



Pediatric Foot Deformities-1



Professor Freih Abu Hassan



Embryology

□ Prenatal

– 5th Gestational week skeletal elements seen.

□ Postnatal

– 9 weeks - Metatarsal/distal phalanges

– 13 weeks - Calcaneus

– 8 months - Talus

– 3-5 years - Navicular



Congenital deformities



Congenital

- 1- Calcaneovalgus**
- 2- CTEV**
- 3- MA**
- 4- CVT**
- 5- Curly toes**
- 6- Polydactyly**
- 7- Oligodactyly**
- 8- Syndactyly**
- 9- Overlapping 5th toe**
- 10- Macroductyly**
- 11- Hallux varus**
- 12- Brachymetatarsia**
- 13- Lobster foot**
- 14- Amniotic bands**



1-Calcaneovalgus

- Most common neonatal deformity

A soft tissue contracture characterized by excessively dorsiflexed valgus hindfoot





Physical exam

- = Excessively dorsiflexed hindfoot that is passively correctable to neutral
- = Dorsal surface of the foot rests on anterior tibia
- = External tibial torsion





D.DX

1- Posteromedial tibia bowing

= caused by intrauterine positioning

2-CVT

you can differentiate on physical exam and with plantar flexion radiographs

3-Paralytic foot deformity

may be caused by L5 spina bifida





- **Reflection of generalized ligamentous laxity**
- **More common: in 1st Female due to the increased molding effects of the primigravida uterus.**
- **Treatment**
 - = Gentle stretching exercises by the parents → normal within 3 - 6 months.
 - = Resistant feet require serial casting.



2-Congenital Talipes Equino Varus

- Idiopathic
 - Genetic
- Postural



Club foot

- Neurogenic
- Syndromic



Postural deformity

= Due to

- intrauterine crowding or
- breech position.

= It it easily corrects to a normal position with manipulation & will resolve over time.



CTEV

- = Idiopathic deformity
- = > in males 2X
- = 50% of cases are bilateral

Club foot may be associated with

- = Diastrophic dwarfism
- = Arthrogryposis
- = Tibial hemimelia
- = Myelomeningocele
- = Sacral agenesis
- = Syndromes e.g. Freeman-Sheldon



Pathoanatomy of CTEV

1- Muscles contractures → deformity (CAVE)

Midfoot **Cavus** (tight intrinsics, FHL, FDL)

Forefoot **Adductus** (tight abductor hallucis)

Hindfoot **Varus** (tight Tib. Post.)

Equinus (tight TA)

2- Soft tissues

Tendon sheaths (e.g. peroneal)

Ligaments (e.g. CFL, spring, bifurcate Y)

Capsule (e.g. ankle, subtalar)

Fascia (e.g. plantar fascia)



3-Bony deformity

Talus

= Equinus

= Talar dome laterally rotated in mortise

= Talar neck is medially and plantarly deviated

Navicular

Displaced medially and plantarward

Calcaneus

Varus, Equinus, and rotated medially around talus

Cuboid

displaced medially



4- Others

- = Internal tibial torsion
- = Calcaneocuboid joint abnormality 25%
- = The calf & foot are small



Physical exam

Hindfoot in equinus and varus

Midfoot in cavus

Forefoot in adduction and supination





Radiographs

- Not needed for Dx
- Evaluation of correction or residual /recurrent deformity in older child

Diagnostic findings

- Parallelism of Talus & Calcaneus
- Talo - 1st met. alignment disrupted



Lateral

Parallelism between talus and calcaneus

Dorsiflexion lateral (Turco's)

Talocalcaneal angle of $< 35^\circ$ (N: $> 35^\circ$)

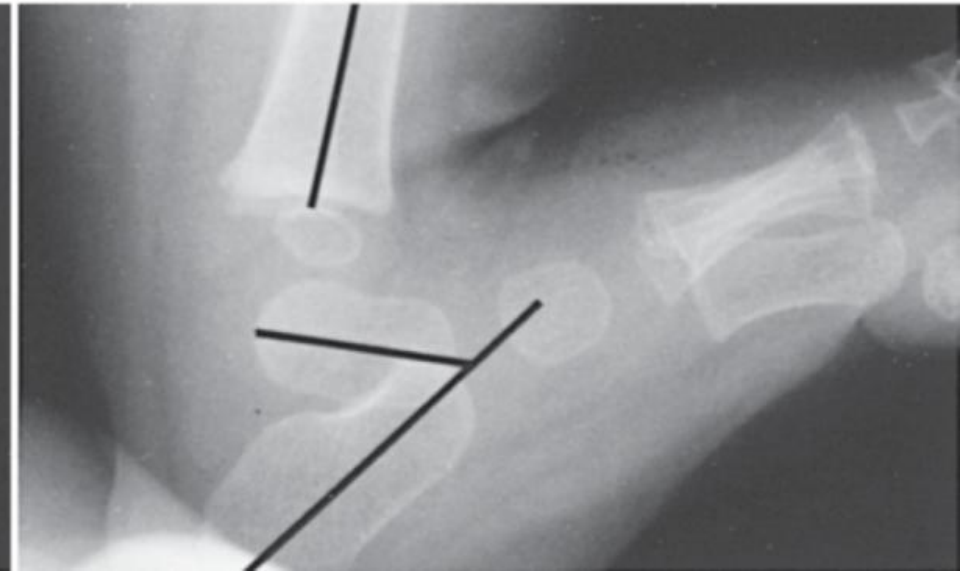
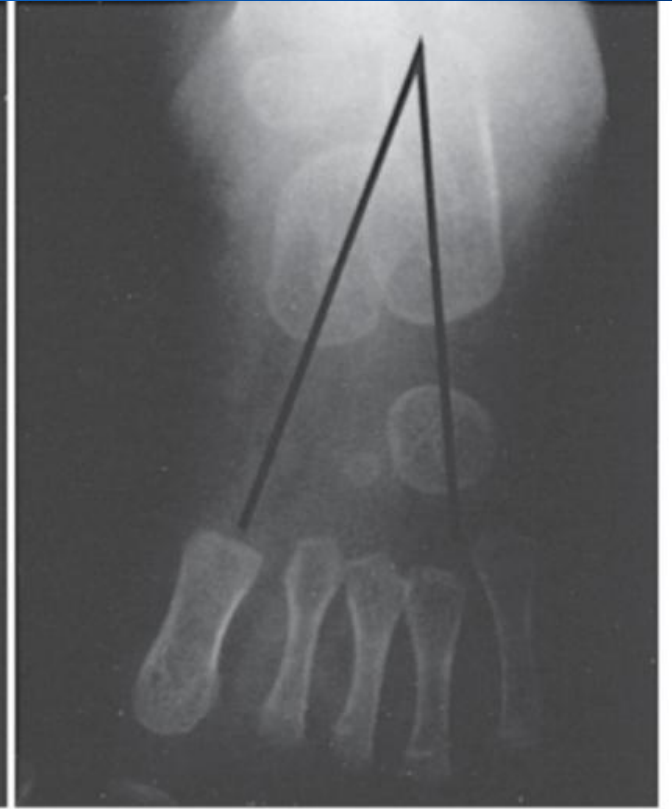
AP

