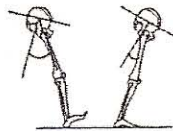


Physical Examination for Gait Analysis

by

Jean Stout, PT, MS

Physical Examination for Gait Analysis: How does it fit with Kinematics?

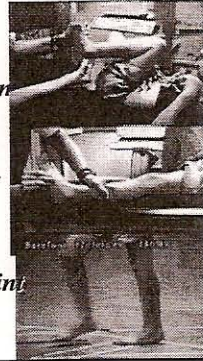


Gillette Children's
Episcopal Hospital

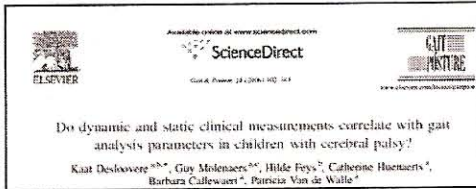
Jean Stout MS, PT
Center for Gait & Motion Analysis

One of the segments vital to gait analysis interpretation

- exam vs. kinematic angles depend on consistency of definition
- differences in muscle function between wt. bearing and non-wt. bearing positions
- how the model defines and determines joint angles and joint center locations



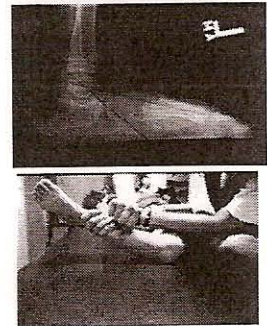
Important to know:



Dynamic Model is better predictor than static model for 85%
Of the gait parameters

Components of Physical Exam

- bony deformity
- x-ray evaluation
- soft tissue tightness
- range of motion
- muscle strength
- spasticity
- selective motor control
- foot exam (WB, NWB)

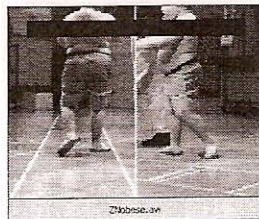


Physical Exam & Anatomic Measurements

Pelvis

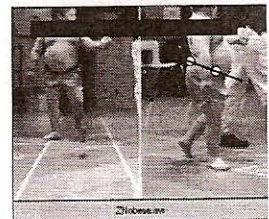
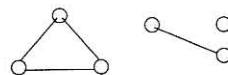
joint center location depends
on accurate measurement of
inter ASIS measurement

placement of markers will
directly affect pelvic tilt
measurement



Physical Exam & Anatomic Measurements

Pelvis



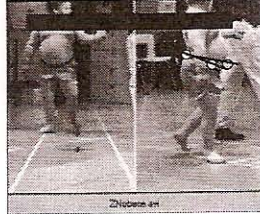
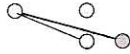
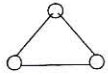
Physical Examination for Gait Analysis

by

Jean Stout, PT, MS

Physical Exam & Anatomic Measurements

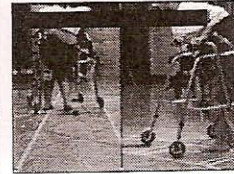
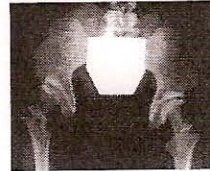
Pelvis



Physical Exam & Anatomic Measurements

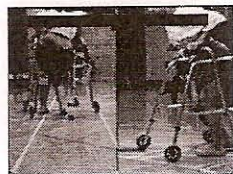
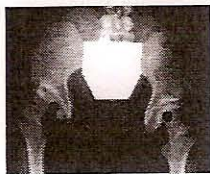
Hip

*joint center location depends
assumes normal anatomy*



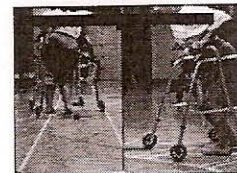
Physical Exam & Anatomic Measurements

Hip Suluxation



Physical Exam & Anatomic Measurements

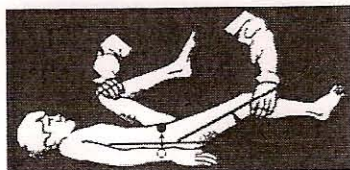
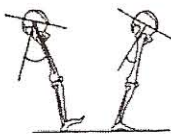
Hip Suluxation



