Rotational deformities of the lower limb in children
Definitions

- Rotation of femur = angle between axis of head and neck and distal femoral condyles (epicondylar axis)
- Tibial rotation = angle of rotation of distal end of tibia relative to proximal end
- If angle > 2 SD from mean = TORSION
Embryology

- At 7 weeks gestation, longitudinal axis of upper and lower limbs are parallel, preaxial components face dorsally, post axial components face ventrally.
- Upper limb bud then rotates externally
- Lower limb bud then rotates internally
- Further intrauterine moulding causes femur to externally rotate and tibias internally
Causes of torsional deformities

• Torsional deformities arise in prenatal period by accentuation or arrest of the normal rotational processes.

• Multifactorial (heredity, mechanical forces, intrauterine position, postnatal habitual sleeping/ sitting positions).
# Torsional profile (Staheli)

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Technique</th>
<th>Normal Values (deg)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot progression angle</td>
<td>Foot vs straight line</td>
<td>-5 to +20</td>
<td>Nonspecific</td>
</tr>
<tr>
<td>Int rotation</td>
<td>Prone knee flexed</td>
<td>20 - 60</td>
<td>&gt;70 femoral torsion</td>
</tr>
<tr>
<td>Ext rotation</td>
<td>Prone knee flexed</td>
<td>30 - 60</td>
<td>&lt;20 femoral torsion</td>
</tr>
<tr>
<td>Thigh foot angle</td>
<td>Prone knee flexed</td>
<td>0 - 20</td>
<td>&lt;-10 internal tibial torsion</td>
</tr>
</tbody>
</table>
## Aetiology of toeing in and out

<table>
<thead>
<tr>
<th>Level of affection</th>
<th>Toeing in</th>
<th>Toeing out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet/Ankles</td>
<td>Pronated feet</td>
<td>Pes valgus</td>
</tr>
<tr>
<td></td>
<td>Metatarsus varus</td>
<td>Talipes calcaneovalgus</td>
</tr>
<tr>
<td></td>
<td>Talipes equinovarus</td>
<td>Planovalgus</td>
</tr>
<tr>
<td>Leg/knee</td>
<td>Tibia vara</td>
<td>External tibial torsion</td>
</tr>
<tr>
<td></td>
<td>Internal tibial torsion</td>
<td>Fibula hypoplasia</td>
</tr>
<tr>
<td></td>
<td>Genuvalgum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tibial hypoplasia (+ rel fibula overgrowth)</td>
<td></td>
</tr>
<tr>
<td>Femur and hip</td>
<td>Persistent femoral anteversion</td>
<td>Femoral retroversion</td>
</tr>
<tr>
<td></td>
<td>Spasticity of internal rotators (CP)</td>
<td>Flaccid paralysis of int rot</td>
</tr>
<tr>
<td>Acetabulum</td>
<td>Maldirected facing anteriorly</td>
<td>Maldirected facing posteriorly</td>
</tr>
</tbody>
</table>

- **Level of affection**: The point at which the aetiology affects the toeing in or out.
- **Toeing in**: Conditions that cause the toes to point inwards.
- **Toeing out**: Conditions that cause the toes to point outwards.
Most common

• 1 Metatarsus adductus (0-1 yrs)
• 2 Internal tibial torsion (1-2 yrs)
• 3 Femoral anteversion (>3 yrs)
Femoral torsion/persistent femoral anteversion

- **Incidence**
- Common
- **Sex**
- Female:Male
- 2:1
- **Natural course**
- *Femoral rotation decreases with age*
  - Age 1 year - 39deg
  - Age 2 yrs - 31 deg
  - Age 10 yrs - 24 deg
  - Age 16 yrs - 16 deg
Clinical features

• Symptoms
  • Intoeing of gait, clumsiness

• Signs
  • Standing, patellae point inwards when feet aligned forward
  • Compensatory extorsion of tibia increases Q angle.
Measurement of femoral torsion

- Clinically
- Prone examination, knees flexed to 90 deg. Compare IR vs ER.
- CT
- Most accurate.
- Femoral neck and femoral condyles imaged.
- Angle between fem neck axis and transcondylar axis = femoral rotation.