Talocalcaneal angle (Kite's) is $< 20^\circ$

(N: $20-40^\circ$)

Talus-first metatarsal angles is -ve

(N: $0-20^\circ$)





Nonoperative
> 90% success rate

Serial manipulation and casting (Ponseti method)

Goal is to rotate foot laterally around a fixed talus

Orders of correction (*cave*)

Midfoot Cavus

Forefoot Adductus

Hindfoot Varus

Hindfoot Equinus (TAL)



Operative

**PML soft tissue release and tendon lengthening
(Cincinnati)**

= resistant feet in young children or
= when "rocker bottom" feet develop as a
result of serial casting

**at 9-10 months of age so the child can be
ambulatory at one year of age**

- **No wire in subtalar joint**
 - **Aim: Gain maximal ER of joint at time of cast change**



Table 38.11 The four stages of a peritalar release that might be required for the correction of a severe clubfoot deformity

Site	Structures requiring lengthening or release
Posterior	Tendo Achilles Ankle and subtalar joints Calcaneofibular ligament Posterior elements of the peroneal tendon sheaths
Medial	Abductor hallucis Tibialis posterior Talonavicular joint Toe flexors
Lateral	Calcaneocuboid joint
Plantar	Plantar ligaments Plantar fascia
<i>Protect</i>	<i>Neurovascular bundle</i> <i>Talocalcaneal interosseous ligament (if possible)</i>



Late CTEV

1- Medial opening or lateral column shortening osteotomy

In older children from 3 - 10 years

2- Triple arthrodesis

3- Ilizarov

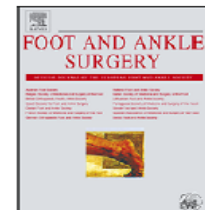
4- PMR + Cross leg flap

In refractory feet at 8-10 years of age



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Complete subtalar release for older children who had recurrent clubfoot deformity

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ABSTRACT

Background: Neglected idiopathic clubfoot deformities, and severe recurrent deformity after previous surgery presents technical difficulties for correction and challenges for surgeons to achieve primary skin closure.

Methods: Between 2000 and 2006, 18 children (30 feet), had complete subtalar release (CSTR) for failed previous surgery in 28 feet and severe neglected congenital talipes equinovarus (CTEV) in 2 feet followed by cross leg fasciocutaneous flaps for reconstruction of residual defect at the ankle and foot after full correction of the deformity.

Mean patients followed up were 4.5 years (average 2–8 years). 23 feet were classified as Dimeglio III and 7 feet as Dimeglio IV.

Results: All cases achieved a plantigrade foot, better walking ability ($p < 0.03$), and parental satisfaction with the result ($p < 0.001$).

Ankle joint doriflexion increased from mean (-21.33°) preoperatively to (12.5°) postoperatively. All cases showed postoperative improvement in their radiographic findings. The mean preoperative talocalcaneal angle increased from (15.7° to 30.03°). The talo-first metatarsal angle improved from a preoperative mean of -16° mean of 5.53° postoperatively. At the final follow-up cosmetically acceptable plantigrade foot was achieved in all feet. Four legs (14.28%) developed hypertrophic scars at the donar flap site. One patient developed 1.5 cm marginal necrosis of the flap, which did heal after debridement by secondary intention. None of the feet had recurrence at the final follow up. Despite the enormous improvement clinically and radiologically, their was no statistical significant difference between preoperative and postoperative radiological angles ($p < 0.069$).

