Talipes Equinovarus
‘Clubfoot’

- Christine Walton
Talipes Equinovarus

A complex, congenital contractural malalignment of the bones and joints of the foot and ankle

- Plantar flexed (equinus of hindfoot)
- Forefoot swung medially (MT adductus)
- Sole facing inward (varus/inversion of subtalar jt complex)
- Cavus (plantar flexion of the forefoot on the hindfoot)
Epidemiology

- Prevalence: 1 to 3 per 1000 live births
- Ethnic variance: Polynesian ancestry (7 per 1000) vs. Asian ancestry (~.5 per 1000)
- Male: Female, 2:1
- Bilateral in ~50% of cases
Embryology

*Development of the Foot...*

Begins at 5 1/2 weeks GA with mesenchymal condensations of precartilaginous bone

7 wks → joint spaces exist

8 wks → movements of the limbs begin*

The foot is adducted in the development of the lower limb bud, but resolves by 3 months.

Pronation is not completed until after birth
High incidence (14%) of genetic anomalies, Including:

- Trisomy 18
- Larsen syndrome
- Neural tube defects
- Congenital heart defects
Clubfoot Associated Factors

**Intrinsic**
- Chromosomal
  - Trisomy 18
  - Deletions of chromosomes 18q, 4p, 7q, 9q, 13q
- Connective tissue
  - Arthrogryposis
  - Collagen defects
  - Joint synostosis
- Neurologic
  - Anencephaly
  - Anterior motor horn cell deficiency
  - Hydrancephaly
  - Holoprosencephaly
  - Meningomyelocele
  - Spina bifida
- Muscular
  - Myopathy
  - Myotonic dystrophy
- Skeletal dysplasia
  - Camptomelic dysplasia
  - Chondrodysplasia punctata
  - Diastrophic dysplasia
  - Ellis–van Creveld
- Syndromes
  - Escobar syndrome
  - Hecht syndrome
  - Larsen syndrome
  - Meckel–Gruber syndrome
  - Multiple pterygium
  - Pena Shokeir
  - Smith–Lemli–Opitz
  - Zellweger syndrome

**Extrinsic**
- Amniotic bands or synechiae
- Early amniocentesis
- Intrauterine crowding
  - Fibroids
  - Multiple gestation
  - Oligohydramnios
  - Potter sequence
- Malposition
  - Breech

Arthrogryposis
Spinal muscular atrophy
Spinal bifida
Sacral Agenesis
Paralytic states
Current Theories

- Intrauterine enteroviral infection
- Primary muscle lesion
- Primary bone deformity (germ plasm defect)
- In utero molding (constricting annular bands)

Abnormal muscle development (Type I)
- normal innervations but S.R. and mitochondria changes and loss of myofibrils is evident

Localized soft-tissue contracture
- +ve stain for vimentin (myofibroblast marker)

1st degree = 17x
2nd degree = 6x

monozygotic twins: 32.5% rate of concordance
heterozygotic twins: 2.9% rate of concordance
Genetic Factors
+
Environmental Factors
*(which modulate genetic expression)*
Classification

1) Congenital (idiopathic or neurogenic)
2) Teratologic (NM disorders)
3) Positional (normal foot)
Anatomy

Primary abnormality is in the talus: small and abnormal

Subluxation of the talo-calcaneo-navicular joint

Underdevelopment of the soft tissues on the medial side of the foot + calf and perineal muscles

Shortening and fibrosis in the gastroc-soleus + tib post

Calcaneus
  • inverted under the talus
  • posterior end displaced upward and laterally
  • anterior end displaced downward and medially
**O/E**

Single (occasionally double) posterior skin crease

Calcaneus is difficult to palpate b/c fatty heel pad

Deep transverse skin crease across midfoot & extends under the longitudinal arch

Head of talus: palpated on the dorsolateral aspect of the midfoot/hindfoot, anterior to ankle joint

Smaller foot and calf, shorter tibia and femur

Hypertrophic anterior tibial artery

AbN distribution of Type I and II fibers (↑ NMJ)

