Rotational Deformity in Children’s Legs

- Version represents the normal rotational alignment of the limb or bone, while torsion represents the pathological mal-alignment.

<table>
<thead>
<tr>
<th>Femoral Anteversion</th>
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</thead>
<tbody>
<tr>
<td>Birth</td>
<td>40 degrees</td>
</tr>
<tr>
<td>10 years</td>
<td>24 degrees</td>
</tr>
<tr>
<td>Adolescence</td>
<td>16 degrees</td>
</tr>
<tr>
<td>Adult</td>
<td>15 to 20 degrees</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tibial Torsion</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth</td>
<td>-15 degrees</td>
</tr>
<tr>
<td>1 year</td>
<td>+5 degrees</td>
</tr>
<tr>
<td>Child</td>
<td>10 degrees</td>
</tr>
<tr>
<td>Adult</td>
<td>20 to 24 degrees</td>
</tr>
</tbody>
</table>

In Toeing

- Causes of in-toeing gait
  - Neuromuscular disorders (e.g. cerebral palsy)
  - Hip deformity (e.g. DDH)
  - Fracture malunion
  - Excessive femoral anteversion (mid-childhood)
  - Internal tibial torsion with loss of external/lateral rotation (toddlers)
  - Metatarsus adductus of the foot
- Average orientation of foot in toddler group is 4 degrees of toeing-out, but up to 8 degrees of in-toeing is within 2 standard deviations for this age group, and can be considered normal.
- It is common for in-toeing to worsen as child begins to walk, when the hip starts to lose the flexion-external rotation contracture resulting from “intra-uterine packaging”, and moves into an initially more internally rotated position on weight bearing. Explain this to anxious family.
- Excessive femoral anteversion or femoral ante-torsion
  - 63% spontaneously correct by age 8
  - Correction usually by compensatory external tibial rotation, and not by reduction of the femoral anteversion = torsional malalignment syndrome
  - Can result in subsequent anterior knee pain, and patello-femoral disease.
- Neuromuscular causes of in-toeing often need derotation osteotomies
- Malunion of fractures by up to 25 degrees can be compensated for without symptoms

Toeing Out

- Normal toeing out defined by 3 degrees of external rotation of the foot relative to the longitudinal axis of the tibia at age 4-5. Increases to 7 degrees by age 16.
- Excessive toeing out:
- Heavier children
- Excessive compensatory external/lateral tibial torsion
- Reduced femoral anteversion (uncommon)
- Neuromuscular disease (Cerebral palsy)
- SUFE

- Function of the foot is intact with up to 60 degrees toing-out, but is cosmetically troublesome, and predisposes to patello-femoral disease and anterior knee pain.

**Evaluation**

- Determine history of clumsiness in walking, birth history, oligohydramnios and family history.
- Excessive femoral anteversion seen by children sitting in “W”-position, and in-turning patella.
  - Alternatively look for increased internal rotation
  - Reduced external rotation of the hip in extension from taught anterior capsule
  - Improvement in external rotation of flexing the hip, which is restored on flexing the hip to 90 degrees to relax the anterior capsule.
- Measuring the torsional profile (Staheli’s)
  - Thigh-foot angle or angle of transmalleolar axis
  - Femoral version by degree of hip rotation while patient is lying prone with knee flexed to 90 degrees.
    - Hip rotated until greater trochanter is felt to be most prominent, indicating the head-neck axis is horizontal
    - Angle of the leg relative to the vertical measured
    - >60 degrees signifies excessive femoral anteversion
  - Foot progression angle – normal around 4 degrees (range -8 to + 16 degrees). Measured by position of foot during stance phase relative to direction of gait.
    - Presence of a foot deformity by measuring projection of hindfoot axis towards forefoot
      - Normally hindfoot axis projects to 2nd/3rd webspace
      - Displaced laterally in metatarsus adductus

**Treatment**

- Conservative splintage using twisting cables and orthotics **no use**, and can have detrimental effect on knee.
  - *Except when in-toeing caused by forefoot pathology. Metatarsus adductus corrects well with serial casting ± Achilles tendon tenotomies.*
- Surgical derotation osteotomy indications:
  - Functional gait abnormality
  - Intolerable cosmetic deformity
  - Pain
  - Age > 8 years to maximise chance for spontaneous correction, unless neuromuscular aetiology where the deformity may be progressive
- Derotation osteotomies in neuromuscular disorders will improve gait mechanics and energy requirements for ambulation
- Femoral osteotomy:
- Demonstration of 80 degrees internal rotation hip
- Femoral anteversion > 50 degrees
- Inter-trochanteric osteotomy with blade plate fixation or Ilizarov techniques. IM-nails possible, but avoid in children <12 years to minimise risk of AVN of the femoral head.

**Tibial Osteotomy:**
- More severe than -10 degrees of *internal* tibial torsion
- More than 40 degrees of *external* tibial torsion (as measured by thigh foot angle)
- Distal osteotomy, pin fixation and POP cast for pure rotational correction
- Proximal osteotomy for simultaneous angular correction
- Fibular osteotomies also tend to be performed for proximal tibial osteotomies rather than distal.