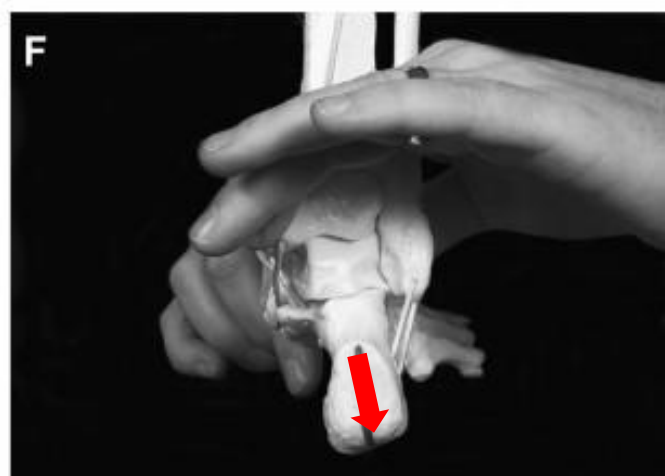
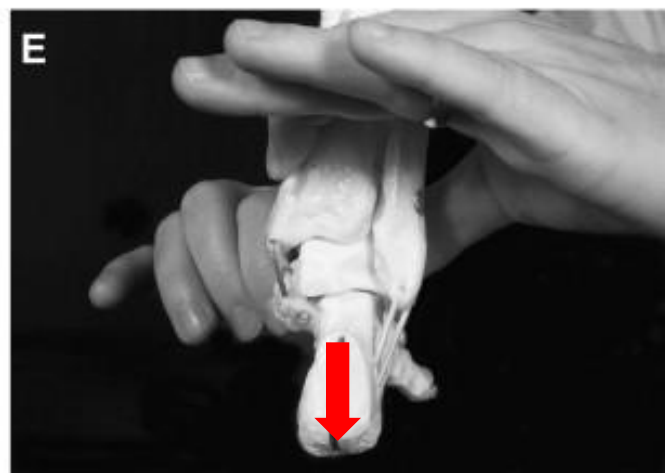
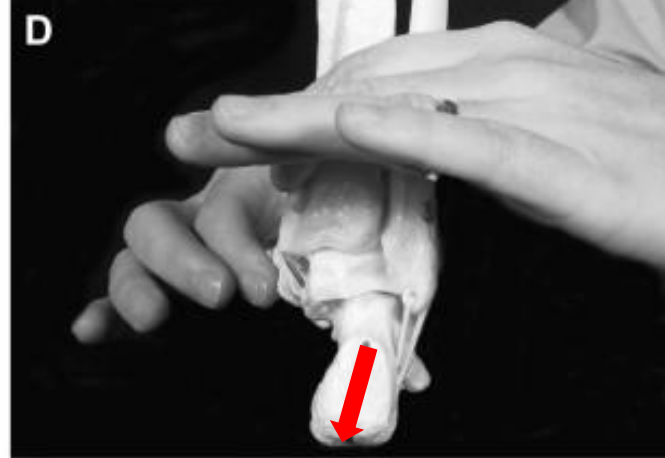
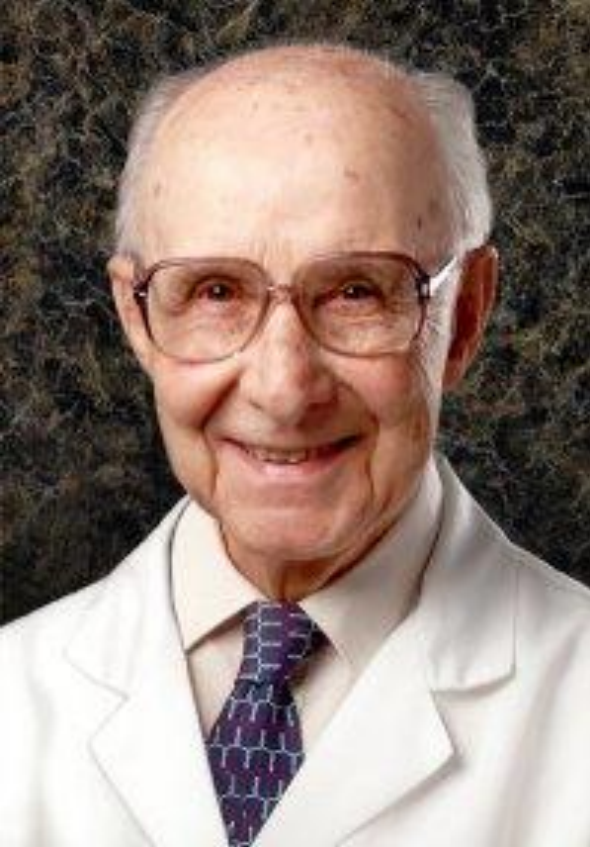
The number of previous surgical interventions had no influence on the outcome. All the previously treated feet had inadequate release of important tethered soft tissue.

Conclusion: This is indicative of the enormous value of complete subtalar release combined with cross leg fasciocutaneous flap without the need for bony intervention in previously operated failed feet or neglected deformities.

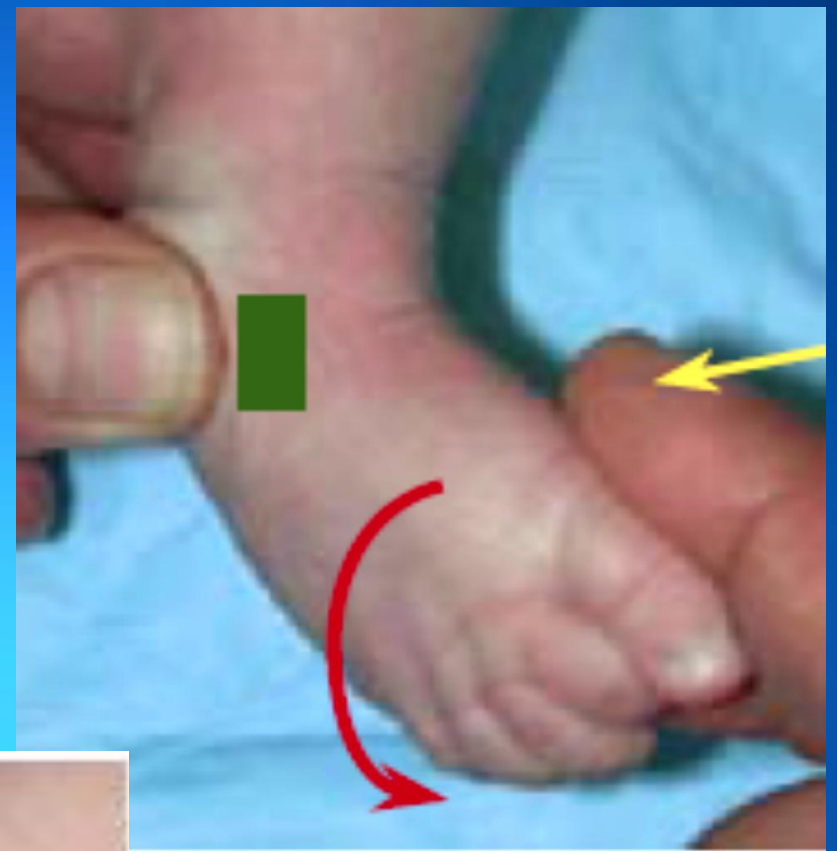


Manipulation

- **Localize** lateral head of the talus
- **Stabilize** head of talus with thumb
 - This will be pivot point for abduction of forefoot.
- **Abduct** forefoot in supination as far as possible without causing discomfort
- **Hold** for a short period of time and repeat



