Pediatrics

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The Goldfarb Foundation

Standing on the Shouders of Giants

- Much Thanks to Dr. Charles C. Southerland, DPM, FACFAS
- For his dedication to pediatrics and advancing podiatric education!

Remember there is an entire child above that foot”

Vincent Mosca

It all Begins with a Baby!

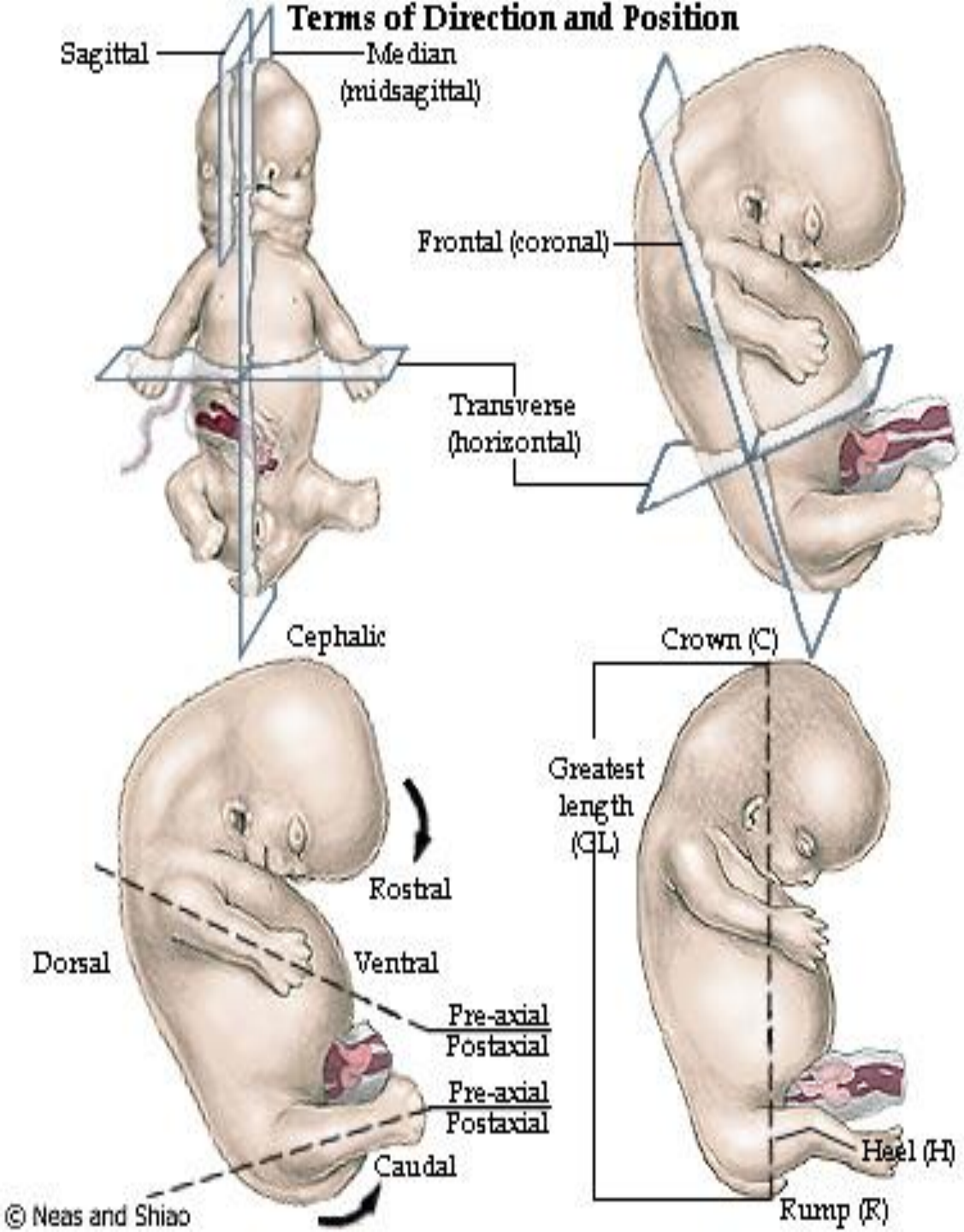
Neonate Examination

- Based upon observations made at 1 and 5 minutes after birth
  - 1 minute is an index of asphyxia
  - 5 minutes index of death or neurological defects
- 5 observed findings: (scores of 0-1-2 are given)
  - Heart rate
  - Respiration
  - Muscle tone
  - Reflex irritability (nasal catheter response)
  - Skin color
- Lower the score the more depressed the infant
  - Low scores indicate severe acidosis

APGAR Score (Dr. Virginia Apgar-1952)

Points	2	1	0
Color	Completely pink	Pink with blue extremities	Blue or white
Heart Rate	>100 bpm	<100 bpm	Absent
Respiration	Crying Lustily	Shallow and Irregular	Absent
Muscle	Active Movement	Some Flexion of Extremities	Flaccid
Reflex Irritability	Cough	Grimace	Nil

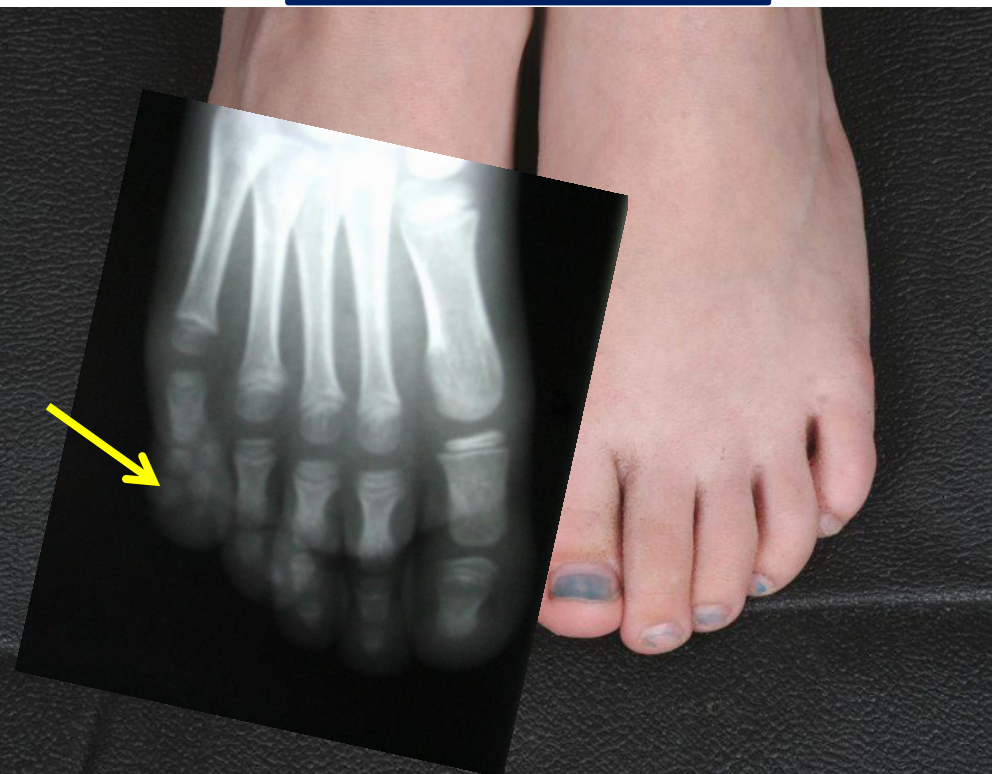
- Terms of Direction & Position
  - **Cephalad**
  - **Caudal**
  - **Crown**
  - **Rump**
  - **Rostral**
  - **Dorsal**
  - **Ventral**
  - **Pre-Post Axial (Hallux/Pollux)**

