Pathology & Primary Treatment of Clubfoot

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Introduction

The affected foot

- Restricted motion
- Diminished muscle strength
- Predisposed to deg. arthritis of ankle & knee
- Small foot & LLD
Four classes of clubfoot

- **Idiopathic variety**
  - Otherwise normal children
  - Not resolve without intensive Tx

- **Postural variety**
  - Resolve completely with manipulation, or with one or two casts

- **Neurogenic clubfoot**
  - Myelomeningocele

- **Syndromatic clubfoot**
  - Other anomalies, tend to be rigid & quite resistant to Tx

*Mosca, Lovell & Winter’s Pediatric orthopaedics, 5th ed. 2001*
Pathoanatomy of Clubfoot
Pathoanatomy

Deformities of the clubfoot

- Deformation in shapes of bones
  (Intraosseous deformity)
- Malalignment of bones at joints
  (Interosseous deformity)
- Soft tissue contracture
Deformation in shapes of bones
(Intraosseous deformity)
Talus

- Main pathologic structure

  - Medial & Plantar deviation of anterior end
  - Short talar neck projecting from dysmorphic small body
  - Talar neck–body declination angle

    : Invariably decreased (N : 150–160° )
Calcanenous

• Normal contour, Small size
  • Underdeveloped sustentaculum tali
    • Dysplasia of talar facet
  • Medially deviated & deformed anterior articular surface
    (varus deformity)
    • Interosseous deformity of calcaneocuboid joint
Navicular & Cuboid

More normal shape

- Misshapen only by interosseous relationship with calcaneus & talus

- Hypertrophied medial tuberosity of navicular
Malalignment of bones at joints
(Interosseous deformity)
"Acetabulum pedis"
(AP, Sarrapa, 1995)

“Pes acetabulum"
(Scarpa, 1994)

Ellipsoid articular cavity, holds & rotate around talar head

Bony element

- Post. articular surface of navicular
- Ant. & middle facet of calcaneus
Calcaneocuboid joint

- Navicular articulate with medial neck of the talus
- Due to equinus, Tibia & fibula are visible
- Cuboid is displaced medially on the distal end of calcaneus

*Carrrol NC, etc, Orthop Clin North Am, 1978; 9: 225*
“True Club Foot” (Carroll N.)

- Contracted calf
- Tight post. capsule
- Shortened post. C-F & T-F ligs.
- Focusing on posterolateral tether

Thick shortened C-F lig.
Transverse plane of ankle

Tibial torsion & Position of talus: Controversy

- **True medial tibial torsion**: Unusual
  - McKay (JPO, 1982)
    - Neutral aligned Talus
    - Talus is internally rotated
  - Carroll (Orthop Clin North Am, 1978)
    - Talus is externally rotated

- **Recent 3D MRI study**
  - Externally rotated position of talus
Coronal plane of ankle

- **Talus**
  - Pronation or "intorsion" deformity

- **Calcaneus**
  - Inverted or Supinated

- **Associated structure**
  - Ligament of tibiotalar & subtalar joint

- **Subtalar joint complex**
  - Severely inverted (combination of int. rotation, supination, plantar flexion)
  - Axis of rotation
    : Interosseous talocalcaneal lig.
Pronation or Intorsion of Talus

- Rotated Talar articular surface: counter-clockwise "intorsion" to med malleolus
- Supination & Varus of the heel

Release of the most posterior connection of the talus to the medial malleolus (post deltoid lig)

- Talar articular surface: perpendicular to the long axis of the tibia

Tachdjian’s Pediatric Orthopaedics, 3rd ed, vol 2
Contracture of periarticular soft tissue
Suspected Pathogenesis

- Fibrosis of tissue
  - Plantar fascia
  - Calcaneonavicuclar ("Spring") lig.
  - Tibionavicuclar lig.
  - Master knot of Henry (FHL & FDL at their decussation)
Suspected Pathogenesis

Associated structure

- Mobility of navicular
  - Tibialis posterior & master knot

- Mobilizing talus & calcaneus out of equinus
  - Achilles tendon

- Rotation of talar body & calcaneus
  - Peripheral subtalar capsule
But..... Clubfoot is ???/%*#!!!
Goal of Tx & Conservative

Goal of Treatment

- To achieve
  - plantigrade
  - supple
  - painless foot (looks normal)

Goal of Conservative

- To achieve above goal
- To achieve partial correction of deformity
  - Decrease the extent of surgery

Mosca, Lovell & Winter’s Pediatric orthopaedics, 5th ed. 2001
Failure of Correction

Causes

- Severity of the deformity
- Age at which tx. is initiated
- Experience of the physician
- Arthrogryposis, MM, Larsen, Diastrophic dwarfism
Normal

