall<br>Staggers/grabs but catches self<br>Steady | =0<br>=1<br>=2 |
| 7. Eyes closed with feet together | Unsteady<br>Steady | =0<br>=1 |
| 8. Turning 360 degrees | Discontinuous Steps<br>Continuous steps<br>Unsteady<br>Steady | =0<br>=1<br>=0<br>=1 |
| 9. Sitting Down | Unsafe<br>Uses arms/not smooth<br>Safe/Smooth | =0<br>=1<br>=2 |

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# Tinetti Gait Evaluation

| | | |
|---|---|---|
| **10. Initiation of gait after told to "go"** | Any hesitancy or multiple attempts to start<br>No hesitancy | =0<br>=1 |
| **11. Step Length and Height** | **Right swing foot:**<br>Does not pass left stance foot<br>Passes left stance foot with step<br>Right foot does not clear floor with step<br>Right foot completely clears floor<br>**Left swing foot:**<br>Does not pass right stance foot<br>Passes right stance foot with step<br>Left foot does not clear floor with step<br>Left foot completely clears floor with step | <br>=0<br>=1<br>=0<br>=1<br><br>=0<br>=1<br>=0<br>=1 |
| **12. Step symmetry** | Right and left foot step length unequal<br>Right and left foot step appear equal | =0<br>=1 |
| **13. Step continuity** | Stopping or discontinuity between steps<br>Steps appear continuous | =0<br>=1 |
| **14. Path** | Marked deviation<br>Mild/moderate deviation or uses aid<br>Straight without walking aid | =0<br>=1<br>=2 |
| **15. Trunk** | Marked sway or uses walking aid<br>No sway but flexion of knees or back or spreads arms while walking<br>No sway/flexion/arm use/no aid | =0<br>=1<br><br>=2 |
| **16. Walk Stance** | Heels apart<br>Hells almost touching while walking | =0<br>=1 |

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# POMA

- Patients stand from chair without using arms, step forward, put feet close together, receive mild nudge to sternum, close eyes, turn 360, walk about 25 feet at normal speed, turn around, walk back at faster speed, sit down
  - Total score: 0-28

- Reproducible, sensitive, 3 minutes
- Score less than 20: 5 x risk for falling

# Video Clips of Abnormal Gait

- http://library.med.utah.edu/ neurologicexam/html/ gait_abnormal.html#01