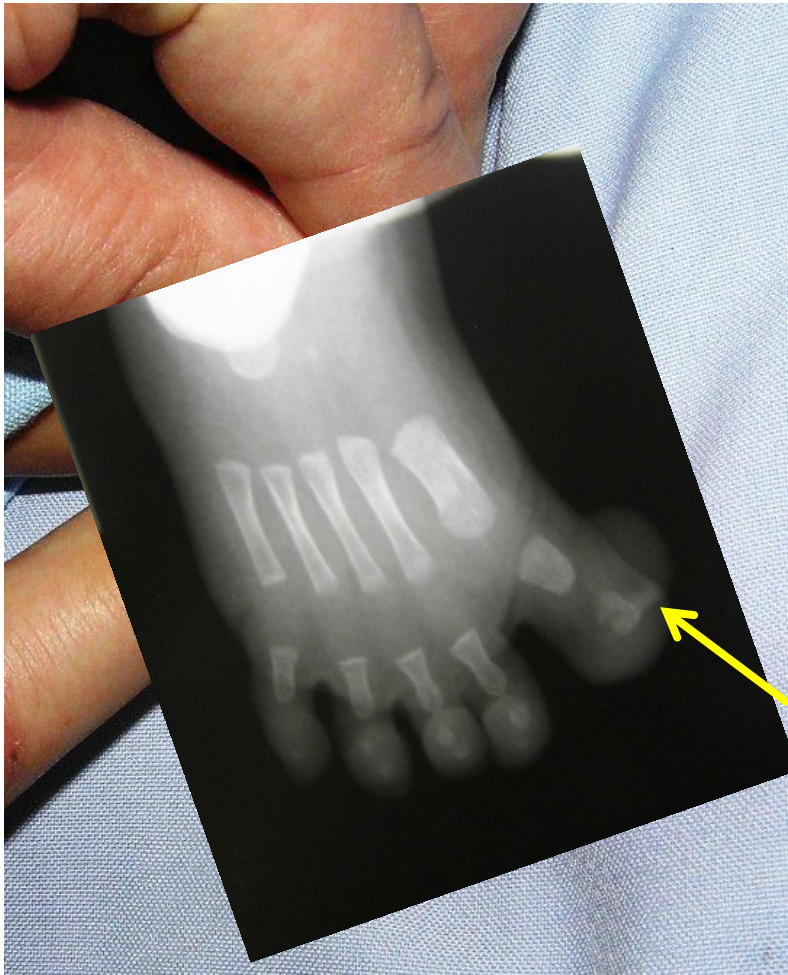


Developmental Disorders
Polydactyly

Pre Axial Polydactyly of the 1st toe

Post Axial Polydactyly of the 5th toe





Polydactyly

- **Definition**:
  - Presence of supernumary digits or metatarsals
- **Hereditary malformation**:
  - Transmitted as an **autosomal dominant trait**
  - Most common congenital deformity of the hand and foot
- **Two presentations**:
  - Single deformity in the foot (*non-syndromatic*)
  - Associated with accessory digits in the hand, and there may be other congenital malformations as well (*syndromatic*)
- **Clinical appearance**:
  - Pre-axial (hallux) - 10%
  - Post-axial (5th toe) – most common (80%)
  - Central (2,3,4 digits) – rare (< 5%)

Development

- First appearance of limb buds
  - 5th Week Interuterine
  - Critical period for upper and lower limb development is from **24-44 days** after fertilization
    - Most vulnerable to cellular injury
      - Thalidimide
      - Radiation

Development

- First appearance
- Bones
  - Trends
    - To the Elbow I Grow, From the Knee I Flee
    - First to form is last to fuse
  - Start to form primary centers of ossification in long bones during the 7th Week Intrauterine
    - Femur – Early 7th week
    - Tibia – Later in 7th week
    - Fibula – 8th week (4 “fibs” of the fibula)

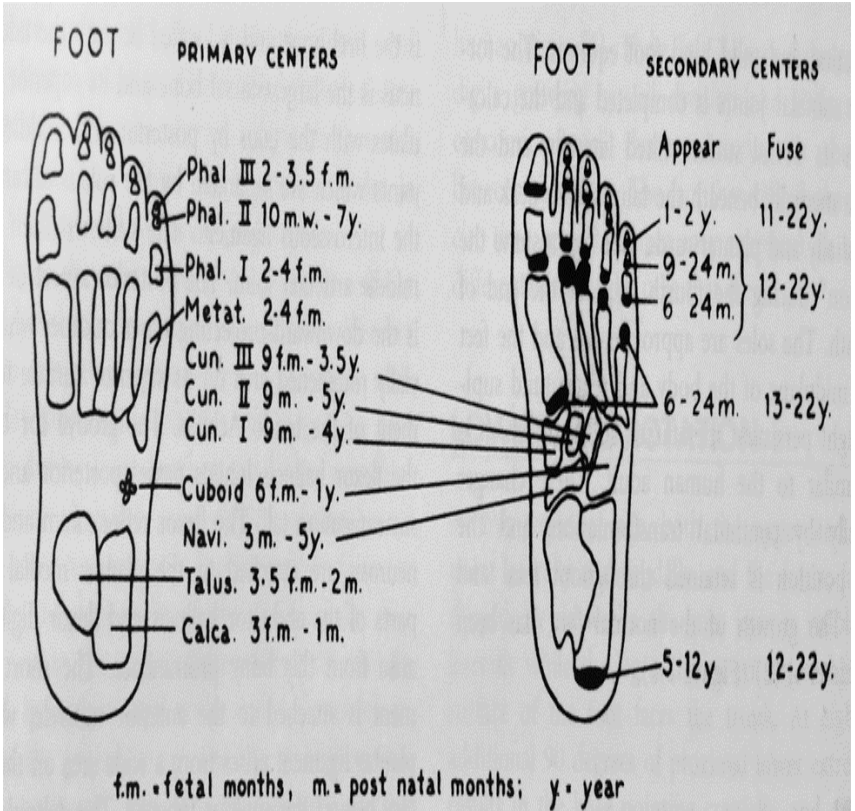
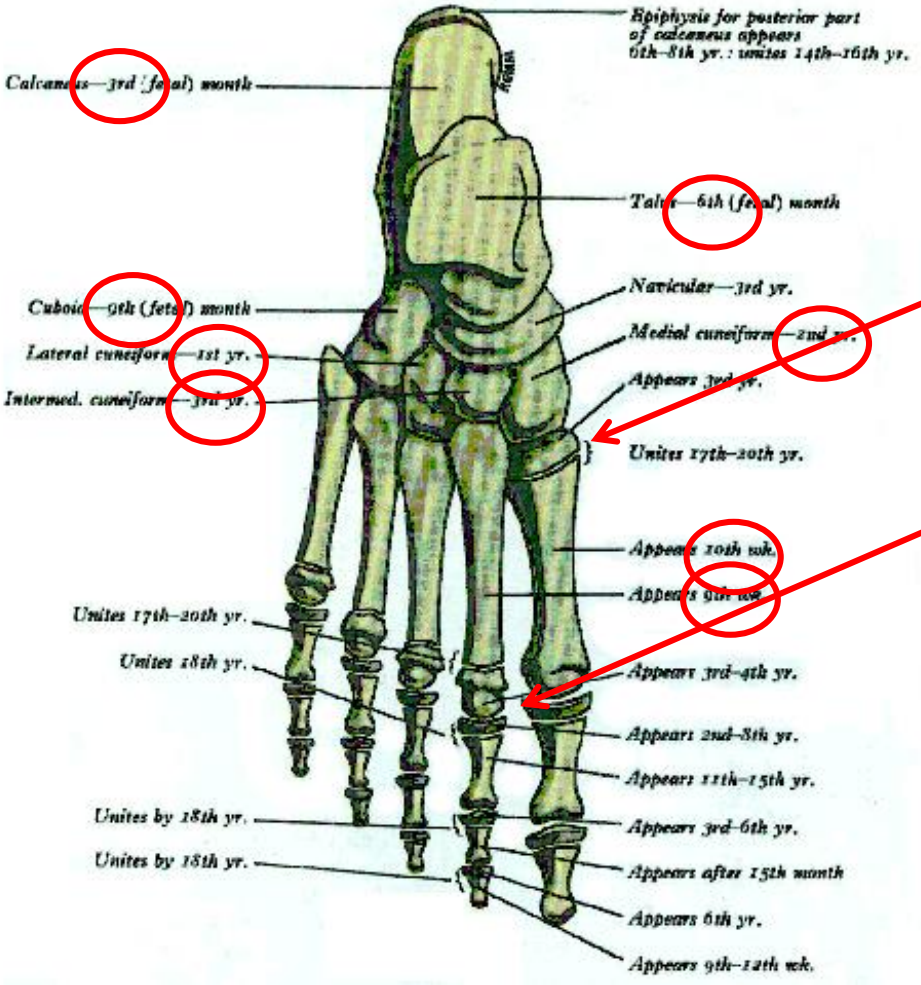


