Measuring The Child

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Measuring The Child

- Analyzing Gait
- Observation Is Key to your evaluation
- After noting any areas of concern on your exam, it can then direct you to further investigation
Measuring The Child

- Observation Techniques
- Stand
- Check the Base of Gait, Posture
- Close Their Eyes
- Observe them Walking
  - Shoes on and off
What to Look At

- “Top to Bottom” “Head To Toe’
- Head and Shoulder
- Arm position and Swing
- Pelvic Height
- Symmetry and Step Length
What is normal and at what age?
Lower Extremity Examination of the Infant

JAMES V. GANLEY, DPM

In this paper the author attempts to share his extensive experience in the examination of lower extremity infant deformities. He recommends an initial overview of the limb position, followed by an orderly and specific study of each component of the foot and leg. The reader will find many practical clinical hints in the specifics of this examination method which are seldom mentioned in standard texts. The author emphasizes the responsibility of the examiner to inform both parent and referring physician of the presence and nature of the problem in terms which are readily understood.

Pediatric patients will seldom present peripheral vascular or dermatologic problems. Attention, therefore, is directed toward the musculoskeletal system and in some cases the neuromuscular system. Conservation of time in a busy clinical practice dictates that the examination be comprehensive, but simple. This can only be accomplished through a logical sequence of questions, observations, and maneuvers consistently applied. The outcome of a good examination is to observe and record pertinent features related to the condition.

At the initial interview, it is better to avoid physical and eye contact with the child. Talking directly to the child or touching him is often interpreted as a threat, causing a fear response. It is better to address the parent in a soft conversational tone as a friendly neighbor would do, thus allowing the child time to study and accept you. In this manner, a brief record is obtained including the birth, developmental, and family history.

The baby is then placed on a flat, padded examining table which is covered with a large paper drape. Most parents are receptive to the doctor recording his observations aloud as he examines the child. The practitioner or his assistant makes a simultaneous record of the findings as the examination progresses.

It is not difficult to identify the location and nature of biomechanical problems if the examination proceeds from general to specific. Rule: Examine the foot and leg of infants by using the R.T.M.

A. Attitude at Rest

Here one may wish to observe the infant in both the prone and supine attitudes since these are the only positions he is able to assume. The most demonstrative maneuver is to hold the child's knees parallel and straight, and then note the attitude of the legs and feet. (Figs. 1 and 2). A simple statement should record the general attitude and position for example, the feet and ankles are medially rotated and the left foot is in equinus.

One must not be too hasty in concluding that a position of deformity at any given moment is the true attitude at rest. If in doubt, the limb may be held by the calf and gently shaken into flexion. If the part cannot be shaken out of the fixed attitude, or if it promptly returns to the position of deformity, it is best to diagnose the condition.

1 In order to avoid confusion, it must be pointed out that rocking the limb loose is also used to suspected muscle spasticity. A true spastic will not loosen up with shaking since the stimulus of the movement further excites the spastic muscles.

Journal of the American Podiatry Association
*Attitude at Rest
*Relationship of Component Parts
*Motion of Joints

*Ganley
Measuring the Child

* Attitude At Rest
Measuring the Child

- **Relationship to Component Parts**
- Thigh and Body
- Ankle to Knee
- Rearfoot To Leg
- Forefoot To RF
RELATIONSHIP TO COMPONENT PARTS

- Thigh and Body
  - Femur assume a lateral rotation
- Ankle to Knee
  - Knees face anteriorly, worry about torsion
- Rearfoot to Leg
  - Grasp the heel and look for abnormality in sagittal and frontal planes
- Forefoot to Rearfoot
  - Look plantarly, met adductus or abductus
  - Then look at forefoot varus and valgus
Measuring the Child
Measuring the Child

- Motion Of Joints
- Active Movements Observed
- Passive Movements Measured
Abnormalities of Gait in Pediatrics

Rotational Abnormalities

* Angle of Gait
* Patellar Position
* Patella to Foot Position
Starting at the Hip

- Determination of local deformities in bone and musculature
- True Etiology
- Rotational Abnormalities yield investigation into pathological conditions
Orthopedic Examination

