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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<td>Internal tibial torsion</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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<th>Genu Valgum</th>
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<td>Leg Length Discrepancy</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*
Development of the tibiofemoral angle during growth

+ Varus
- Valgus

Varus
Valgus

Age, y

Extreme values

+34 ± 0
+21 - 13
+20 - 20
+13 - 19
+4 - 17
±0 - 11
±0 - 10
±0 - 14
±0 - 13
±0 - 12
±0 - 12
±0 - 11
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 Varus

• “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