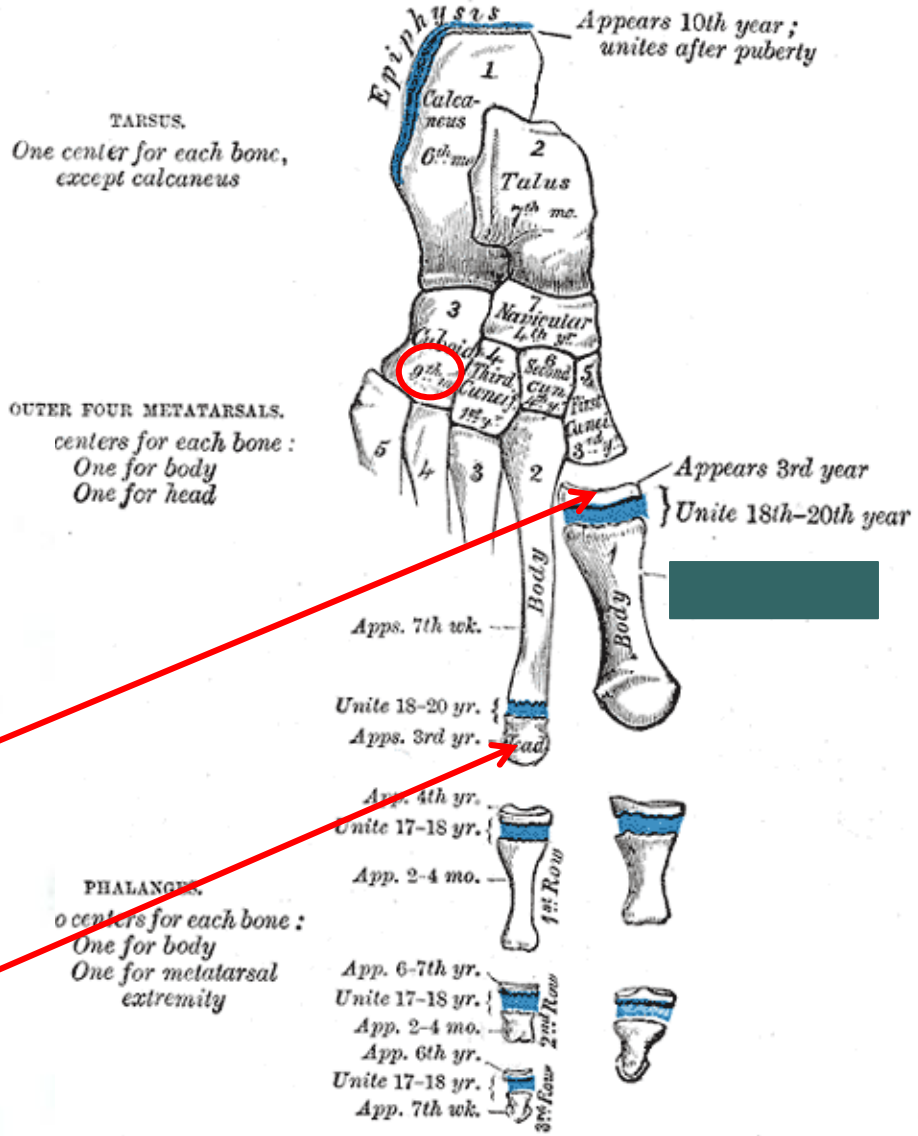
FIGURE 1-2 Schedule for appearance of primary and secondary ossification centers and fusion of secondary centers with the shafts in the heel. (From Caffey J. The extremities: anatomic variations. In: *Pediatric x-ray diagnosis*, 4th ed. Chicago: Year Book Medical, 1961;784 with permission.)

Development

- First appearance
- Bones
- Appendageal Structures
  - Nails - 3rd Month
  - Hair – 4th Month

Development (Ossification Trends)





Development

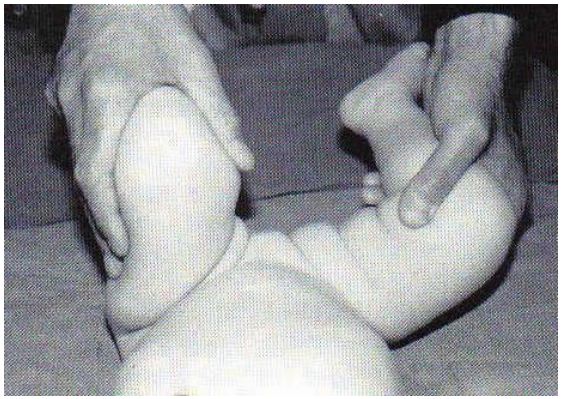
- First appearance
- Bones
- Nails
- Appendageal Structures
- Post Partum
  - Bones largely Cartilaginous until ~ 4th year
  - “FAT, FLAT, FLOPPY”
    - Rule of 7