- ROM/Position
- **Hip**
  - External 2:1 Internal up to 3 years
  - Total ROM > 100 degrees
  - Decreases with age
  - External ROM decreases till 5-6 years then equalizes
HIP ROM

Outward=Int Rotation of Hip

Inward = Ext Rotation of Hip
HIP ROM

- Hip ROM assessment
- Position as soft tissue influence are negated
- =Flexed
- Measurement ~ 5-10 degree leeway
- Rotate leg to assess internal and external ROM
- Inward=External Rotation of hip
Terms and Tricks to Remember

- Antetorsion definition
- Retrotorsion definition
- **Abnormal antetorsion** will lead to **intoeing**
- **Retrotorsion** will lead to **out toeing**
Development of the Hip

- Angle of the femoral head and neck in reference to the Femoral Condyles
- At Birth: Angle is 30 degrees
- Unwinding occurs
- At Age 5 or 6 8-12 degrees Externally
- Delay can take in to second decade (13 or 14)
- Posterior in position is retrotorsion
Terms and Tricks to Remember

- Certain degree of torque and rotation
- **Torsion** = twist or torque in femur
- **Version** = soft tissue contractures
Measuring the Child

- Ortolani’s Test
  - Spreading the thigh to elicit “click”
Measuring the Child

- Telescoping the Femur
  - Symmetry of pelvis and thighs
Hip ROM

* Internal ROM at Birth = 35-100 degrees (60)
* External ROM at Birth = 45-110 degrees (90)
* At 18 mo – 3 years = Int = or > Ext
* At 8-12 = Equal value of Int and Ext
* Beware of the CAPSULAR soft tissue at this point despite being flexed

* Acetabular Position changes going from HORIZONTAL to VERTICAL
  * POSTERIOR position to a CENTRAL position
Determining Femoral Torsion

- Ryder’s Test
- Palpation of the Greater trochanter
- Antetorsion-lower leg in an external position with the femur internally rotated
- Retrotorsion-internal position of the lower leg with the femur externally rotated
I’m Confused

- Antetorsion = bone twisting = internal
- Anteversion = soft tissue or acetabular position = internal
- Retrotorsion = bone twisting = external
- Retroversion = soft tissue or acetabular position = external
The Knee

- Biomechanics Of the Knee
- Transverse and Frontal plane axis of the knee
- Rotatory movement of the tibia on the Femur
- “Corkscrew”
- 15 degrees of motion in a newborn in transverse plane; flexed position of the knee
Knee ROM in adolescence
- Full Extension is normal
- Minimal Frontal Plane Motion
- Transverse Plane Motion
- Int=Ext ROM
- Total ROM = 40 degrees
Clinical Examination

- Seated at the edge of the table knees flexed and the hips flexed
- Knee unlocked and relaxes muscles
- Rotate using malleoli as point of force
- The lower leg with a protractor below the foot
Internal Genicular Position

- “Cork Screw” and Locked at full extension
- Inequality in muscular balance
- Aka. Intoeing
- Partially flexed knee allows transverse ROM
# Muscular Anatomy of the Knee Joint

<table>
<thead>
<tr>
<th>Movement</th>
<th>Muscles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medial Rotation of Tibia on Femur</td>
<td>Popliteus, Semitendinosis, Semimembranosis, Sartorius, Gracilis</td>
</tr>
<tr>
<td>Lateral Rotation of the Tibia on Femur</td>
<td>Lateral Head of Biceps Femoris</td>
</tr>
<tr>
<td>Flexion</td>
<td>Biceps Fem, Semitend, Semimembranosis, Gastrocnemius, Plantaris, Sartorius, Gracilis, Popliteus</td>
</tr>
<tr>
<td>Extension</td>
<td>Quadriceps Femoris</td>
</tr>
</tbody>
</table>
Internal Genicular Position

- Contractures causing internal rotation on the knee:
  - Continued internal rotation of flexed limb during fetal development
  - Abnormal innervations causing contracture of internally rotated muscles
  - Poor innervations with weakening of the external rotator muscles
  - Poor sleeping habits
  - Spasticity of internal rotator muscles (CP)
Internal Genicular Position