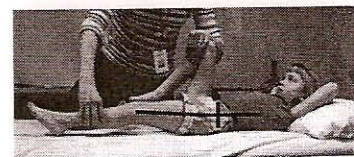
Physical Exam & Kinematics

Hip-Sagittal Plane

*relative angle between long axis of thigh and a
perpendicular to the pelvic plane along a line
connecting the ASIS*



Thomas Test

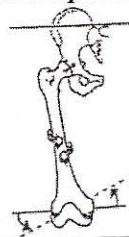


Physical Examination for Gait Analysis

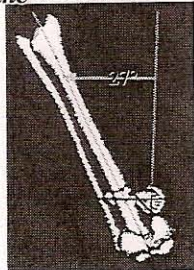
by
Jean Stout, PT, MS

Physical Exam & Kinematics Hip-Transverse Plane

the motion of the thigh segment (as defined by the flexion-extension axis) relative to the ASIS line in the pelvic plane



physical exam issues:
torsional deformity
& range of motion



Physical Exam & Kinematics

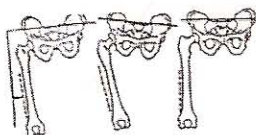
Hip-Transverse Plane



amount of internal rotation required to position the trochanter in most lateral position parallel to frontal plane.

Physical Exam & Kinematics

Hip-Coronal Plane



the relative angle between the long axis of the thigh and a perpendicular to the pelvic plane as viewed from the front of and in the pelvic plane

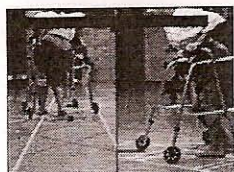
To consider...Hip Flexors/Adductors



- possible true HF/ADD tightness or spasticity vs. weakness
- impact of HF tightness on pelvic position - impact on functional HS length (HS shift)
- impact of abductor weakness/spasticity on pelvic position
- impact of medial hamstring tightness on adductor measurements

Physical Exam & Kinematics

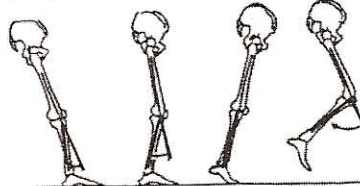
Hip-Coronal Plane



tightness of the hip adductors/ weakness of the abductors is highly influenced by weight bearing, bony deformity. Kinematics influenced by trunk position and compensations.

Physical Exam & Kinematics

Knee-Sagittal Plane



the relative angle between the long axis of the thigh and the shank segments as viewed along the knee flexion extension axis.

Physical Examination for Gait Analysis

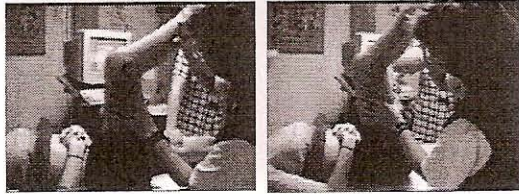
by

Jean Stout, PT, MS

Physical Exam & Kinematics

Knee-Sagittal Plane

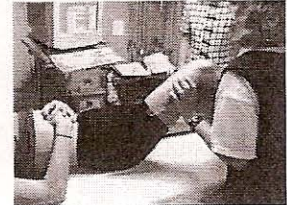
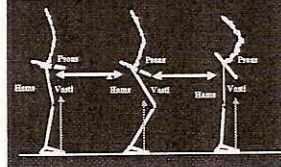
*hamstring tightness/hamstring shift/capsular contracture
rectus femoris tightness/spasticity*



Hamstring Tightness vs Hamstring Shift

Impact of hip flexor tightness on pelvic position
impacts functional HS length (HS shift)

The Hamstring Shift



Components of Physical Exam

Rectus Femoris Spasticity/Tightness



Ashworth Scale

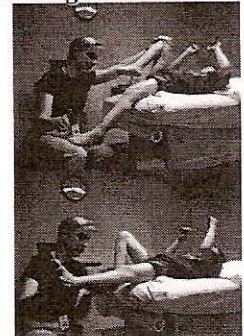
- 1 no increase in tone
- 2 slight increase in tone
- 3 more marked increase in tone
- 4 considerable increase in tone
- 5 affected part rigid