Developmental Motor Skills

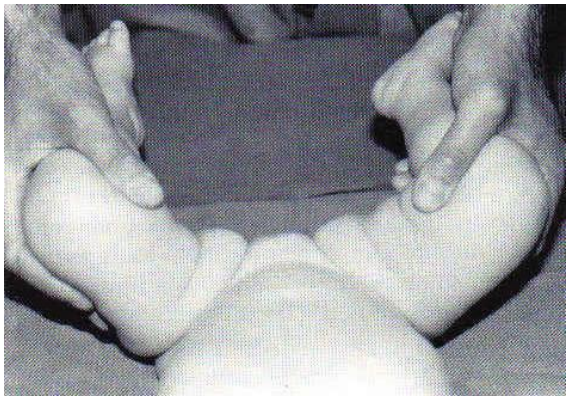
- **Crawls**: 3-5 months
- **Creeps**: 7-9 months
- **Stands**: 9-14 months
- **Cruises**: 9-12 months
- **Walks**: 7-18 months (average is 13 months)

Developmental Disorders Congenital Hip Dislocation

- Barlow's test- middle finger on greater trochanter, thumb on inner thigh, pressing back and outwards- head slides



- Ortolani's sign- examin one at a time, grasp thigh with middle finger over greater trochanter, and lift and abduct thigh, while stabilizing other thigh



Normal Development Knee/Leg Relationship

Age	Position
<2	Varum
2-4	Straight
4-7	Valgum
7-12	Straight
13-18	Valgum
Adult	Straight
Geriatric	Varum

Normal Development of the Knees

- Genu valgum:
  - knock-kneed
  - normal position during development
  - noticed 1st between 3 & 5 years
  - outgrown by 8
  - second episode may develop in 12 to 14 year olds, (especially females)
- Genu recurvatum: posterior deflection of the femur on the tibia
  - may be normal in early years, but later may indicate gastrocnemious equinus

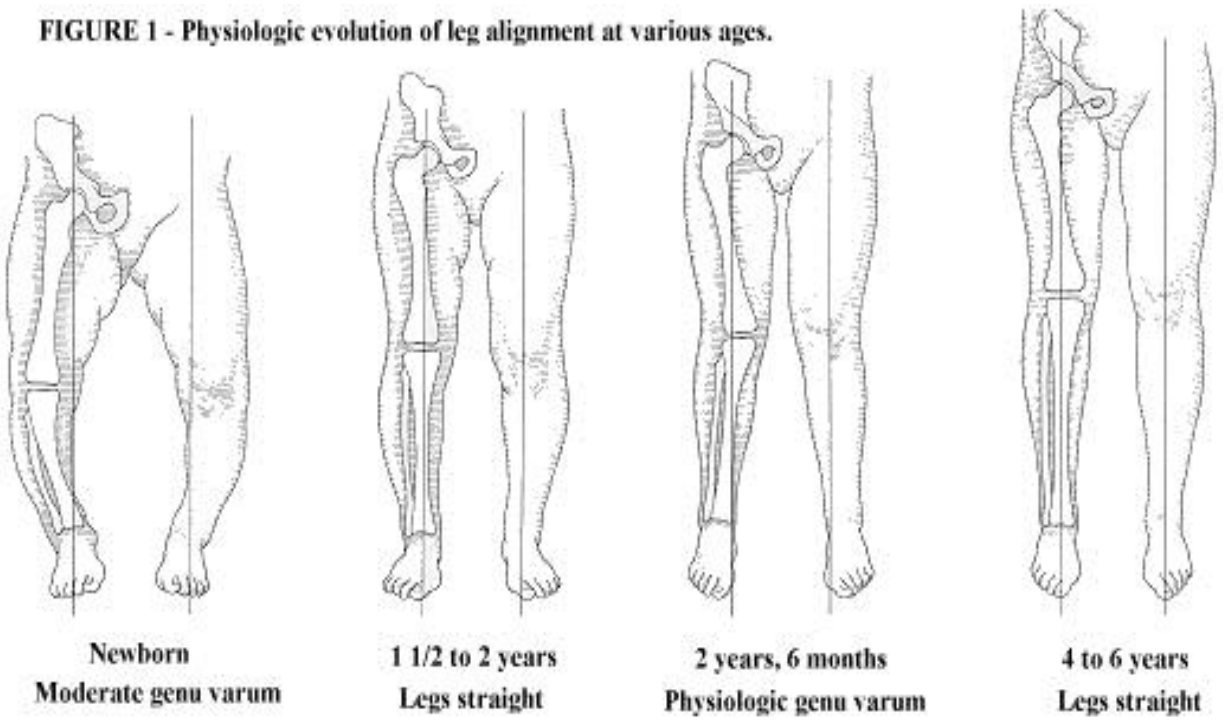
Normal Development of the Tibia

Physiologic bowing of leg is normal from birth to 2-4 years with as much as 5-10 normal bowing at birth

Reduces to nearly straight by age 2-4 years

Overcorrects to Valgus 2-4 years

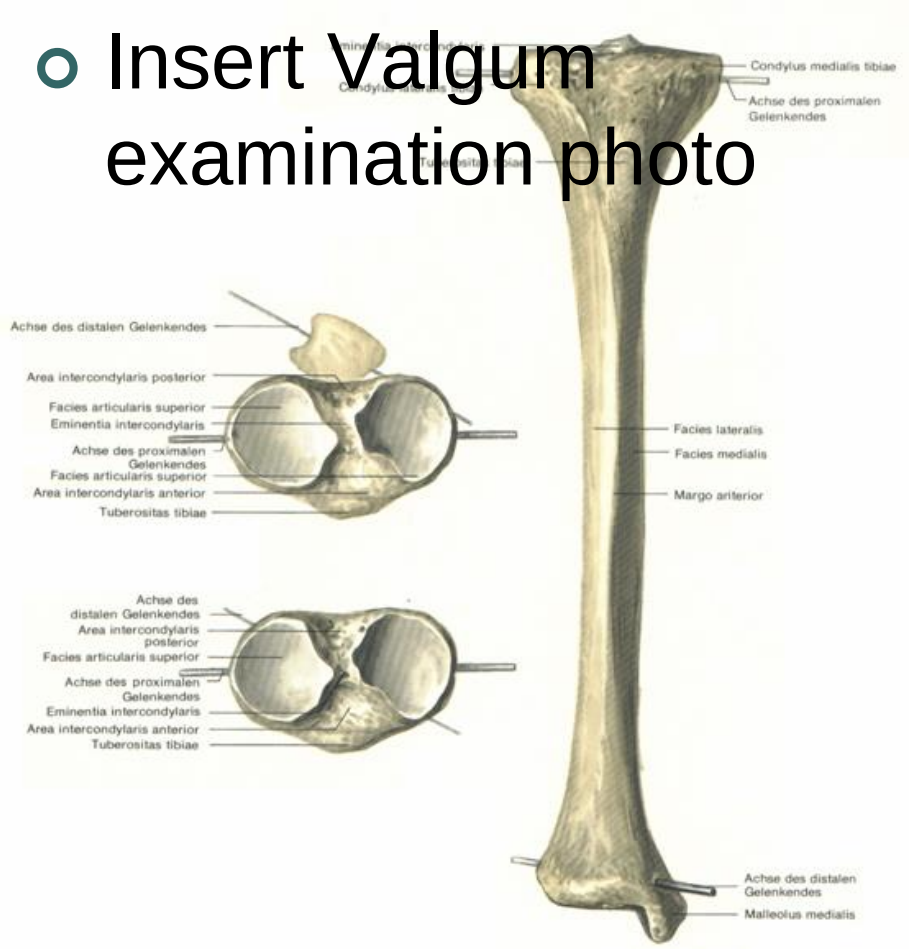
Straightens between 4-6 years



Normal Development Tibial Torsion

- Amount of true tibial torsion which occurs during development is between 18 & 23 degrees
- measured with malleolar position
- 13 to 18 degrees external tibial torsion noted by age 7 to 8 years
- TMA (*transmalleolar axis*) = 0-5° at birth
  - Increases at rate of 1.5° per year
  - Until gets to 13-18° at 6-7 years of age
    - NOTE: MEASURED as 18°- 23°