Ponseti Technique





Series of casts

4-6 weeks



Stage 1



Stage 2



Stage 3



Stage 4



Stage 5





G



F





= Static not dynamic

= Distract mother attention



Complications with nonoperative treatment

Deformity relapse

= Relapse in child < 2 years

early relapse usually the result of
noncompliance → repeat casting



= Relapse in child > 2 years

- Treat initially with casting
- Consider Tib Ant. tendon transfer to lateral cuneiform (can only do if lateral cuneiform is ossified)
- Consider repeat TAL



Complications of Casting

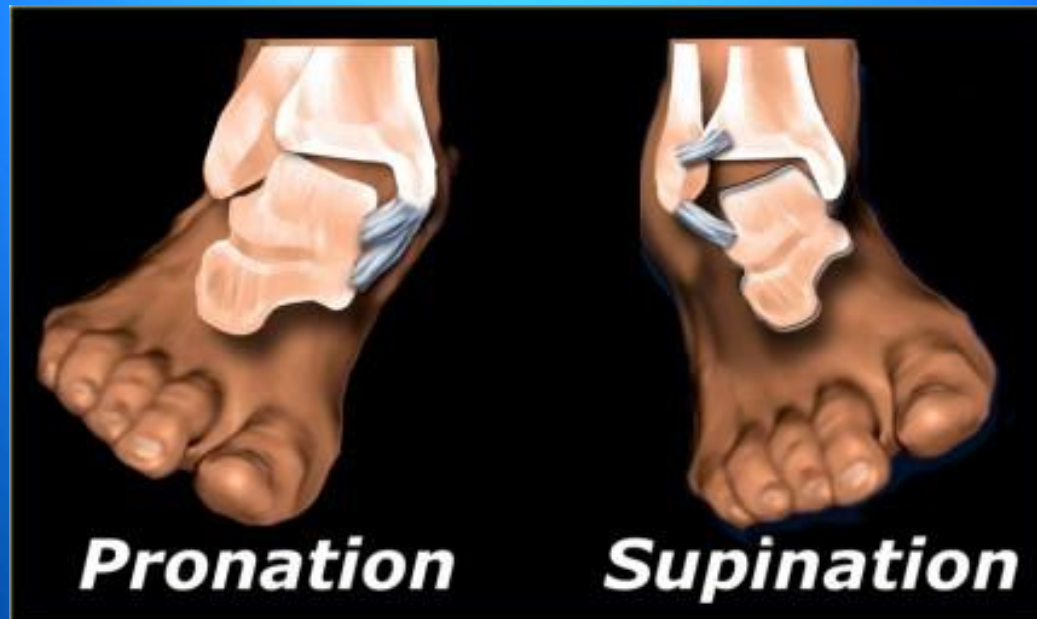
- Flat top talus
- Rocker bottom





Dynamic supination

Needs whole anterior tibial tendon transfer (preferred over split anterior tibial tendon transfer)





Complications with Surgical Treatment

Residual cavus

result of placement of navicular in dorsally subluxated position

Pes planus

results from overcorrection

Undercorrection



Osteonecrosis of talus

results from vascular insult to talus
resulting in osteonecrosis and
collapse

Dorsal bunion

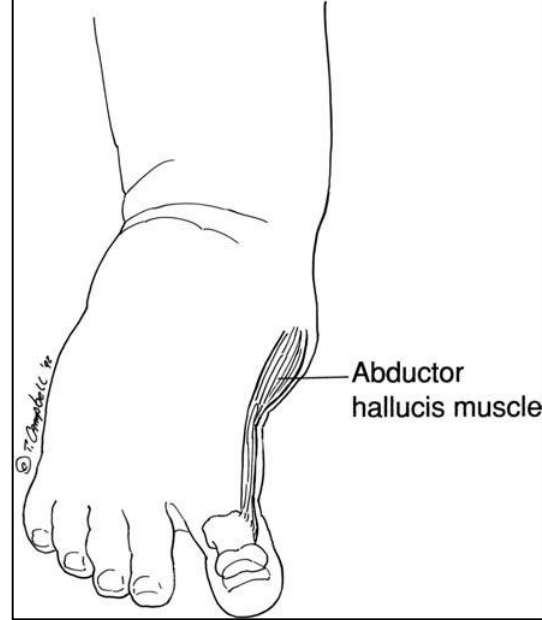
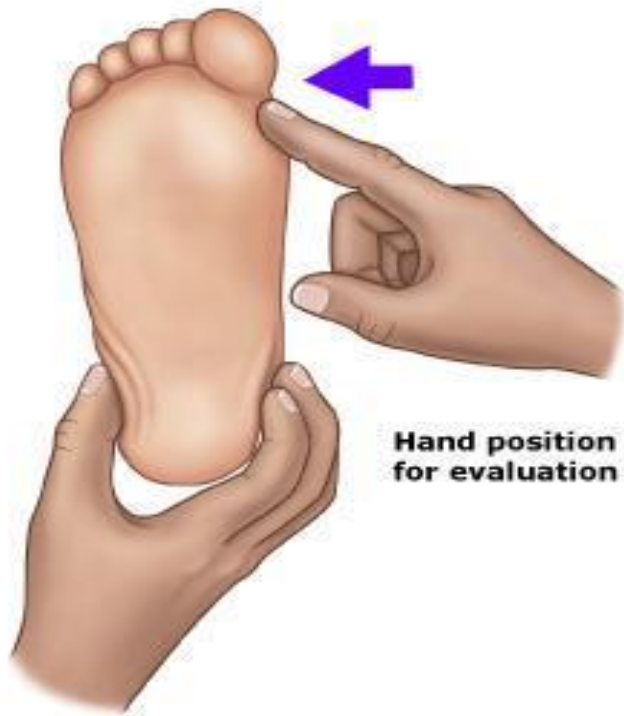
caused by dorsiflexed first metatarsal
and overactivity of anterior tibialis