Physical Exam & Kinematics

Knee-Sagittal Plane Extensor Lag

*the difference between
the active and passive
range of motion during
knee extension*

*deficiency of extensor
control - position
eliminates influence of
hamstring tightness*



Screening for Patella Alta



- To screen, position patient supine with knees extended. Palpate the top of the patella.
- The superior edge of the patella is typically one finger width proximal to the adductor tubercle

Physical Exam & Kinematics

Knee-Sagittal Plane

knee kinematic is influenced by:



*standing posture
speed of movement
hip
ankle*



Physical Examination for Gait Analysis

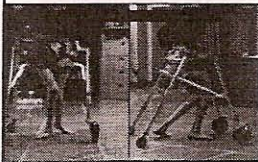
by

Jean Stout, PT, MS

Physical Exam & Kinematics

Knee-Transverse Plane

the motion of the shank segment (as defined by a line between the medial and lateral malleoli) relative to the distal transcondylar line in the plane of the thigh



*through knee joint
rotation*

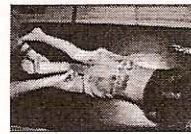
ligamentous laxity



Physical Exam & Kinematics

Tibial Torsion

Second Toe Test

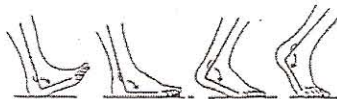


*Eliminates the rotational
instability of the knee in
flexion*

Physical Exam & Kinematics

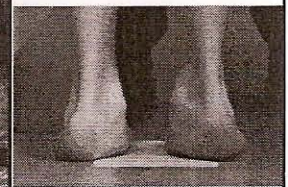
Ankle -Sagittal Plane

the relative angle between the long axis of the shank and the plantar aspect of the foot as views from an axis perpendicular to the shank-foot plane



Physical Exam & Kinematics

Ankle -Sagittal Plane

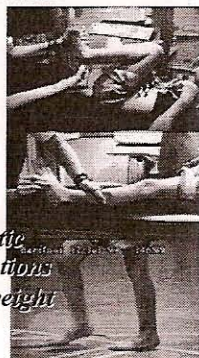


Physical Exam & Kinematics

Ankle -Sagittal Plane

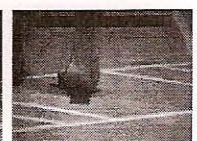
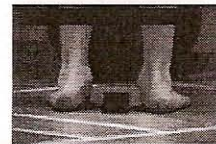
*in the presence of foot deformity
restraint of motion at one joint is
often accommodated by excessive
motion at other joints*

*often discrepancies between kinematic
and physical exam are related to motions
at other joints or the force of body weight
in stance phase vs. testing in supine*



Other Physical Exam Issues

Ankle - Subtalar Joint - Midtarsal Joint

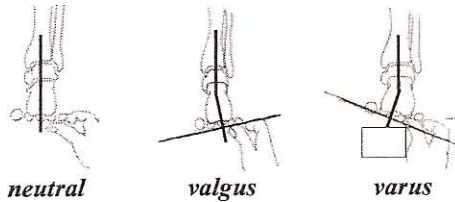


Physical Examination for Gait Analysis

by
Jean Stout, PT, MS

Non-Weightbearing Foot Exam

Assess the position of hindfoot relative to tibia and forefoot in relation to hindfoot in a subtalar neutral position



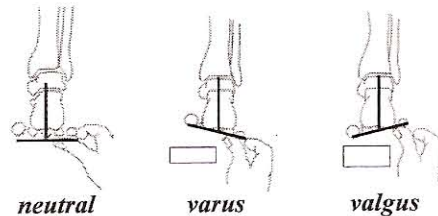
neutral

valgus

varus

Non-Weightbearing Foot Exam

Assess the position of hindfoot relative to tibia and forefoot in relation to hindfoot in a subtalar neutral position



neutral

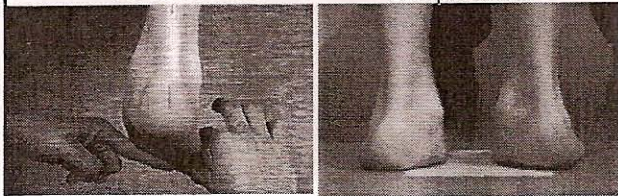
varus

valgus

Weightbearing Compensations

Forefoot Varus

Compensated

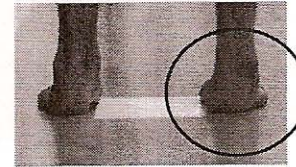


Non-Weightbearing

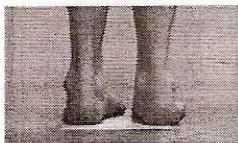
Weightbearing

- which comes first, the hindfoot valgus or the planus?