- Insert Valgum examination photo



Epiphyseal Anomolies
Formational Osteochondroses

- Navicular: *Köhler's disease*
- 2nd metatarsal head: *Freiberg's disease*
- Talus:
  - *Mouchet's- Primary*
  - *Diaz- Secondary*
- Medial Cuneiform: *Buschke's disease*
- 5th metatarsal base: *Iselin's disease*
- Sesamoids:
  - *Ilfeld's or Renandier's* - Tibial
  - *Treve's - Fibular*
- Accessory tarsal navicular: *Haglund's disease*
- Calcaneal apophysis: *Sever's disease*
- Phalanges: *Thiemann's syndrome*

http://emedicine.medscape.com/article/1254668-overview#aw2aab6b3

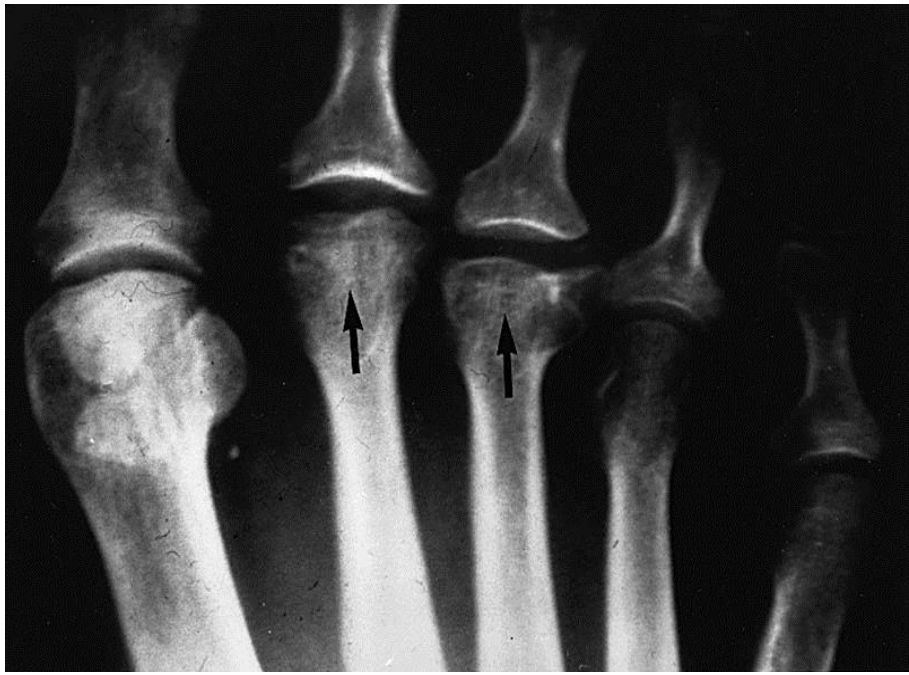
Osteochondrosis

Talus	Diaz
Cuneiforms	Bushke's Disease
Fifth Metatarsal Base	Iselin's Disease
Sesamoids	Treve's
Accessory Tarsal Navicular	Haglund's Disease
Navicular	Kohler's Disease
Second Met Head	Frieberg's Disease
Calcaneal Apophysis	Sever's Disease

- Radiographic Findings i.e. Kohler's

Freiberg's Infraction

- True AVN at secondary center of ossification (metatarsal Head)
- Also referred to as "Kohler's disease of the 2nd metatarsal"
- Usually greater than 13 years old
- Females >>> males (3:1)
- 2nd metatarsal head is the most common location
  - However, can affect <u>any</u> metatarsal head
  - May affect more than one metatarsal head
- Etiology unknown
  - Believed to be related to a single traumatic event or chronic microtrauma

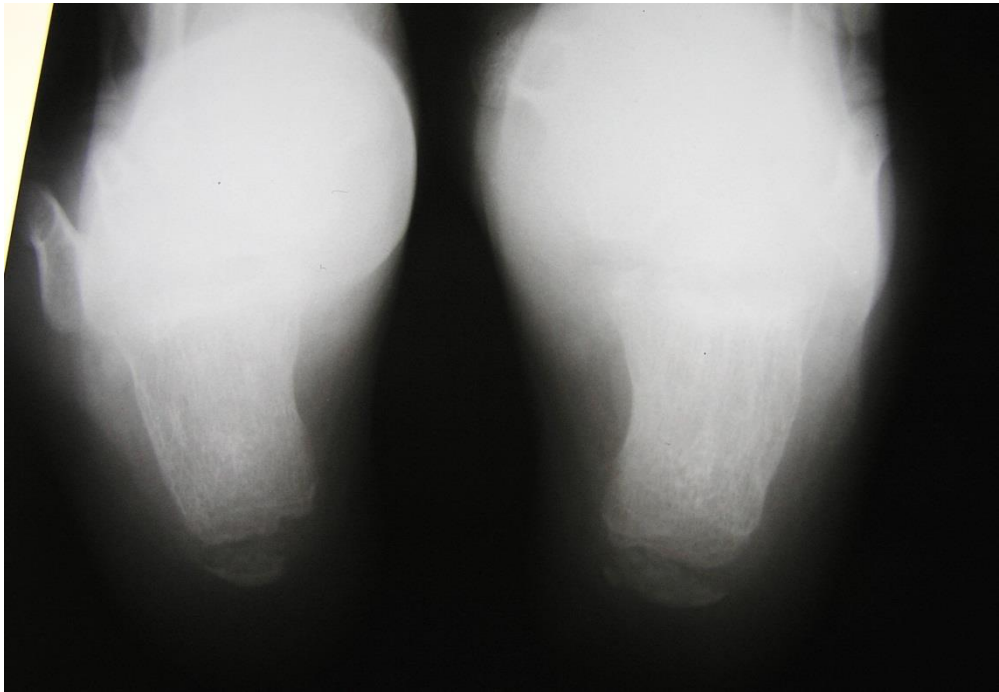


Freiberg's Treatment

- Cheilectomy
- Decompression osteotomy
- Gauthier and Elbaz (1979): Dorsiflectory Capital Osteotomy
- Osteochondral transplant (OATS)
- Interpositional soft tissue arthroplasty
- Metatarsal head excision
- Joint implant

Treatment of Osteochondroses

- Avoid Surgery
- Wait for Skeletal Maturity
  - Most will outgrow deformity
- Palliate Symptoms
  - i.e. Heel Lift and NSAIDS for Sever's disease



Developmental Anomolies Brachymetatarsia

- Aberrant condition in which a metatarsal is **short** and **hypoplastic**
- Most commonly affects the **4th metatarsal**
- Abnormality usually results in a **contracted** and cosmetically unacceptable fourth digit