Clubfoot
Conservative Treatment of Clubfoot
Classification
(By Dimeglio A, Bensahel H, 1997)

- Equinus
- Varus
- Adduction
- Internal rotation

Classification of Clubfoot

<table>
<thead>
<tr>
<th>Classification Grade</th>
<th>Type</th>
<th>Frequency (%)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>benign</td>
<td>20</td>
<td>(&lt;5)</td>
</tr>
<tr>
<td>II</td>
<td>moderate</td>
<td>33</td>
<td>(5&lt;10)</td>
</tr>
<tr>
<td>III</td>
<td>severe</td>
<td>35</td>
<td>(10&lt;15)</td>
</tr>
<tr>
<td>IV</td>
<td>very severe</td>
<td>12</td>
<td>(15&lt;20)</td>
</tr>
</tbody>
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Assessment of Clubfoot by Severity Scale

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Points</th>
<th>Characteristics</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducibility</td>
<td></td>
<td>Other parameters</td>
<td></td>
</tr>
<tr>
<td>90°-45°</td>
<td>4</td>
<td>Posterior crease</td>
<td>1</td>
</tr>
<tr>
<td>45°-20°</td>
<td>3</td>
<td>Medial crease</td>
<td>1</td>
</tr>
<tr>
<td>20°-0°</td>
<td>2</td>
<td>Cavus</td>
<td>1</td>
</tr>
<tr>
<td>&lt;0° to -20°</td>
<td>1</td>
<td>Poor muscle condition</td>
<td>1</td>
</tr>
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Sagittal plane evaluation of equinus.
Frontal plane evaluation of varus.
Horizontal plane evaluation of derotation of the calcaneopodial block.
Horizontal plane evaluation of forefoot relative to hindfoot.
Initial Tx for idiopathic clubfoot should be nonoperative

The earlier the Tx is begun, the more likely that it will be successful

Modalities

Serial manipulation & casting, Taping, PT & splinting, CPM exercise...
Widely performed 2 methods

- Kite & Lovell Technique
  
  *The clubfoot, New York: Grune and Stratton, 1964*

- Ponseti Technique
  
  *Treatment of congenital clubfoot, JBJS Am, 1992*
Ponseti Technique

- Correcting all component simultaneously

- Emphasized the correction of
  - forefoot cavus
    - Forefoot should be corrected by supination
    - Dorsiflexion of 1st metatarsal

- Shifting navicular, cuboid, calcaneus in relation to the talus
  - Abducting the foot in supinated position
Ponseti Technique

- Heel was not constrained (Kite)
  - Calcaneus could evert during maneuver
- Percutaneous achilles tendon lengthening at final casting
  - 85% of patient
- Denis Browne bar
  - Full time & part time application for up to age 6 years
• Talus & calcaneus: severe flexion
• Calcaneus, navicular, cuboid: adducted, inverted
• Navicular tuberosity: closed to med malleolus
• Metatarsus: adducted
1st metatarsal more flexion than other metatarsal

: causing Cavus deformity

Cavus correction

: Extending 1st metatarsal & Supinating the forefoot

Must never pronated !!!!!!
- Abducting supinated foot
- Counterpressure applied on the lateral aspect of the head of the talus
- Index finger rest over post surface of medial malleolus
Complete correction of clubfoot

- Heel must not be touched
- Calcaneus abducts by rotating & sliding under talus
- Heel varus correction
• **Weekly manipulation, long leg cast**

• **1st – 4th cast**
  4 to 7 wks

• **5th & Final cast immobilization**
  (Percutaneous achilles tenotomy)
  20° degree Dorsiflexion
  70° degree External rotation

• **Denis Browne bar**
  23 hr for 3 month, night time 3–4 years

• **Tibialis anterior transfer to 3rd cuneiform**
  2.5–4 years, in 20–30%
Clubfoot Rt
(4 week after delivery)
Ponseti Serial Cast correction
Common error of Manipulative reduction

Ponseti, I.V., Int Orthop. 1997
Common error of Manipulative reduction

: Pronation or eversion of foot

- Increasing the cavus
- Locking the adducted calcaneus under the talus
- Midfoot & forefoot twisted into eversion

Increased Cavus

Bean-shaped foot
Common error of Manipulative reduction: External rotation of foot with calcaneus in varus

Posterior displacement of lateral malleolus by externally rotating the talus in the ankle mortise (iatrogenic deformity)

- Abducting supinated foot
- Counterpressure applied on lateral aspect of head of talus
Common error of Manipulative reduction:
Abducting the foot with thumb near Calcaneocuboid joint.