which comes first, the hindfoot varus or the plantarflexed first ray?

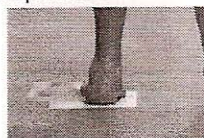


Coleman Block Test



Hindfoot varus and forefoot adductus...

- Is this a flexible foot?
- Which part of the foot is the cause and which is the compensation?



Other Physical Exam Issues

Strength

assessed simultaneously with selectivity to provide a broad picture strength
standard manual muscle test 0-5 scale



Physical Examination for Gait Analysis

by
Jean Stout, PT, MS

Other Physical Exam Issues

Strength

Clinically, strength is actually the ability to produce an adequate moment at a joint: $M = F \times d$

Muscles work in isotonic and eccentric modes - but tested isometrically

Function in both distal end fixed and distal end free conditions

Other Physical Exam Issues

Strength



Other Physical Exam Issues

Motor Control

Selectivity Scale: assessed simultaneously with strength to provide a broad picture of selective motor control

- 0 Patterned Movement Only (synergy)
- 1 Partially Isolated Movement (associated rxns)
- 2 Completely Isolated Movement

Other Physical Exam Issues

Motor Control/Strength

Spasticity/Muscle Tone

Ashworth Scale

- 1 No Increase in Tone
- 2 Slight Increase in Tone
- 3 More Marked Increase in Tone
- 4 Considerable Increase in Tone
- 5 Affected Part Rigid



SPASTICITY (Ashworth Scale)

Hip flexors	_____	_____
Adductors	_____	_____
Hamstrings	_____	_____
Rectus femoris	_____	_____
Plantar flexors	_____	_____
Posterior tibialis	_____	_____
Ankle clonus	_____	_____

Hypertonia Assessment Tool-Discriminant

Features	Body Part									
	Head/Neck		Upper Extremities				Lower Extremities			
	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
1. Sustained strong flexion of neck	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
2. Sustained strong flexion of arm										
3. Sustained strong flexion of arm										
4. Sustained strong flexion of arm										
5. Sustained strong flexion of arm										
6. Sustained strong flexion of arm										
7. Sustained strong flexion of arm										
8. Sustained strong flexion of arm										
9. Sustained strong flexion of arm										
10. Sustained strong flexion of arm										
11. Sustained strong flexion of arm										
12. Sustained strong flexion of arm										
13. Sustained strong flexion of arm										
14. Sustained strong flexion of arm										
15. Sustained strong flexion of arm										
16. Sustained strong flexion of arm										
17. Sustained strong flexion of arm										
18. Sustained strong flexion of arm										
19. Sustained strong flexion of arm										
20. Sustained strong flexion of arm										