Incidence

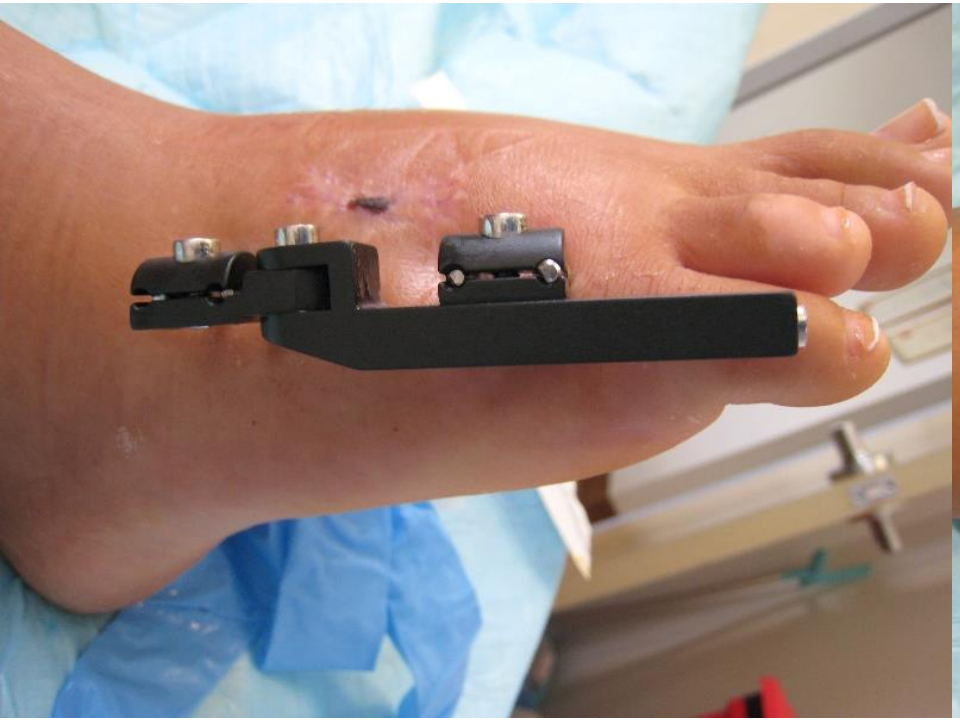
- Rare condition in general population (**2.2/1000**)
- Females to males in a ratio of **25:1**
- Commonly found **bilaterally** (> 70%)
- Often an inherited disorder

Surgical Management

- **7 surgical procedures have been proposed**:
  1. Callus distraction (Ilizarov technique)
  2. Syndactylization
  3. Bone graft
  4. Implants
  5. Auto-implants
  6. Step-up osteotomies
  7. Amputation

Callous Distraction

- Also known a "***Ilizarov Technique***"
- Developed by Wakisaki in 1988

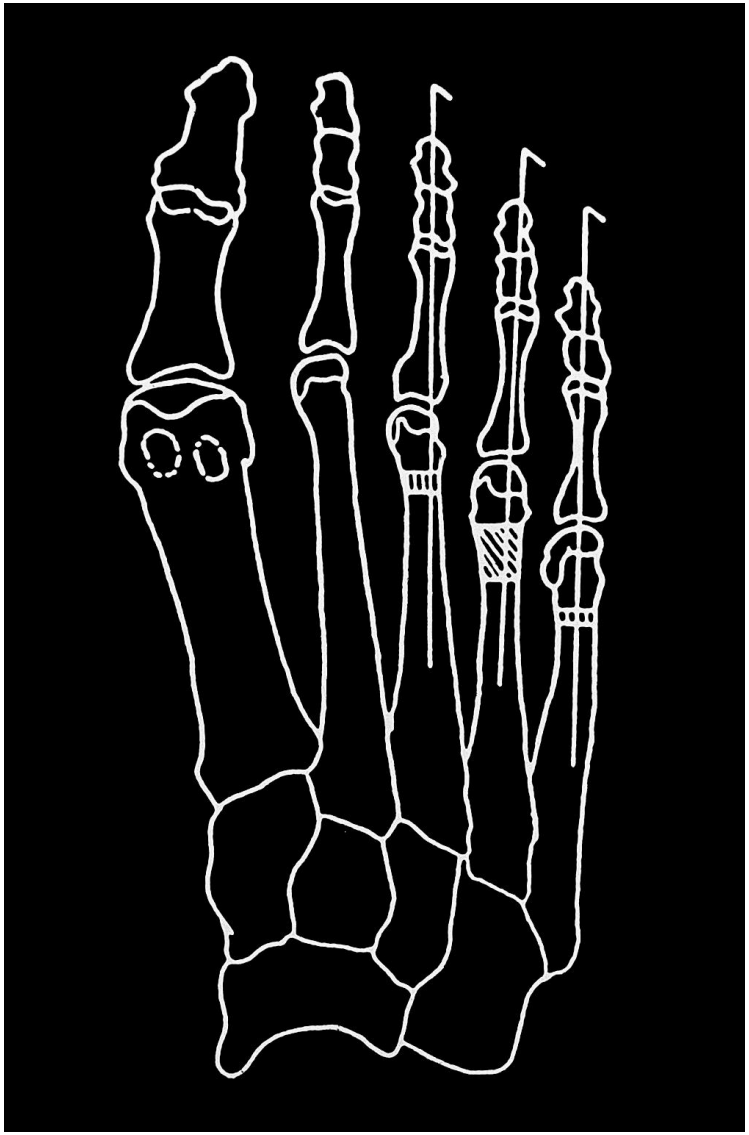


Callous Distraction

Syndactylization

Bone Graft Procedure

- ***Most common procedure for deformity***
- **McGlamry and Cooper (1969) took graft from plantar-lateral calcaneus**
- Kaplan and Kaplan (1978) took longest appearing metatarsal
- **Jimenez (1979) harvest graft from tibial plateau**
- McGlamry and Fenton (1982) took graft from distal tibial metaphyseal area
- **Pasternack (1988) took graft from navicular**
- Mahan (1993) took bone graft from posterior-superior aspect of calcaneus