- Television position, “W” and positions of comfort
- Loss of Flexion at the knee as the child matures
Clinical Exam

- Ext: Int ROM 2:1 or even 1:1; If Greater internal than Internal Genicular position present
- If Rotation is greater with hip flexion than extension: assume muscles
- If rotation is unaffected by flex and extension: assume ligamentous and muscle secondarily
- **INTERNAL** Genicular position: Internal ROM of 70-100 degrees and External of 0-20 degrees.
Measuring the Knee

* Supine position; knees together; measure distance between medial malleoli
* Abnormalities in Gait in Pediatrics
* Varum
* Intramalleolar Distance less than 5cm=normal
* Valgum
  * If it is occurring in the gait cycle when it shouldn’t be needs further investigation
  * If not resupinating in Gait can lead to forefoot deformities (HAV and digital deformities)
Torsional Abnormalities

- Abnormalities of Gait in Pediatrics
- Frontal Plane Evaluation
- Genu Varum and Valgum
- Most common Parental Complaint

<table>
<thead>
<tr>
<th>Age</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2</td>
<td>Varum</td>
</tr>
<tr>
<td>2-4</td>
<td>Straight</td>
</tr>
<tr>
<td>4-7</td>
<td>Valgum</td>
</tr>
<tr>
<td>7-12</td>
<td>Straight</td>
</tr>
<tr>
<td>13-18</td>
<td>Valgum</td>
</tr>
<tr>
<td>Adult</td>
<td>Straight</td>
</tr>
<tr>
<td>Geriatric</td>
<td>Varum</td>
</tr>
</tbody>
</table>
Clinical Examination

- Rotation of the knee should not change with extension until the knee is locked in full extension
- Neutral position of the knee joint:
- Total Amount of Int and Ext ROM and divide by two. Take this amount and subtract it from the amount of either Int or Ext
  - Eg: Int 90 + Ext 10 = 100/2 = 50
  - Int 90-50 = Int 40
  - Ext 10 – 50 = -40 Ext
Tibia Fibula

* Torsion
  * Twist in the bone affecting positional alignment
  * Infant presents with a certain degree of torsion then progresses through maturity
Examination

* Supine; with knees fully extended
* Place femoral condyles and tibia on the frontal plane
* Palpate the Tibial tuberosity, and align in sagittal plane of the body
* Estimate the degree of the malleolar axis deviates from zero
* (If knee is flexed, the IGP has effect and can increase this angle)
Tibia Fibula

- External rotation at birth = 0 degrees
- Minimal torsion at birth
- Int/Ext of up to 5-10 degrees still considered normal
- At age 1-2, Externally rotated by 10-15 degrees
- At age 5-7, Externally rotated by 20-30 degrees
Examination
• Less than these values will present with a form of in-toeing gait
• Excessive External torsion, yielding an out-toeing gait pattern
Intoeing Compensation

* Greater External Femoral Position
* External Knee Position
* Pronation of the Foot
Don’t forget the Fibula’s Role in all of this

- External rotation of the bone
- Forms the ankle mortise, directing position of the foot
- Tibial torsion, but don’t forget about the fibula
- The foot follows the direction of the malleolar axis
Tibia Fibula

- Multifactorial Causes of In-Toeing
- For Tibia-Fibula driving the In-Toeing it would have to be excessive
- Internal Genicular position
- Rotation of the lower leg when knee is unlocked
- A small amount of rotation proximally will cause significant change distally
Tibia Fibula

* Excessive External rotation
  * Occurs when the child ambulates in an ABducted attitude
  * Poorly managed tibia fracture that led to external
* Excessive Femoral Ante torsion
  * Distal femoral section is rotated internally when hip is neutral
Examination

- True measurement of torsion difficult in a child
- Instruments to measure; not typical in an office setting
- Use what god gave you: eyes and hands
Orthopedic Exam

- Tibiofibular Segment evaluation
  - Knee doesn’t completely straighten
  - Femur is laterally rotated
  - Measuring the Tib-Fib ROM
  - Evaluate for Torsion (twisting)
  - Evaluation of Rotation
Normal Development