Other Physical Exam Issues

Motor Control/Strength

Balance & Motor Planning



Gillette Children's Specialty Healthcare
Physical Assessment

Name: _____

MR#: _____

DOB: _____

	MOTION		SELECTIVITY, STRENGTH	
	L	R	L	R
HIPS				
Flexion	_____	_____	_____	_____
Extension	_____	_____	_____	_____
Thomas test	_____	_____	_____	_____
knee 0	_____	_____	_____	_____
knee 90	_____	_____	_____	_____
Abduction	_____	_____	_____	_____
hips extended	_____	_____	_____	_____
hips flexed	_____	_____	_____	_____
Adduction	_____	_____	_____	_____
Ober test	_____	_____	_____	_____
Internal rotation	_____	_____	_____	_____
External rotation	_____	_____	_____	_____
Anteversion	_____	_____	_____	_____
KNEE				
Extension	_____	_____	_____	_____
Flexion	_____	_____	_____	_____
prone	_____	_____	_____	_____
supine	_____	_____	_____	_____
Popliteal angle	_____	_____	_____	_____
unilateral	_____	_____	_____	_____
bilateral	_____	_____	_____	_____
HS shift	_____	_____	_____	_____
Extensor lag	_____	_____	_____	_____
Patella alta	_____	_____	_____	_____
TIBIA				
TF angle	_____	_____	_____	_____
BM axis	_____	_____	_____	_____
2nd toe test	_____	_____	_____	_____
ANKLE SUBTALAR				
Dorsiflexion	_____	_____	_____	_____
knee 90	_____	_____	_____	_____
knee 0	_____	_____	_____	_____
Confusion test	_____	_____	_____	_____
Plantarflexion	_____	_____	_____	_____
Anterior tibialis	_____	_____	_____	_____
Posterior tibialis	_____	_____	_____	_____
Peroneus longus	_____	_____	_____	_____
Peroneus brevis	_____	_____	_____	_____
Extensor hallucis longus	_____	_____	_____	_____
Flexor hallucis longus	_____	_____	_____	_____

Selectivity Grade Key
 0 - Only patterned movement observed.
 1 - Partially isolated movement observed.
 2 - Completely isolated movement observed

Range of Motion
 NEU = Neutral w/ Stretch

	FOOT POSITION	
	L	R
FOOT NON-WEIGHTBEARIN		
Subtalar neutral	_____	_____
Hindfoot position	_____	_____
Hindfoot motion	_____	_____
eversion	_____	_____
inversion	_____	_____
Arch	_____	_____
Midfoot motion	_____	_____
Forefoot position 1	_____	_____
Forefoot position 2	_____	_____
Bunion def.	_____	_____
1st MTP DF	_____	_____
FOOT WEIGHTBEARING		
Hindfoot position	_____	_____
Midfoot position	_____	_____
Forefoot position 1	_____	_____
Forefoot position 2	_____	_____
SPASTICITY (Ashworth Scale)		
Hip flexors	_____	_____
Adductors	_____	_____
Hamstrings	_____	_____
Rectus femoris	_____	_____
Plantarflexors	_____	_____
Posterior tibialis	_____	_____
Ankle clonus	_____	_____
Ashworth Scale		
1 - No increase in tone		
2 - Slight increase in tone		
3 - More marked increase in tone		
4 - Considerable increase in tone		
5 - Affected part rigid		
POSTURE / TRUNK		
Abdominal Strength	_____	_____
Back Extensor Strength	_____	_____
LIG LAXITY		
_____	_____	_____
LEG LENGTH		
_____	_____	_____

STANDING POSTURE

BALANCE

COMMENTS

Hypertonia Assessment Tool – Discriminant (HAT-D)¹

Clinical assessment of nine different features of hypertonia (based on definitions of tone¹) for five different body areas (head/neck, arms, legs)

Feature	Body Part									
	Head/Neck		Upper Extremity				Lower Extremity			
			Left		Right		Left		Right	
Examined Body Part at Attempted Rest	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
1. Increased Resistance to Passive Stretch										
2. Spastic Catch										
3. Velocity Dependent Resistance to Passive Stretch										
4. Equal Resistance to Passive Stretch in Different Direction										
5. Variable Abnormal Postures										
6. Slow Twisting Quality of Involuntary Movements/Postures										
7. Fluctuation of Tone with Multiple Trials										
8. Increased Tone with Voluntary Movement of Distant Body Part										
9. Increased Involuntary Movement/Twisting Posture with Voluntary Movement of a Distant Body Part										

Scoring: Each body part must have hypertonia (Yes to item 1) to be scored further

Spasticity: For each limb, must have Yes to item 2 or 3

Rigidity: For each limb or head/neck, must have Yes to item 4

Dystonia: For each limb or head/neck, must have Yes for items 5 & 6 and at least one of 7, 8, or 9

Subject ID number:

Subject Name:

Subject Birthdate:

Evaluation Date:

¹ Sanger TD, Delgado MR, Gaebler-Spira D, Hallett M, Mink JW, Task Force on Childhood Motor Disorders. (2003). Classification and definition of disorders causing hypertonia in childhood. *Pediatrics*, 111, 89-97.