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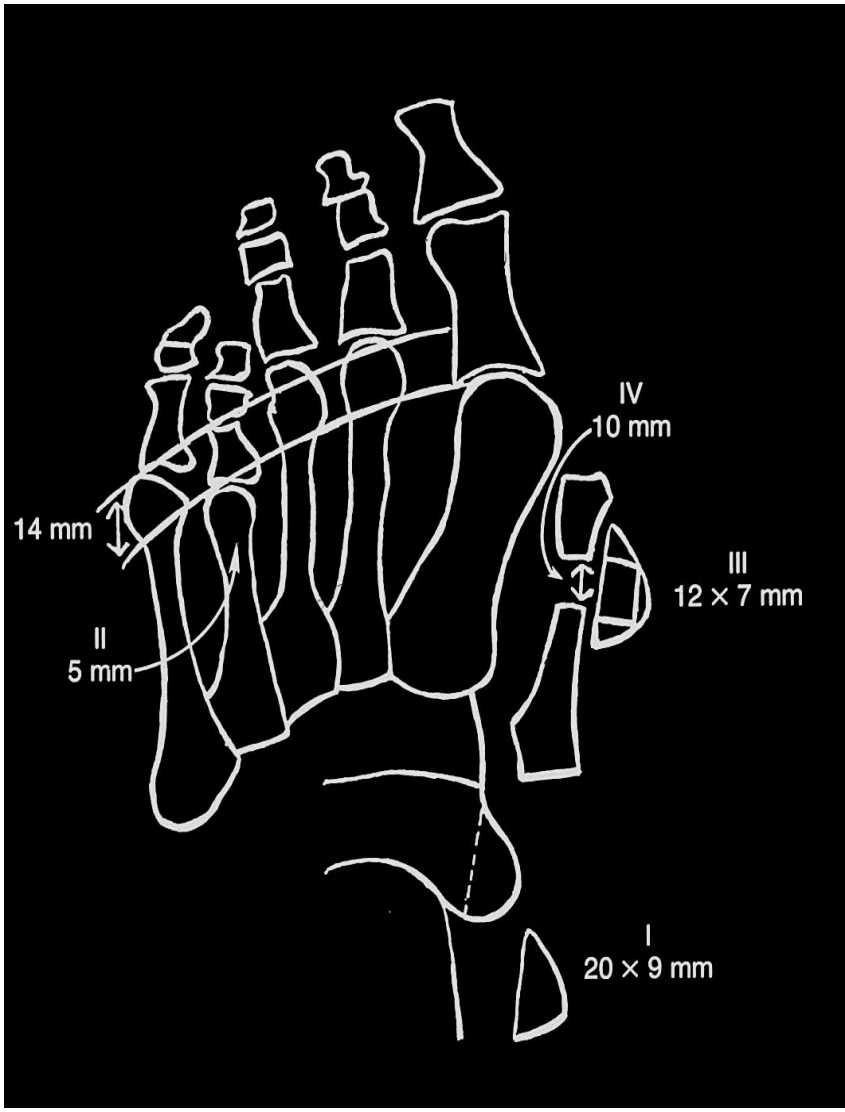

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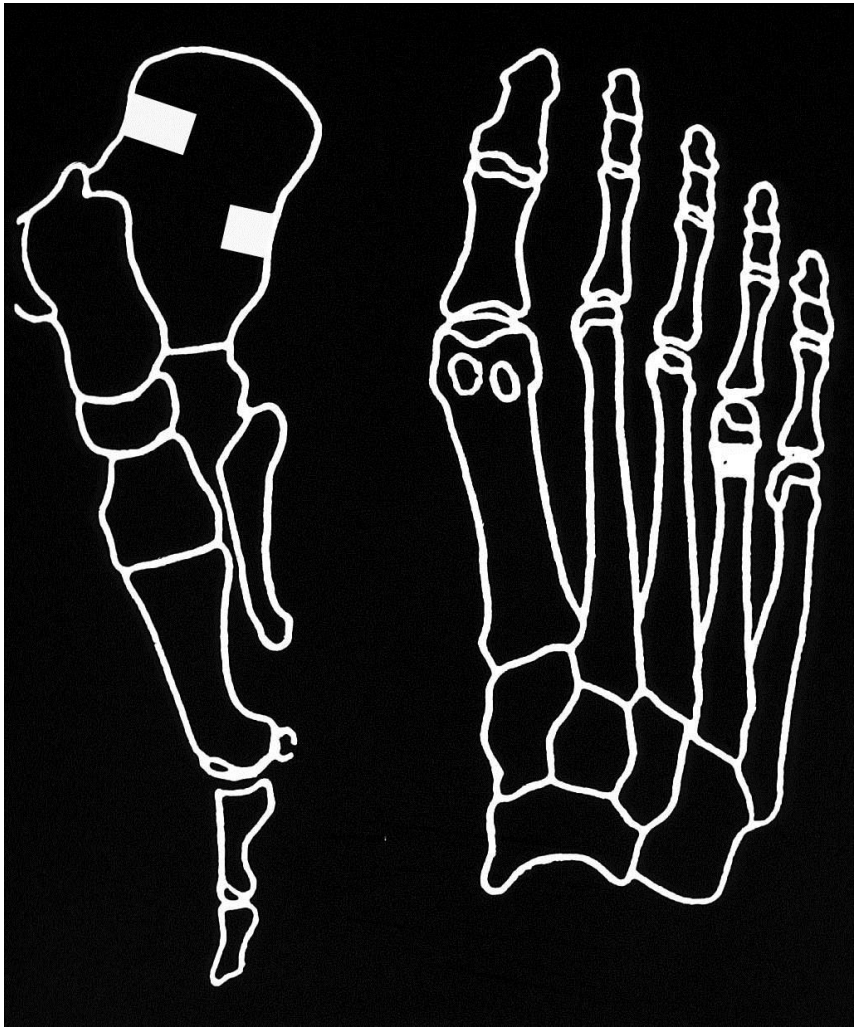

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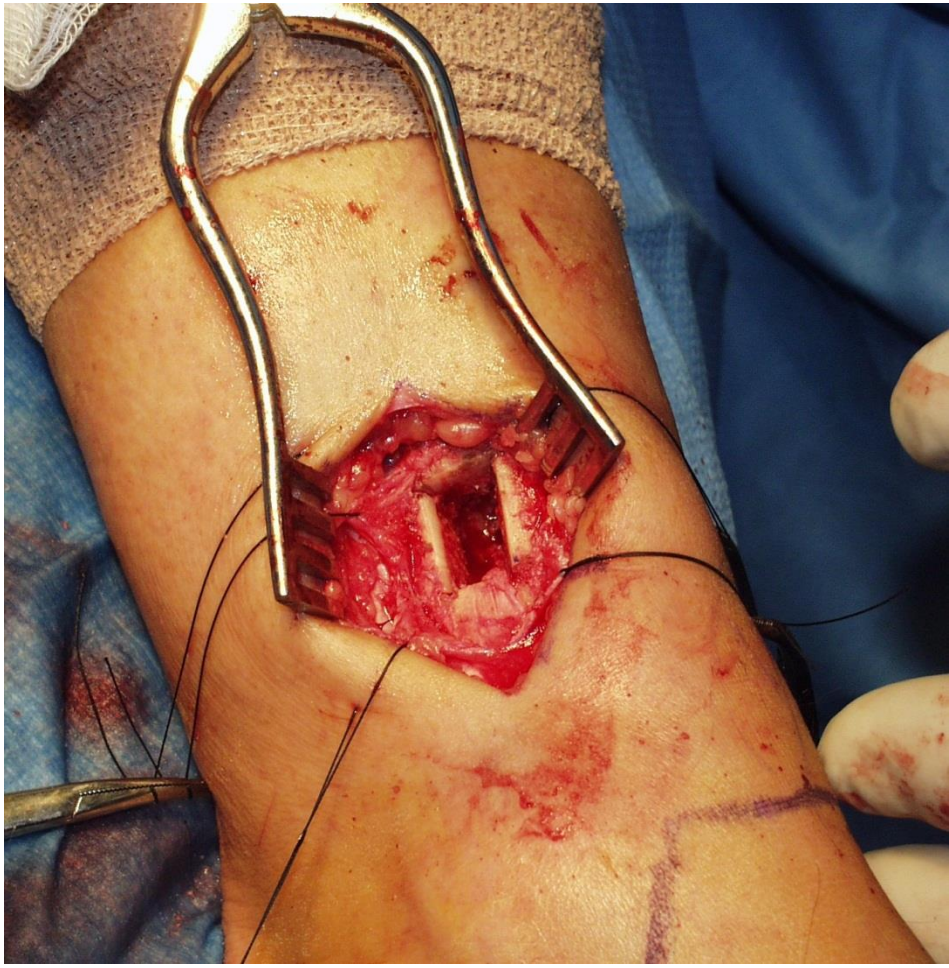