Tibial Torsion

* Amount of true tibial torsion which occurs during development is between 18 & 23 degrees
* measured with malleolar position
* 13 to 18 degrees external tibial torsion noted by age 7 to 8 years
* TMA (transmalleolar axis) = 0-5° at birth
  * Increases at rate of 1.5° per year
  * Until gets to 13-18° at 6-7 years of age
  * NOTE: MEASURED as 18°-23°

* Insert Valgum examination photo
* **Tibial Position**
  * Sitting position with knees together
  * Palpate distal malleoli in relation to the frontal plane and tibial tubercle
  * Transmalleolar axis = 5 degrees at birth
  * Increases at a rate of 1-1/2 degrees per year
Pediatric Gait Evaluation

* Abnormalities in Gait in Pediatrics
* Genu Recurvatum
  * Secondary to:
    * Internal Hip position
    * External Tibial Position
    * Tight Gastrocs
* Normal Ankle ROM:
  * At Birth: No limitations; 75 degrees of DF
  * Age 3: 20-25 degrees of DF
  * Age 10: 15 degrees of DF
  * Age 15: Adult 10 degrees of dorsiflexion
To obtain measurement:

- Supine with the hip may be flexed or extended
- Foot is maximally dorsiflexed with the subtalar joint at neutral
- Pronated STJ allows the MTJ to be unlocked = excessive forefoot DF
- Mild supination of the RF will not limit DF
* Place your tractograph on the lateral aspect of the foot and the lower 1/3 of the leg
* Some Tractographs have a cheat feature!
* If the pediatric patient, pushes against you, sweep the sole of your foot and measure while they withdraw
* Silfverskiold Test
  * Normal
  * Normal DF with the knee extended
  * Normal DF with the knee flexed
Evaluation

- Silfverskiold Test
- **Pure Gastrocnemius Equinus**
- No DF with the knee extended
- Normal DF with the knee flexed

Fig. 3: Pure gastrocnemius equinus. A, No ankle dorsiflexion with knee extended (20 degrees of plantarflexion). B, With knee flexed to 90 degrees (Silfverskiold test), ankle dorsiflexion improves (10 degrees of dorsiflexion). Isolated gastrocnemius recession or gastrocnemius-soleus recession is the recommended treatment for a patient with gastrocnemius equinus. (Modified with permission from the Journal of American Podiatric Medical Association 95(1):18–25, 2005. Copyright 2005, American Podiatric Medical Association.)
Evaluation

- Silfverskiold Test
- Pure Gastrocnemius-Soleus Equinus
- No Ankle Dorsiflexion with the knee bent and extended
* Subtalar Joint
  * Posterior Calc to lower 1/3 of leg
  * Total ROM = 50 degrees at birth
  * Total ROM = 30 degrees at year 3
* Midtarsal Joint
  * Lock MTJ, STJ in Neutral
  * Look down the foot and evaluate for forefoot varus and valgus
  * Foot should not have these characteristics in a mature foot
Pediatric Flatfoot

- Lay term used to describe a group of conditions whose common feature is a flattened medial longitudinal arch

- All early walkers present with a flatfoot

- Persistent flatfoot with symptoms (including other areas, i.e. hip, knee)
# Pediatric Radiology: DP Angles

<table>
<thead>
<tr>
<th>Angles</th>
<th>Birth</th>
<th>6-9 years</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMA</td>
<td>12°</td>
<td>10°</td>
<td>8-10°</td>
</tr>
<tr>
<td>Engel</td>
<td>30°</td>
<td>25°</td>
<td>Less than 21°</td>
</tr>
<tr>
<td>MA</td>
<td>25-30°</td>
<td>15-25°</td>
<td>Less than 15°</td>
</tr>
<tr>
<td>Talocalcaneal (Kite’s Angle)</td>
<td>40-50°</td>
<td>20-40°</td>
<td>20-25°</td>
</tr>
<tr>
<td>Talar-First Metatarsal</td>
<td>Slightly medial</td>
<td>Parallel</td>
<td>Parallel</td>
</tr>
</tbody>
</table>
# Pediatric Radiology: Lateral Angles