<table>
<thead>
<tr>
<th></th>
<th>IR (deg)</th>
<th>ER (deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>70-80</td>
<td>10-20</td>
</tr>
<tr>
<td>Moderate</td>
<td>80-90</td>
<td>0-10</td>
</tr>
<tr>
<td>Severe</td>
<td>&gt;90</td>
<td>0</td>
</tr>
</tbody>
</table>
Treatment

- Conservative
- Reassurance and observation. Usually corrects spontaneously by 8 yrs
- Shoe modifications and splints should not be used.
- Change of sitting position from TV position not shown to improve situation.
Operative

• Derotational femoral osteotomy
• Should not be performed <8 yrs (chance of spontaneous recovery).
• Should not be delayed until late adolescence because of possible development of secondary lateral tibial torsion.
• Technique- rotate distal femur laterally until degree of internal rot = degree of lat rot.
Prognosis

- No evidence that incidence of hip OA is increased
Tibial Torsion

- Natural course
- *Tibia rotates laterally with increasing age*
- Fetus- medial malleolus behind lateral malleolus
- At birth- tips of malleoli level
- On walking- 20 degrees lat tibial rotation, lateral malleolus behind medial malleolus.
- In adult- mean rotation = lateral of 20 deg
Measurement of tibial rotation

- Medial rotation -ve value
- Lat rotation +ve value

Clinically
- Thigh foot angle
- Angle between tibial tuberosity and 2\textsuperscript{nd} metatarsal with foot in neutral

CT - Transverse tomograms of upper and lower tibia made with patient supine.
Internal tibial torsion

- **Incidence**
  - Rare in isolation
  - Check for congenital metarsus adductus & genu valgum

- **History** - Intoeing

- **Examination**
  - -ve thigh foot angle
  - Usually symmetrical
  - With patellae facing forwards in stance, feet turn inwards
Treatment

• Conservative
  – Most resolve spontaneously by age 8

• Operative
  – Supramalleolar osteotomy age 8.
  – Treat more aggressively if family history of persistent medial torsion as this group is less likely to spontaneously correct.
External tibial torsion

• Incidence
  • Rare in isolation.
  • Can occur as an acquired deformity due to ITB contracture or in response to persistent femoral anteversion

• Clinically
  • In stance, with patellae facing forwards, feet turn outwards
  • Thigh foot angle increased.
  • Perform Obers test to look for iliotibial band contracture (lie on opposite side, abducting hip causes knee flexion)
Treatment

- This *does not* correct with growth
- Early treatment recommended
- **Conservative**
  - Stretching of soft tissues, including iliotibial band
  - Denis Browne splints at night to hold ankles medially rotated
- **Operative**
  - Supramalleolar medial rotation osteotomy at age 10-12.
Metatarsus adductus

- Incidence - 1/1000 live births
- Sex - M:F 4:3
- Heredity
  - If one child affected, risk of 2\textsuperscript{nd} occurrence 1 in 20
  - Associated disorders - 10-15\% ass with DDH
Pathology

• Medial subluxation of tarsometatarsal joints with adduction and inversion of all five metatarsals
• Hindfoot is in neutral or slight valgus
Clinically

- Present at birth but often not noticed for months
- Difficult to fit shoes, child walks on lateral border of sole
- Forefoot adducted, hindfoot neutral or valgus
- Fixed, can't be passively corrected
Investigations

- X-ray
- not useful initially as clinical diagnosis. Once over 3 years, show adducted forefoot at tarsometatarsal joints. Talocalcaneal angle normal or increased cf. Talipes equinovarus (talocalcaneal angle decreased).
Treatment

- True congenital metatarsus adductus should be treated early

  - Nonoperative
    - Manipulation and Corrective above knee plaster cast
    - Avoid tendency to abduct and evert the whole foot, for 4-10 weeks, changing at 2 weekly intervals.

  - Operative
    - If not responding to casting
    - More likely if presenting over 1 year of age