* Gait Analysis Essentials
* Lori Karol MD
* Assistant Chief of Staff
* Medical Director, Movement Science Lab
* 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