“Kite’s error”

- Abduction of calcaneus is blocked
- Interfering with the correction of heel varus
- Grasping the heel with hand prevent calcaneus from abducting

“Calcaneus can evert only when it is abducted (i.e. laterally rotated) under talus”
Common error of Manipulative reduction

: Attempt to correct equinus before heel varus & foot supination

- Residual tight tendo Achilles
- No function in the TP, FHL, FDL
- Ligament laxity

Rocker bottom foot
Flat-top Talus

**Causes**

- A nut being compressed in a **nutcracker** during forced DF
- Osteochondral compression Fx. or ischemic necrosis

**False or True ??**
Flat-top Talus

Treatment

- Calcaneus deformity with flat-top talus: Reduce heel height by McFarland calcaneal osteotomy
- Stiff ankle: Supramalleolar osteotomy
Other Common error of Manipulative reduction

- Manipulation with no casting
- Failure to use Denis bar splint
  
  3 months full time application 2–4 years night time application
- Attempt to obtain perfect anatomic correction
Risk factor for recurrence of the deformity

- Non-compliance with the use of foot-abduction orthosis (primary risk factor)
- Level of parental education

Recurrence is not dependent on

- The initial severity of the deformity
- The age of the initial treatment
- The number of casts required for correction
- Whether the patient had previous non-operative treatment of the deformity

A. Siapkara, R. Duncan. JBJS Br 2007
T/F from Other Hospital (6 month / Male)

After Ponseti manipulation from post-delivery 2 month

( d/t Failure to use Denis bar splint )

TAL & Cast correction
Bracing following correction of idiopathic clubfoot using the Ponseti method
Brace?

- Ponseti method for the management of idiopathic clubfoot
  - Popular & excellent outcomes

- Achieving a successful outcome
  - Not in correcting deformity but in preventing relapse

- The most common cause of relapse
  - Failure to adhere to the prescribed postcorrective bracing regimen

- New, more user-friendly braces have been introduced in the hope of improving the rate of compliance
Controversy

Denis Browne bar VS FAO
Proper Use of the Foot Abduction Orthosis

- Successful use of the FAO; obtaining full correction of the clubfoot

- Achilles tenotomy
  - Required to obtain the $15^\circ$ to $25^\circ$ of dorsiflexion necessary to allow proper use of the brace
  - Inadequate dorsiflexion: heel to pull up out of the shoe
    $\rightarrow$ irritation and skin ulceration.

- The heel should easily sit in the shoe
- The width of the shoe should accommodate the width of the foot
Proper Use of the Foot Abduction Orthosis

Before treatment with the Ponseti method

Posttenotomy cast removal

15° to 25° of dorsiflexion
Proper Use of the Foot Abduction Orthosis

**FAO components**
- A bar with shoes attached to hold the affected foot in approximately $70^\circ$ of external rotation
- Unilateral deformity $\rightarrow$ unaffected foot positioned in $40^\circ$ of abduction
- Placed at shoulder width for comfort
- Ends of the bar bent or adjusted to allow $5^\circ$ to $10^\circ$ of dorsiflexion

**FAO use**
- 23 hours per day for 3 months following cast removal from a fully corrected foot.
- The hour off is for bathing and a brace–free play period.
- After 3 months, the brace is worn at nighttime & nap time
Proper Use of the Foot Abduction Orthosis

The foot grows quickly during infancy

- Up to two new pairs of orthotic shoes needed during the first year of bracing and
- One new pair of shoes will be required for each year thereafter
- Complete overlap of the toes at the edge of the sole: Indication that the infant is outgrowing the shoes
Duration of FAO use

- Not thoroughly studied
- Ponseti and Smoley
  - Bracing be continued until the child achieved age 3 to 5 years
- Ponseti (later)
  - Brace should be worn at night for 2 to 4 years
- Abdelgawad et al
  - No longer convincing the affected child to sleep with the brace applied by the time the child reached age 3 years
  - Device be continued as long as the child could tolerate it at night
Proper Use of the Foot Abduction Orthosis

Recurrence management

- 2 to 3 manipulations and cast applications at 1- to 2-week intervals
- If dorsiflexion is limited
  - Age < 1 year → achilles tenotomy may be repeated
  - Age > 1 year → open Achilles tendon lengthening is preferred

In general, **full-time bracing is recommended** for infants who developed a recurrence early in their treatment course
Repeated recurrences management

- Family is having difficulty complying with use of the FAO
- Re-instituting bracing is usually optimal
- Anterior tibial tendon transfer may be the best option in this situation

In these difficult cases, it is preferable to maintain bracing until the child is aged approximately 30 months: Ossific nucleus of the third cuneiform is usually sufficiently large to permit anterior tibial tendon transfer
Thanks you for your attention