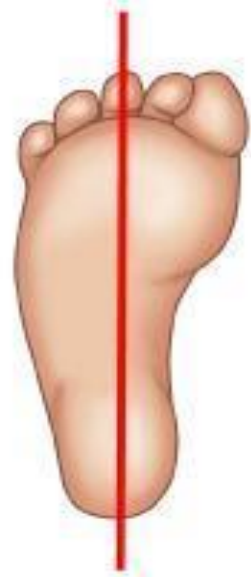
3-Metatarsus Adductus

- **50% bilateral**
- **Onset**
- **Abnormal intrauterine position**
- **Forefoot adducted at TMT joint, sole is kidney shaped**
- **Heel is NOT in equinus**

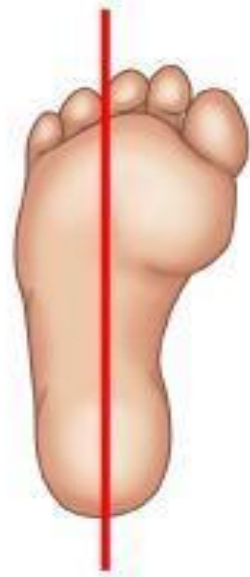




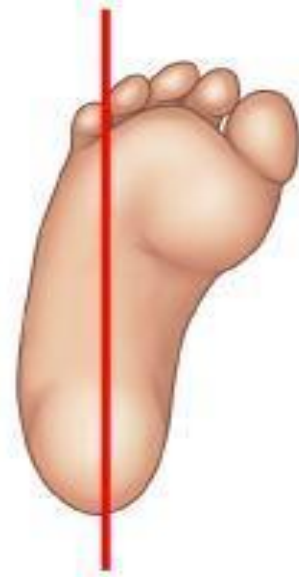
Normal



Mild



Moderate



Severe



Rx for Metatarsus adductus

> 90% resolve without Rx by age 1 year

- **Mild**

- = Can overcorrect into abduction with little effort.

- = Stretching exercise should not be performed

- **Moderate**

- = Passively correct to the neutral position.

- Passive stretching exercises

- Regular FU and casting if no improvement



- **Severe or rigid**
- **Unable to be passively abducted to the midline.**
- **Corrective casting is required.**
Results are best with early Rx before 8 m.
of age



- **SURGERY**

Children >4-5y with severe symptomatic residual metatarsus adductus.

- **Age <7:** Soft tissue release tarsometatarsal joint

or

- **Age >7:** Metatarsals Osteotomy



4-Congenital Vertical Talus

- Irreducible dorsal dislocation of navicular on talus → rigid flatfoot
- **50%** bilateral
 - **NM + Genetic 50%**
 - Chromosomal abnormalities
 - Arthrogryposis
 - Myelomeningocele
 - **Idiopathic 50%**
 - **Iatrogenic - overcorrection CTEV**



Pathoanatomy

= **Hindfoot** fixed equinovalgus
(rockerbottom)

due to contracture of the Achilles and
peroneal tendons

= **Midfoot** rigid dorsiflexion
secondary to the dislocated navicular

= **Forefoot** abducted and dorsiflexed
due to contractures of the EDL, EHL and
tibialis anterior tendons

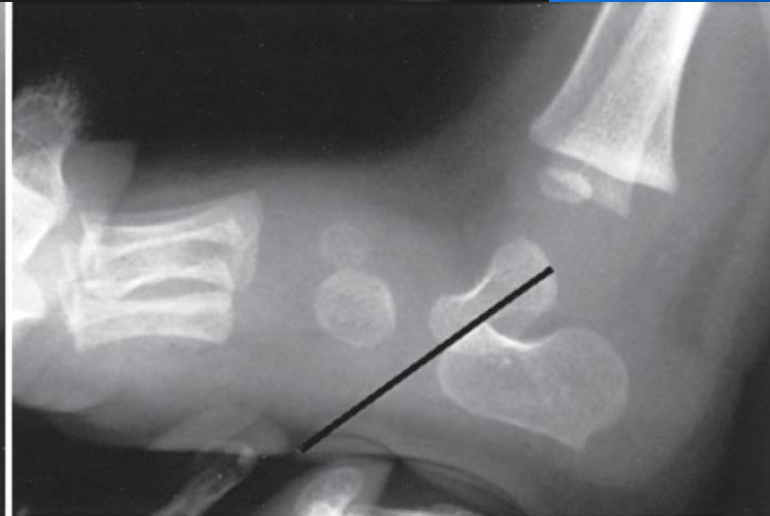
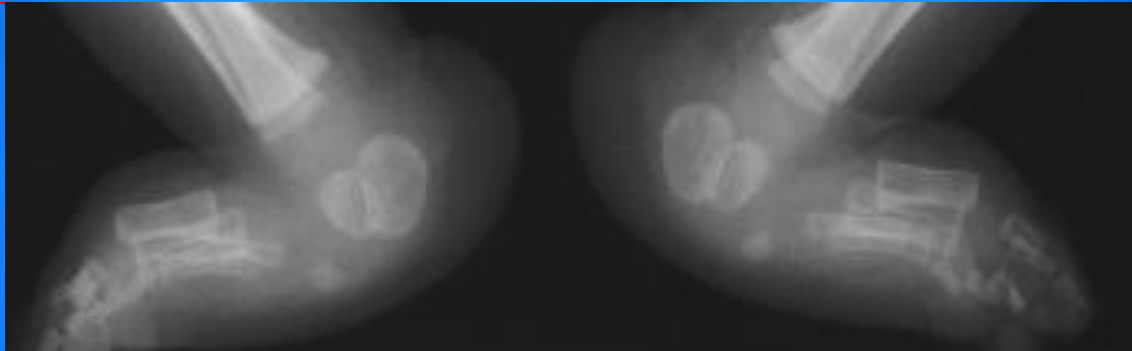


