UNDERSTANDING NORMAL & PATHOLOGICAL GAIT

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Objectives:

► To understand basic components and terminology of gait.
► To understand common gait abnormalities and attempt to treat them.
Gait Cycle - Definitions:

- **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 - Definitions:

- **Gait Cycle** =
  - Single sequence of functions by **one limb**
  - Begins when reference font contacts the ground
  - Ends with subsequent floor contact of the **same foot**
Gait Cycle - Definitions:

- **Step Length:**
  - Distance between 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 the two feet
Gait Cycle - Definitions:

- **Cadence:**
  - 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
  - Instantaneous velocity varies during the gait cycle
  - Average velocity (m/min) = step length (m) x cadence (steps/min)

- **Comfortable Walking Speed (CWS):**
  - Least energy consumption per unit distance
  - Average = 80 m/min (~ 5 km/h, ~ 3 mph)
A. Gait Cycle - Subdivisions:

A. Stance phase: (60%)
   1. Heel Strike
   2. Foot-flat: ‘Loading response’
   3. Midstance
   4. Heel-off
   5. Toe-off: ‘Pre-swing’

B. Swing phase: (40%)
   1. Initial swing: ‘Acceleration’
   2. Midswing:
   3. Terminal swing: ‘Deceleration’

Single vs. Double support (of Stance phase limb):
- Single support (40%)
- Double support (20%)
Path of Center of Gravity

- **Center of Gravity (CG):**
  - midway between the hips
  - Few cm in front of S2
  - Least energy consumption if CG travels in straight line

- **Overall displacement of CG:**
  - Sum of vertical & horizontal displacement
  - Figure ‘8’ movement as seen from AP view
GAIT

- Low muscular demand:
  - \(~ 20\%-25\% \text{ max. muscle strength}~
  - MMT of \(\sim 3^+\)
COMMON GAIT ABNORMALITIES

A. Antalgic Gait
B. Lateral Trunk bending
C. Functional Leg-Length Discrepancy
D. Increased Walking Base
E. Inadequate Dorsiflexion Control
F. Excessive Knee Extension
G. Rhythmic disturbances
“Don’t walk behind me, I may not lead. Don’t walk ahead of me, I may not follow. Walk next to me and be my friend.”

Albert Camus
A. Antalgic Gait

- Gait pattern in which stance phase on affected side is shortened
- Corresponding increase in stance on unaffected side
- Common causes: OA of hip or knee, bursitis, tendinitis
B. Lateral Trunk bending

- **Trendelenberg gait**
- Usually unilateral
- Bilateral = waddling gait
- Common causes:
  A. Painful hip
  B. Hip abductor weakness (e.g. L4, L5, S1 radiculopathy)
  C. Leg-length discrepancy
  D. Abnormal hip joint
Ex. 2: Hip abductor load & hip joint reaction force

Fig. 3.2 Schema of single legged stance: the force in the left hip is the sum of the mass of the trunk, the mass of the right leg, and the contraction force of the abductor muscles (see note to Fig. 3.1).

Fig. 3.3 Lateral trunk bending reduces the clockwise moments about the left hip, permitting the pelvis to be stabilized by a smaller abductor force, with a corresponding reduction in hip joint force (see note to Fig. 3.1).
C. Functional Leg-Length Discrepancy

- Swing leg: longer than stance leg
- 4 common compensations:
  A. Circumduction
  B. Hip hiking
C. Functional Leg-Length Discrepancy

- common compensations:

  C. Steppage
  D. Vaulting
D. Increased Walking Base

- Normal walking base: 5-10 cm
- Best seen from: Front/behind
- Common causes:
  - Deformities
    - Abducted hip
    - Valgus knee
  - Instability
    - Cerebellar ataxia
    - Proprioception deficits
E. Inadequate Dorsiflexion Control

► In stance phase
(Heel contact – Foot flat):

Foot slap

► In swing phase
(mid-swing):

Toe drag

► Best seen from: Side

► Causes:

- Weak Tibialis Ant. (e.g. stroke; peripheral neuropathy; L4, L5 radiculopathy)
- Spastic plantarflexors
F. **Excessive knee extension**

- Loss of normal knee flexion during stance phase
- Knee may go into hyperextension
- *Genu recurvatum:* hyperextension deformity of knee due to prolonged stretching of knee capsule
- Best seen from: Side
- Common causes:
  - Quadriceps weakness
  - Quadriceps spasticity
  - Knee flexor weakness
G. Rhythmic Gait disturbances

► Abnormalities in the timing of the gait cycle

1. Asymmetric: difference in timing between the two legs. e.g.:
   - Antalgic gait: short time on pathological side, longer on normal side. Asymmetric between the two sides but generally regular.

2. Irregular: timing differences between one stride and the next. e.g.:
   - Cerebellar ataxia
   - Proprioception deficits
THANK YOU