Rotational and Angular Variations in Pediatrics.

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Objectives

• Review the musculoskeletal exam when evaluating for rotational and angular variations.

• Discuss the diagnosis, natural history and treatment of common lower extremity rotational and angular variations.
Rotational Variations
Embryology/Development

• Limb bud development
  • 5th week

• Intrauterine positioning
  • Relative external rotation of hip
  • Internal rotation of tibia
  • Variable, flexible, positioning of feet
Development

• External Rotation During Growth
  • Femur ~25°
  • Tibia ~15°

• Adult alignment ~ 8-10 years of age
Evaluation

• Identify the concerns
  • Current appearance of the feet?
  • Function?
  • Persistence of the appearance?
Evaluation

• History – Onset, Function, Progression/Improvement

• Past Medical History
  • Birth history, Developmental milestones

• Family History
  • Rotational variations in family members
Exam

• Dynamic (Gait)
  • Foot progression angle (FPA)

• Static (Rotational Profile)
  • Heel bisector
  • Thigh foot angle
  • Hip rotation
Exam - Dynamic

*Walk the hall*

- Feet
- Knees
- Hips
- Other
  - Symmetry
  - Posturing with running
  - Hip/Knee flexion
Exam - Static

• General appearance
  • Facial features, asymmetry, maturity/development

• Lower extremities
  • Range of motion, Asymmetry

• Spine
Exam - Static

• Heel bisector
  • Line intersecting the midline of the hindfoot and forefoot
  • Neutral should pass through the 2\textsuperscript{nd} metatarsal

• Shape of the foot
  • Convex border
Exam - Static

• Hip rotation

  • Internal rotation
    • Infant ~ 40° (10-60°)
    • Child ~ 50° (25-65°)

  • External rotation
    • Infant ~ 70° (45-90°)
    • Child ~ 45° (25-65°)
Exam - Static

• Thigh foot axis
  • Angle created between:
    • Long axis of the thigh and Axis of the tibia/hindfoot
  • Infant ~ -5° (-30° - +20°)
  • Child ~ +10° (-5° to +30°)
Prone Rotational Exam

Lay child on their stomach, flex knees, and rotate femurs internally and externally, keep pelvis level – this tests femur rotation
Prone Rotational Exam

Lay child on stomach, flex knees, and see how long axis of foot lines up with long axis of thigh – this tests for tibial torsion.
# Differential Diagnosis

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<th>Out-toeing</th>
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<td>External tibial torsion</td>
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<tr>
<td>Internal tibial torsion</td>
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<td>Clubfoot (Talipes equinovarus)</td>
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<td>Skew foot</td>
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<td>Spastic Hemiparesis</td>
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Metatarsus Adductus
Internal Tibial Torsion

• Common in-toeing etiology in toddlers

• 2/3 bilateral

• Parents report frequent tripping, clumsy

Average Toddler

• 2368 steps/hr

• 17 falls/hr

http://www.psych.nyu.edu/adolph/publications/Adolph%20EtAl%20HowDoYouLearnToWalk.pdf
Internal Tibial Torsion

• Treatment
  • Observation/Education
    • Tibia continues to externally rotate with growth
  • Bracing/Splints are NOT effective
  • Surgical intervention – Rare
Femoral Anteversion

• Common intoeing etiology of childhood
  • Peaks on average age 5

• Refers to angle between the axis of femoral feck and the condyles (M/L) knee

• Natural history
  • Infant ~40°
  • Adult ~ 15°

• Symmetric
Femoral Anteversion

• Report of “W” sitting

• “Eggbeater” running motion

• Knee caps point medially

• Excessive internal rotation relative to external rotation
Femoral Anteversion

• Treatment
  • Observation/Education

• Surgical
  • Severe anteversion
  • Functional limitations
  • After skeletal maturity
Out-toeing

- *Positive* foot progression angle
  - Unilateral or bilateral
  - Progressive vs Static

- Differential diagnosis
  - External tibial torsion, femoral retroversion, pes planovalgus
  - Slipped femoral capital epiphysis
Out-toeing

• Exam

  • Positive FPA

  • Hip range of motion
    • External rotation > Internal rotation (femoral retroversion)
    • Red flags (limp, decreased flexion, abduction, internal rotation)

  • Thigh foot angle

  • Foot/Ankle
    • Achilles contracture
Out toeing

• Identify the cause
  • Hip/Acute injury
  • External tibial torsion/Femoral retroversion
  • Pes planovalgus

• External tibial torsion may progress with age
Angular Variations

Genu varum and Genu valgum
Case #1

• 18 month boy is brought to clinic by his mother because of “bowed legs”. He is otherwise healthy. He began walking at age 13 months and is at the 50% mark for height and weight.
Exam

• Dynamic
  • Assess gait (walking age)

• Static
  • Standing and supine

*Rotational and angular deformities often will present together*
## Differential Diagnosis

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<tr>
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<td>Rickets/metabolic disorder</td>
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<tr>
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<td>Skeletal dysplasia</td>
<td>Leg Length Discrepancy</td>
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<td>Traumatic</td>
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Physiologic genu varum

Common first 2 yrs of life.

Generally no family history

Children with *normal growth*

Mild to moderate severity

Symmetric

*Generally improves by age 2-3*
Physiologic genu varum
Infantile Tibia Vara
"Infantile Blount’s disease"

• Proximal medial tibial physis fails to grow normally

• Depressed medial tibial condyle

• Usually bilateral
  • Unilateral bowing always red flag

• Tends to occur in early walkers, high weight-for-age infants
Treatment of Infantile Tibia Vara

Bracing
Children <2.5 years with early stage Blount’s
No clear evidence to support the use of bracing

Operative treatment
Osteotomies
Hemiepiphysiodesis – "Guided Growth"
Treatment of Infantile Tibia Vara

• “Guided Growth”
  • Plate & screws around the growth plate to slow down growth on the “long” (convex) side and let the “short” (concave) side catch up.
  • Plates removed once deformity corrected.
  • Minimal surgery
Treatment of Blount’s Disease: Hemiepiphysiodesis

Pre-op

17 months post-op
Case #2

3 y/o brought in by her grandmother for evaluation of “knock-knees”. Child has been growing at the 75th % for weight and length. Child is otherwise healthy.
Physiologic Genu Valgum
“Knock-knees”

- Common after age 2
  - Peaks age 3-4
- Generally no family history
- Children with normal growth
- Symmetric
- Resolves by age 9-12
Physiologic genu valgum

• Treatment
  • Reassurance (resolves by age 9-12)
  • Bracing – no clear evidence
  • Hemiepiphysiodesis in persistent deformity
Other causes of genu varus/valgus

• When evaluating look for:

• **Poor growth/short stature**
  • Asymmetric deformity
  • Family history
  • Dysmorphic features, signs of skeletal dysplasia
  • Risk factors for renal disease, nutritional deficiencies
  • History of LE trauma
Post-traumatic genu valgum

Partial injury to physis
Rickets

• May be nutritional (vitamin D deficiency)

• May be due to renal disease
  • X-linked hypophosphatemic rickets
References