Physical exam

- = Rigid flat foot deformity
- = Talar head is prominent in med. plantar arch → convex plantar surface
- = Careful neurologic exam is needed



Lateral Radiographs + Forced plantar flexion lateral
= vertically positioned talus & dorsal dislocation of navicular
= line in long axis of talus passes below the first metatarsal-cuneiform axis





Differential Diagnosis

Oblique talus

Talonavicular subluxation that reduces with forced plantarflexion of the foot

Some require surgical pinning of the talonavicular joint and achilles lengthening for persistent subluxation



CVT TREATMENT

- **Non-operative** - Stretching for surgery
 - Serial casting in plantar flexion/inversion
- **Surgery** at 6-12mths – soft tissue release
 - **Lengthen** (Achilles, Peroneal, Tib ant, Toe extensors)
 - **Release** (Post. Ankle, Subtalar, Calcaneocuboid, Talonavicular)
 - **Plicate** (Tib post, talonavicular capsule)



- **Recurrent deformity**

Revision STR between 2-6yo.

- **Late treatment:**

STR + navicular excision

Subtalar arthrodesis 2^{1/2}-6yr

Triple arthrodesis > 6yr



5- Congenital Curly Toe

- **Flexion deformity of PIP joint with external rotation and varus**
- **Familial, bilateral, symmetrical, rarely symptomatic**
- **Congenitally short FDB & FDL**
- **25% spontaneous recovery**
- **Early (after age 3) – flexor tenotomy**





6-Polydactyly

30% of patients have a positive family history.

Polydactyly can be

= *Preaxial* (great toe), *central* (2nd, 3rd, or 4th toe)

= *Postaxial* (5th toe)





Mirror Image



أبوسته
أبودية
أبواصبع



Operative

= Ablation of extra digit (usually border digit) at **9-12 months** of age

= Small skin tags can be removed in newborn nursery





7-Oligodactyly

- = Involve the lat. side of the foot.
- = Can impair shoe-fitting.
- = Generally does not cause pain.
- = May be associated with **Fibular hemimelia,**
Tarsal coalition





8-Syndactyly

= Common and rarely interferes with function.

The deformity can be classified into

Zygosyndactyly:

= Complete or incomplete webbing between the 2nd – 3rd toes.

= Rarely causes symptoms and requires no treatment.



Polysyndactyly:

Duplication of the 5th toe with a syndactyly between the duplicated toes and sometimes between the 4th toe and the duplicated toes.

Needs Surgical treatment

Complex (syndromatic)





9- Overlapping 5th toe

- **Familial, bilateral & asymptomatic**
- **5th toe adducted, extended & externally rotated at MTP joint**
- **May cause footwear problems**
- **Contracture of dorsal medial MTP capsule & extensor tendon**
- **Operative - Butler procedure**
 - **V-Y Plasty**



Butler's procedure for congenital varus 5th toe: evaluation with long-term follow-up

Freih Odeh AbuHassan, Akram Shannak and Frank McManus

Butler's procedure has been advocated for the correction of congenital varus (over-riding) 5th toe deformity since 1968. We reviewed 48 procedures in 36 healthy children and young adolescents. The patients were followed for 1–16 years, and the results have been good to excellent in 93.75% of the patients. There was no statistically significant effect of the age on the results of this technique ($P = 0.6550$), thus it can be performed at any age group and remains the gold standard technique. © 2001 Harcourt Publishers Ltd

The Foot (2001) 11, 132–135

V-Y arthroplasty for congenital overriding fifth toe: a retrospective study of 34 operations between 1986 and 2000

F.O. ABU HASSAN,* A. SHANNAK* AND M. STEPHENS†

**Jordan University Hospital, Amman, Jordan and †Children's Hospital, Dublin, Ireland*

Summary

A total of 32 children and adolescents who had undergone V-Y arthroplasty for the correction of overriding fifth toe by multiple surgeons was reviewed retrospectively. Bilateral operations were performed on six patients, giving a total of 38 operations. Patients were followed for 1–13 years (average 8.07 years). A total of 12 patients (15 feet) were clinically examined. The remaining 16 patients (19 feet) completed the assessment sheet by mail. Excellent results were obtained in 7 feet, good results in 16 feet and poor results in 11 feet. All the poor results related to the age at the time of surgery ($P = 0.0047$). A total of 37% of the patients were not satisfied with the results of the operation. With a third of the patients having a poor result, serious consideration should be made in recommending this form of surgery, especially in adolescent children.



10-Macrodactyly

Most common associated with neurofibro & hemangiomatosis.

Surgery is indicated

Relieve functional symptoms, primarily pain or difficulty in fitting shoes.

The cosmetic goal is to to achieve a foot similar in size to the opposite foot.



Surgical procedures

- = Reduction syndactyly,
- = Soft tissue debulking + osteotomy or epiphysiodesis.
- = Toe amputation and ray amputation.





11- Congenital Hallux Varus

a deformity in which the great toe is angulated medially at the MTP joint .