<table>
<thead>
<tr>
<th>Angles</th>
<th>Birth</th>
<th>6-9 years</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tibiocalcaneal</td>
<td>70-75°</td>
<td>65°</td>
<td>55°</td>
</tr>
<tr>
<td>Talar Declination</td>
<td>Slightly above 1&lt;sup&gt;st&lt;/sup&gt; metatarsal</td>
<td>Parallel</td>
<td>21°</td>
</tr>
<tr>
<td>Calcaneal Inclination</td>
<td>10-15°</td>
<td>15-20°</td>
<td>Less than 21°</td>
</tr>
<tr>
<td>Talocalcaneal</td>
<td>35-50°</td>
<td>30-40°</td>
<td>25-30°</td>
</tr>
</tbody>
</table>
2 METHODS OF IN-OFFICE CLINICAL EVALUATION OF THE PEDIATRIC PATIENT

- Richard Shuster’s Navicular Drop
- Ronald ValMassey’s Rule of 7
NAVICULAR DROP
(AN INDICATOR OF EXCESSIVE PRONATION)

- Mark the navicular at its apex or most prominent spot
- Measure distance from patient’s navicular to the supporting surface
- First measurement with foot in the neutral calcaneal position
- Second measurement with foot in a relaxed calcaneal stance position

*Shuster found that differentials greater than 3/8 inch (0.95 cm) was suggestive of excessive pronation in all pediatric groups and considered to be an indication for orthotic intervention*
Navicular drop measurement

Measure STJ neutral vs relaxed stance

Differential greater than 3/8 inch suggestive of excessive pronation
THE RULE OF 7 (NOW KNOWN AS THE RULE OF 8)

At what age is the pediatric flatfoot of concern?
UPON CHILD AMBULATION THE MEDIAL ARCH MAY NOT BE VISUALIZED DUE TO FAT PRESENT IN THE AREA AND NORMAL EVERTED CALCANEUS AT 5-10

During normal development the calcaneal eversion decreases by one degree per year.
RULE OF 8 FORMULA

Subtract the child’s age from the number 8 which will equal acceptable amount of pronation and calcaneal eversion that should be present at any specific age.
Formula for 4 year old child

\[ 8 - 4 = 4 \]

4 degrees acceptable degrees of calcaneal eversion

Should this value be abnormal further evaluation required including consideration for custom orthotics.
Demonstrate to the parent placing child’s foot in neutral position. Then have them watch as the child places their foot in a relaxed position.
Demonstrate to the parent placing the child’s foot in neutral position. Then have them watch as the child places their foot in a relaxed position.

STJ Neutral

Relaxed
Pediatric flatfoot
The Greenstick Effect
Metatarsus Adductus

- C-shaped foot
- Convex lateral border
- Concave medial border
- Appears to have “high arch”
- Prominent 5\textsuperscript{th} metatarsal tuberosity (older child)
- Adduction of metatarsal 1-5 in transverse plane
- Possible FF varus

- May see separation of great toe
- Heel-forefoot bisection is not parallel
- Lack of abduction past midline
- “abduction stress test”
- Muscle hyperactivity
- Tibialis anterior hyperactive
Bleck Grading System
Pediatric HAV

* Recognition and non-surgical Management
* Epiphysiodeses not reliable
* Avoid Open Growth plates

12 y/o with Juvenile HAV
Pediatric HAV

* Recognition and non-surgical Management
* Epiphysiodeses
* Avoid Open Growth plates

12 y/o with Juvenile HAV
What it’s About

- Observation is important
- Never be rushed; you can MISS the OBVIOUS

When your mind tries to verify a preconceived notion you can miss the obvious.

James Cook
What’s missing in this picture?
Abnormal mesenchymal differentiation
OBSERVE THE OBVIOUS
Compensated Juvenile MA

* Rearfoot is pronated

* Develop a collapsing flexible pes planovalgus

* Not a “true” MA

* Positional deformity
Thanks and Any Questions!!