+ complete P/E
Figure 1. Clinical photograph of an 8-month-old boy who has bilateral CTEV.
Figure 3. Clinical photograph of a clubfoot with the child supine. The midfoot flexion crease is more notable on the left foot.
Figure 2. Clinical photograph of a clubfoot from the medial aspect. Note the prominent crease in the midfoot.
Equinus is measured with the knee extended, the subtalar rotation corrected, and the heel in neutral (as much valgus as possible). Although the heel pad may appear well positioned, the Calcaneous may remain in equinus. * Note how the examiner’s finger presses in the heel pad to the Calcaneous in equinus.
In this foot, the heel is in varus but the forefoot is well aligned with the heel. There is no supination of the forefoot on the hindfoot.

*Instructional Course Lecture*
X-Ray Evaluation

\[ \downarrow \text{in talocalcaneal angle and -ve talus/1st MT angle} \]

\[
\begin{align*}
\text{Talocalcaneal angle} &\quad N=(30-55 \, ^\circ) \\
\text{Talus-1st MT angle} &\quad N= 5-15 \, ^\circ 
\end{align*}
\]

\[ \downarrow \text{Talocalcaneal angle of zero and -ve tibiocalcaneal angle on dorsiflex} \]

\[
\begin{align*}
\text{Talocalcaneal angle} &\quad N=25-50 \, ^\circ \\
\text{Tibiocalcaneal angle} &\quad N=10-40 \, ^\circ 
\end{align*}
\]

\[ \text{Talocalcaneal Angle} = \text{Kite angle} \]
Same foot

Top: X-ray beam focused on the midfoot - demonstrates the talonavicular jt and the midtarsal bones (fibula positioned post. + talar dome is flattened)

Bottom: X-ray beam focused on the hindfoot to demonstrate Kite’s angle. Fibula is overlapping the tibia and the talar dome is round and high
Remember: a clubfoot is bean-shaped...

If the X-ray plate is placed against the medial part of the foot, the X-ray beam focuses on the midfoot with the hindfoot rotated (increases valgus)

X-ray plate should be placed against the lateral aspect of the hindfoot so that the X-ray beam is perpendicular to the hindfoot

Instructional Course Lecture
How severe is the Clubfoot?

Based on: severity + rigidity but no system has been universally accepted

**Clinical Classifications:** Carroll, Goldner and Catterall

Pirani et al. And Dimeglio et al.
- Most recent
- based solely on physical examination (no X-rays)
- very good interobserver reliability after the initial learning phase

REQUIRED! Standardized system for scoring severity
Treatment

Goal: Plantigrade, supple, painless foot that looks normal and provides adequate function

Non-Operative: correct / partial correction of the deformity

1) Stretching, taping, splinting and CPM machine
2) Serial manipulation and casting (#1 in NA) Ponseti

1st ray is dorsiflexed to stretch the plantar faschia and unlock the talonavicular joint

The forefoot is abducted and the hindfoot is everted through the subtalar complex around the talus

Hindfoot is dorsiflexed, while avoiding excessive dorsiflexion stress on the forefoot.

...If ‘adequate’ correction achieved, continue with boots and bar bracing

Overall Success Rate 15-80%

Lovell & Winter
Figure 6. Clinical photograph of a child in bilateral long leg casts for CTEV.
Ponseti Method

Dr. Ponseti: 1948 (Iowa) non-operative treatment of clubfoot
Method: serial manipulation and casting of the foot for anatomical correction

**Principles:** “correction of deformity through the production of plastic (permanent) deformation (lengthening) of the shortened ligaments and tendons. Serial manipulation and cast immobilization relies on the viscoelastic nature of connective tissue to produce plastic deformation through a process known as stress relaxation (CREEP)”
Figure 7. Denis-Browne bar for splinting children who have CTEV.
Ponseti Method

- 5-6 casts, applied on a weekly basis
- Manipulations are always gentle, never painful

**Cast #1**: forefoot is supinated, bringing the forefoot in line with the hind-foot, and with the 1st MT elevated (dorsiflexed) (corrects the cavus deformity, usually in 1 casting)

**Cast #2-4**: gradual abduction of the forefoot around the head of the talus, manipulating the foot around the fulcrum of the talar head (no counterpressure at the calcaneocuboid joint). Calcaneus moves into a valgus (everted) position as the talar head is reduced beneath the navicular.