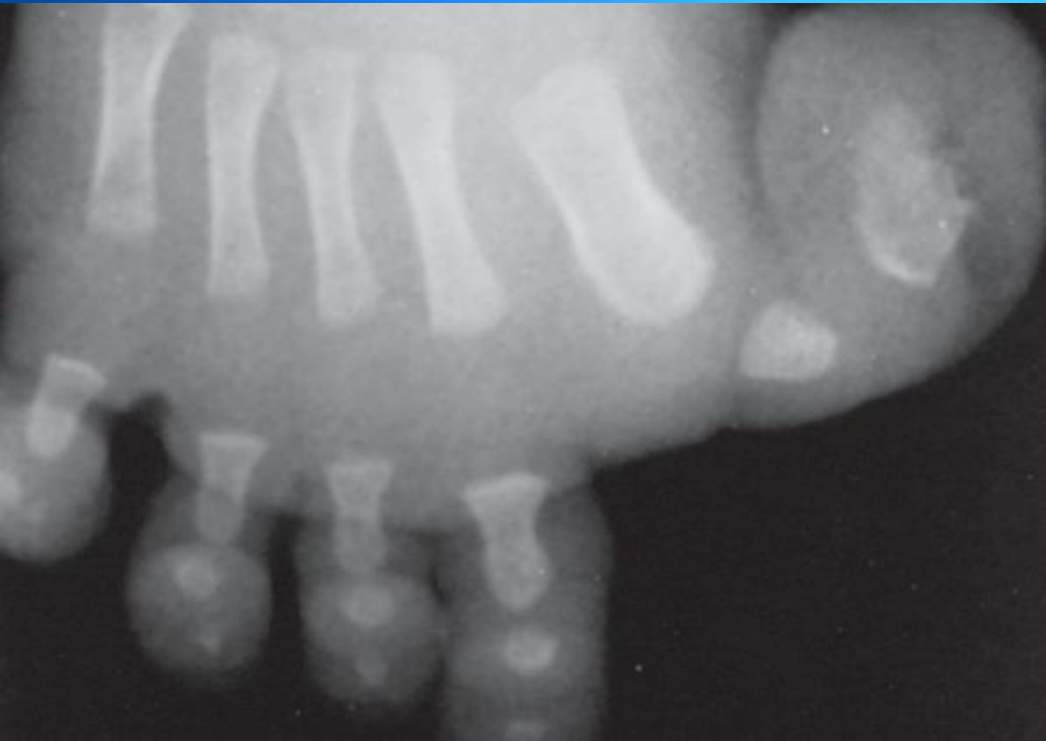
The varus deformity of the toe varies from 10- 90 degrees.

= Unilateral deformity



= Associated with one or more of the following:

- 1- Polydactyly**
- 2- Short, thick 1st met, accessory metatarsals and phalanges.**
- 3- Firm fibrous band that extends from the medial side of the great toe to the base of the first metatarsal.**





The Farmer technique is effective in correcting mild or moderate deformity

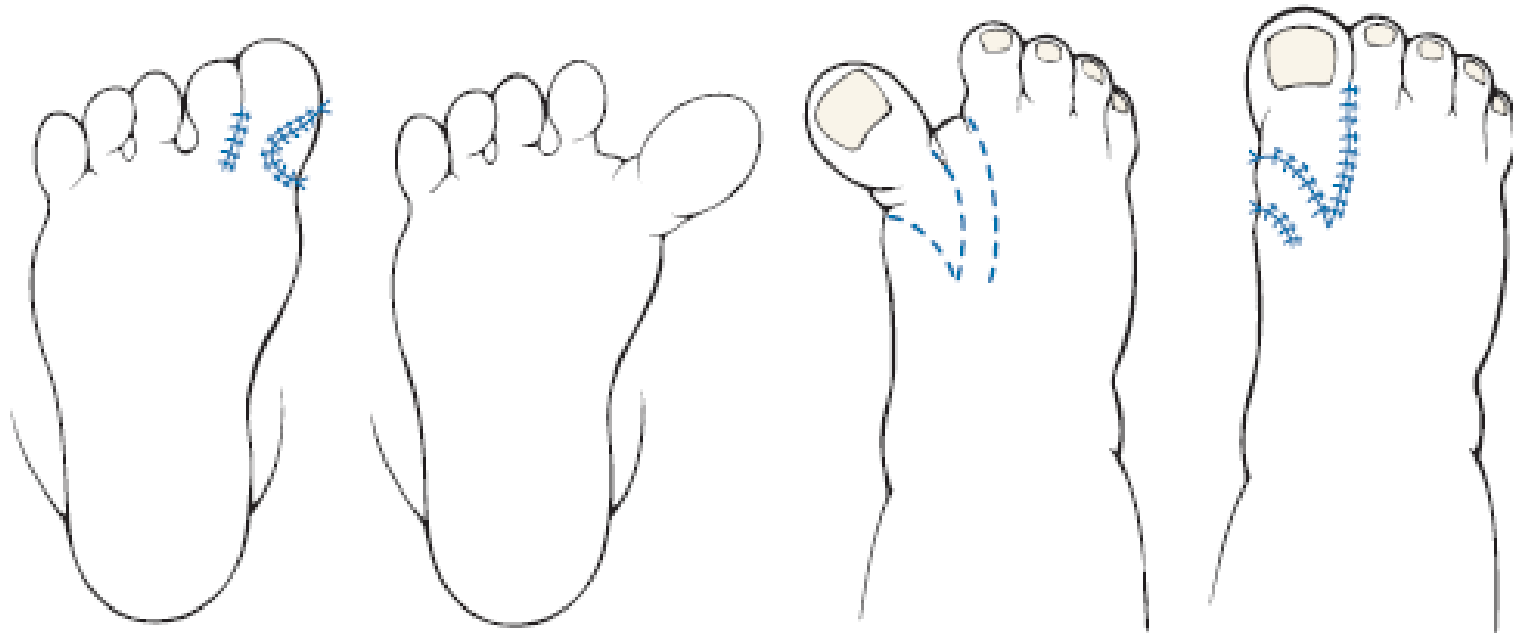



Figure 30-14 Farmer's procedure for correcting congenital hallux varus. (From Beaty JH. In Canale ST [ed]: *Campbell's*



11- Congenital Hallux Valgus





Fibrodysplasia ossificans progressiva (FOP)

Disabling heritable disorder of CT
= Cong. Deformity of the great toes
= Progressive heterotopic ossification
In extraskeletal sites.





