* Gait Analysis Essentials
* Lori Karol MD
* Assistant Chief of Staff
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* Illustrative case
  + 14 yo male with hereditary spastic paraparesis
  + Previous adductor release, medial and lateral hamstring lengthenings, and tendoachilles lengthenings
  + Referred to address knee flexion contractures and hip adduction
* Clinic Visit
  + Referred to movement science lab for evaluation
  + Ordered AP pelvis xray
  + Left hip mildly subluxated
* Clinical Question:
  + Should he have surgery?
  + Should I do hamstring lengthenings again?
  + Should I do a femoral extension osteotomy?
  + Gastrocnemius surgery?
  + Rectus transfer?
* Components of Gait Study
* 1. Clinical examination
* Clinical Gait Studies: 2. Video
* 3. Cadence Parameters
  + Cadence (steps/minute)
  + Step length (each leg)
  + Walking speed (m/sec)
  + Double vs single leg support
* 4. Kinematics
  + The motion of the trunk, hip, knee, and ankle during gait
  + Data gathered by tracking markers
* 4. Kinematics
  + Computer takes data on joint motion and creates a stick man that moves exactly like the human subject
* Kinematic Graphs
  + Initial contact occurs at far left of box
  + Stance phase is left of vertical line
  + Swing phase is right of vertical line
* GAIT CYCLE
* STANCE PHASE
* INITIAL CONTACT: Time when foot (normally the heel) makes contact with floor.
  + Tibialis anterior on to dorsiflex ankle.
* LOADING RESPONSE
  + Forefoot gently lowers to ground.
  + Tibialis anterior on but ECCENTRIC contraction: ankle is plantarflexing.
  + Tib ant pulls the knee forward into flexion.
* MIDSTANCE PHASE
  + Progressive dorsiflexion of the ankle as the tibia (and the body!) moves forward over foot.
  + Gastrocsoleus on eccentrically to control dorsiflexion.
  + Knee extends.
  + Hip extends.
* TERMINAL STANCE
  + Heel rises off the floor to prepare for swing phase.
  + Strong concentric contraction of the gastrocsoleus muscle.
  + Provides power in PUSH-OFF.
* ROCKERS
  + Movement of the ankle during stance phase
  + Linked to shock absorption and power generation
* INITIAL SWING
  + Strong contraction of the hip flexors (especially the iliopsoas) to lift the leg off the ground.
  + Knee passively flexes.
* MIDSWING PHASE
  + Not much muscle activity.
  + Knee swinging from flexion into extension
  + Hip flexed
  + Tibialis anterior is on for foot clearance.
* TERMINAL SWING PHASE
  + Goal – preparation for initial contact
  + Quadriceps on to kick knee into full extension.
  + Hamstrings on (eccentric) to stop hip flexion.
  + Tibialis anterior (concentric) to keep ankle dorsiflexed.
* Clinical Case
  + Knees are nearly fully extended during midstance phase
    - They are stiff in swing phase
* Abnormal ankle kinematics but no severe equinus
* 5. Kinetics  
  The forces during walking
* KINETICS
  + Gastrocsoleus concentric contraction produces power to push the foot off the ground and initiate swing phase.
  + If the gastroc doesn’t work, calcaneus gait.
* CALCANEUS GAIT
  + Common in teenage diplegics
  + Prior tendoachilles lengthening
* CALCANEUS GAIT
  + Kinematics: excessive dorsiflexion and lack of plantarflexion in 3rd rocker
  + Kinetics: minimal power generation at end of stance
* 6. EMG DATA

EMG collected simultaneously with kinematics

* + Anterior tibialis is monitored with surface electrode.
  + Posterior tibialis monitored with electrode inserted into calf.
* EMG DATA
  + Muscle activity is measured during gait and correlated with the joint movements.
* EMG
  + Cerebral palsy: lack of inhibition of muscle activity during gait.
  + Tendon transfers often performed to “rebalance” foot.
  + EMG can help select correct muscle for transfer
* 7. PEDOBAROGRAPH

Pressure mapping force plate that quantifies pressure in different areas of foot (masks) during gait.

But What if No Gait Lab?

* You can reproduce the majority of a gait study with careful physical examination and observation of gait (video helpful)
* EXAMINATION
  + down and look from the level of the child
  + Small children will walk away from you to their parents
* OBSERVATION OF GAIT
  + Look for asymmetry in the proportion of time spent in stance and swing phase.
  + Look for asymmetry in step length (cadence parameters)
* Spastic Gait
  + ↓ step length (tight muscles prevent excursion of limb): cadence parameter
  + ↓ dynamic range of motion of lower extremities: kinematics
* EXAMINATION
  + Watch the child walk from the front, back, and sides (recreate kinematics)
  + Look at each joint separately and systematically
* Jump Gait
  + Plantarflexion ankle during stance phase
  + Toe walkers
  + Variable flexion at knee and hip
  + Can be uni or bilateral

Crouch Gait

* + Flexion of knee and hip (hamstrings/flexors)
  + Excessive dorsiflexion of ankles
  + Looks like sitting down
  + Very energy inefficient: SLOW!

STIFF KNEE GAIT

* + Spasticity in rectus femoris prevents knee flexion in swing phase
  + Can see on EMG
  + Most likely if hamstrings lengthened