Now: heel is valgus, talar head covered + the forefoot maximally abducted....

**Casts #5-6**: Correction of the dorsiflexion (+/- Achilles tenotomy)

*Current Opinion in Pediatrics, 2006*
Initial Manipulation Technique

Reduction of the talonavicular joint with the use of the index finger to gently push the navicular onto the head of the talus.

Instructional Course Lecture
Reduction of the talonavicular joint by pulling the forefoot laterally relative to the hindfoot. Note that the forefoot is aligned with the heel through supination of the forefoot relative to the leg.
Correction of the plantar flexion
If unsuccessful correction after 3 months of conservative Tx.....

**Operative:**  
*(hindfoot often fixed in varus and equinus)*

* Cincinnati incision: safe, extensile and cosmetic
* Tendon Lengthening (may precede manipulation and casting)
* Capsulotomies
* Extensive correction: Turco, Goldner, Carrol and Simons  
  Most surgeons support an “a la carte approach”
* Preferred method: modified McKay procedure through a transverse circumferential (Cincinnati) incision  
  * Cincinnati incision: safe, extensile and cosmetic
  * cast change under anesthesia 1-2 wks following
  * 5-50% require surgical revisions

*Campbell’s*
The Medial Plantar Release

Deltoid Ligament

Intact

“Spring” Ligament
The Lateral Release

Calcaneofibular Ligament
Interosseous Talocalcaneal Ligament
Bifurcate Ligament
Calcaneocuboid Ligament
Interosseous Talocalcaneal Ligament Intact
Lateral Talocalcaneal Ligament
Stabilization of the foot with pins.
Lateral closing-wedge calcaneal osteotomy (Dwyer)
Triple-arthrodesis wedges removed for treatment of residual varus and forefoot adduction
Transfer of the Tibialis Anterior tendon to the base of the Third MT or Lateral Cuneiform

Fig. 15
Transfer of the tibialis anterior tendon to the base of the third metatarsal or lateral cuneiform.
## Resistant Clubfoot

<table>
<thead>
<tr>
<th>Deformity</th>
<th>Treatment</th>
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<tbody>
<tr>
<td>Metatarsus adductus</td>
<td>&gt;5 yr: metatarsal osteotomy</td>
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<tr>
<td>Hindfoot varus</td>
<td>&lt;2-3 yr: modified McKay procedure</td>
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<td>3-10 yr</td>
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<td>Dwyer osteotomy (isolated heel varus)</td>
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<td>Dillwyn-Evans procedure (short medial column)</td>
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<td>Lichtblau procedure (long lateral column)</td>
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<td>10-12 yr: triple arthrodesis</td>
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<tr>
<td>Equinus</td>
<td>Tendo calcaneus lengthening plus posterior capsulotomy of subtalar joint, ankle joint (mild to moderate deformity)</td>
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<td>Lambrinudi procedure (severe deformity, skeletal immaturity)</td>
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<tr>
<td>All three deformities</td>
<td>&gt;10 yr: triple arthrodesis</td>
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<tr>
<td>Age of Patient at Time of Revision</td>
<td>Step</td>
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<tr>
<td>6 mo to 2 yr</td>
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<td>2 to 4 yr</td>
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<td>4 to 8 yr</td>
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<td>8 to 10 yr†</td>
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<td>&gt;10 yr</td>
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<td>10</td>
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</tbody>
</table>

*Not recommended by authors of reports in the literature or by us. †Note that in patients who are ten years old or less, it is possible to start with steps 1 and 2 and then proceed according to the deformity that remains—that is, proceed to step 7 if there is a deformity of the calcaneus or proceed to step 5A, 5B, 5C, or 5F if there is forefoot adductus.
Natural History

- Rigid, unsightly deformity
- Callused bursa develops over the dorsolateral aspect of the hyperflexed midfoot (WB surface of the foot)
- Variable level of function