12-Brachymetatarsia

- Congenital hypoplasia of one or more metatarsals
- Shortening of the fourth metatarsal
- Often bilateral





Nonoperative

Extra-depth or extra-wide shoes, generally will improve symptoms.

Operative

Metatarsal lengthening or amputation may be indicated if symptoms persist (> 16 Y)





13- Lobster foot- Ectrodactyly

It is deficiency or absence of one or more central digits of the hand or foot





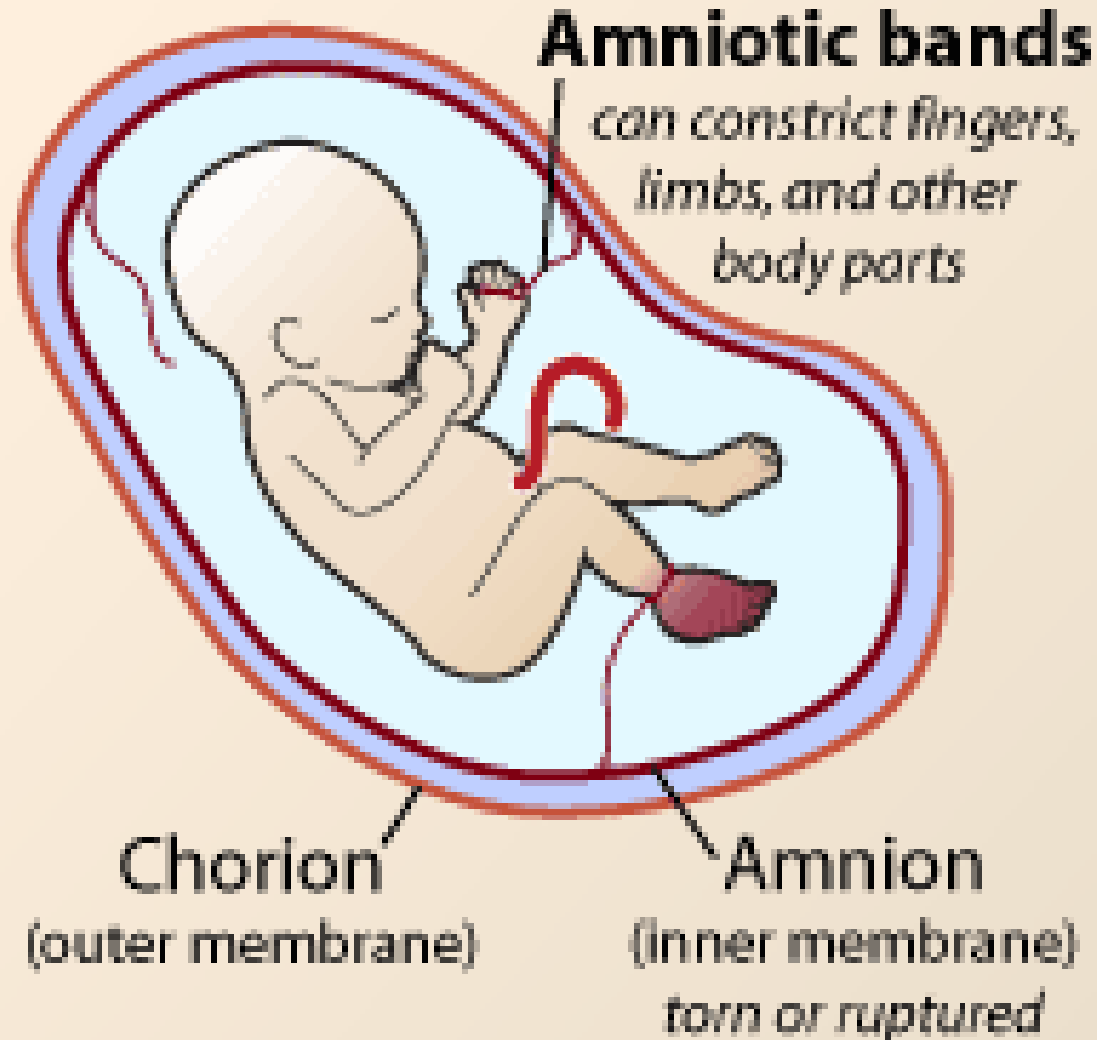
= It is an inherited disorder

= Can be treated surgically

**Early physical and occupational
therapy can help them**



14-Amniotic bands





Constriction bands over various parts of extremity

Can lead to vascular compromise, lymphedema

Deeper bands can produce complete amputations



lymphedema





= **Simple bands** are cosmetic problems and do not require treatment

= **Complex bands** require surgical release, especially if neurovascular

Above ankle tourniquets in young and adolescent children foot surgery

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Received 29 April 2002; accepted 6 August 2002

Abstract

We undertook a prospective study of 53 consecutive foot surgery under general anesthesia in young and adolescent children over a 4.5-year period to assess the safety and efficacy of above ankle tourniquet in the surgery of certain pediatric foot disorders. The average age was 8.4 (1–14) years. The tourniquet pressure used ranged from 200–225 mmHg (average 217.92 mmHg). The average duration of tourniquet ischemia was 39.7 min (6–73 min). There were no post-operative complications noted with ankle cuffs. No patient has neurological complications. The above ankle tourniquet was a safe and effective means in providing a bloodless field for foot surgery in children, and provides a suitable alternative to the routine use of a thigh tourniquet in children.

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