Implants

- Mah (1983) used a silcone ball implant
- Yonenobu (1986) used a ceramic implant
- Should use implants with caution because of the longevity associated with implants, especially in younger patients

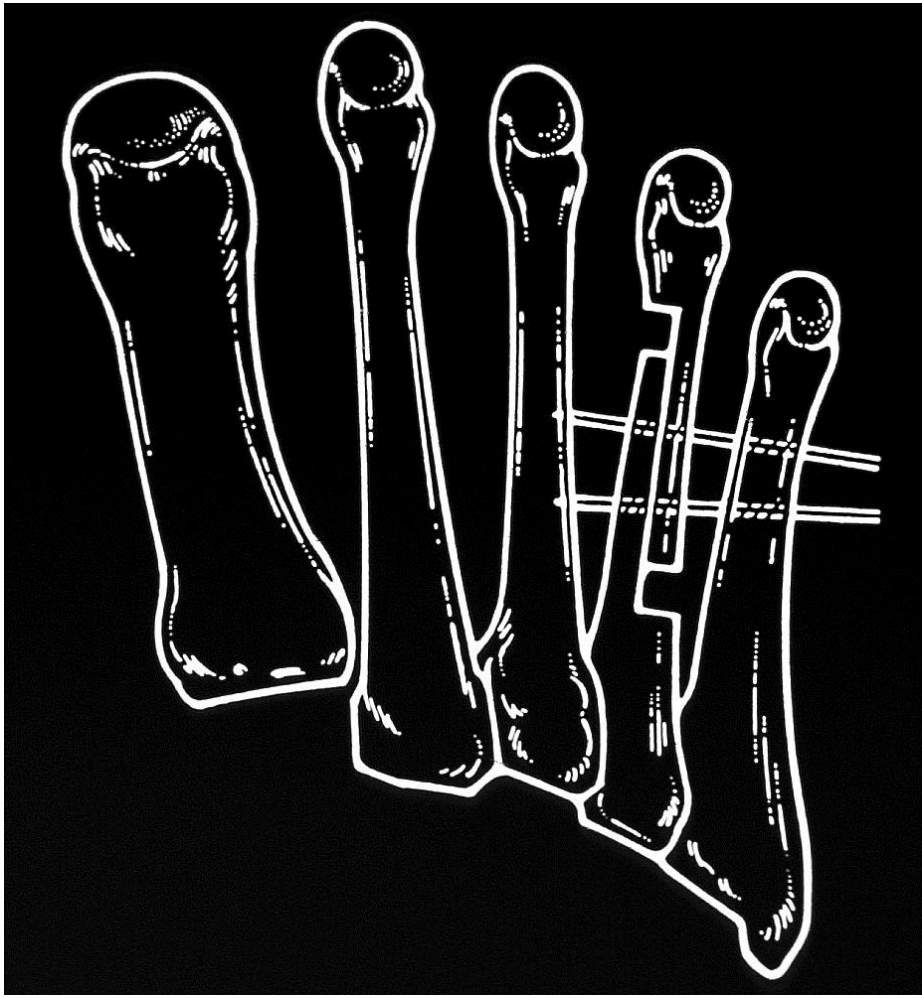
Auto-Implant

- Mercado (1974) switched short 4th metatarsal head and normal 5th metatarsal heads
- Urano and Kobayaski (1978) used a dreidel of bone to create a type of synarthrosis
- Chairman (1983) took 5th metatarsal head and placed it distal to the short 4th metatarsal head

Step-Up Osteotomies

- Marcinko (1984) performed a Z-plasty of bone to length short metatarsal

- Martin and Kalish (1991) performed a two-staged procedure with a Z-plasty
  - Used external fixator to stretch tissues for 4 weeks, then Z-plasty

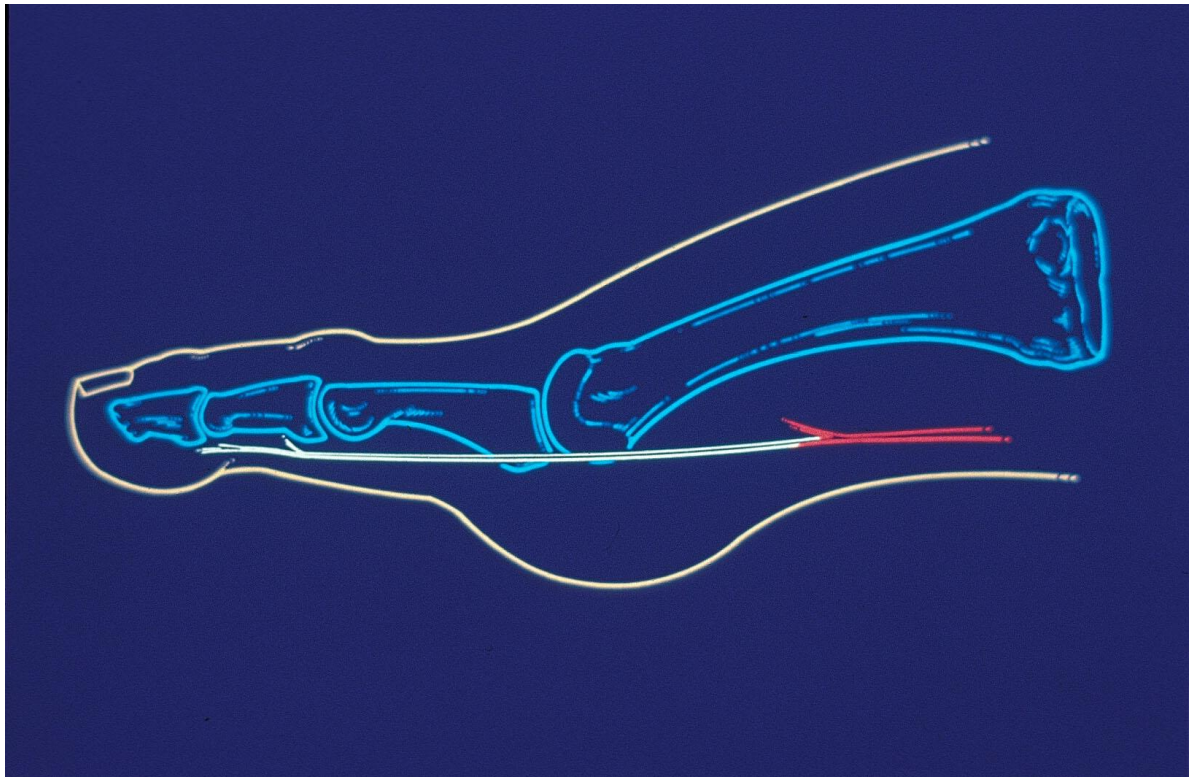


Metatarsal Osteotomy

Amputation

Complications

- Neurovascular compromise
- Overlengthening
- Under correction
- Malunion
- Non-union
- Transfer lesions
- Recurrence



Macrodactyly

- An increase in the size of the digital elements or structures of the affected part including the bones, nerves, subcutaneous fat, nails, and skin
  - Tendons and blood vessels unaffected
  - Hypertrophy primarily involves plantar and distal tissues

Macrodactyly

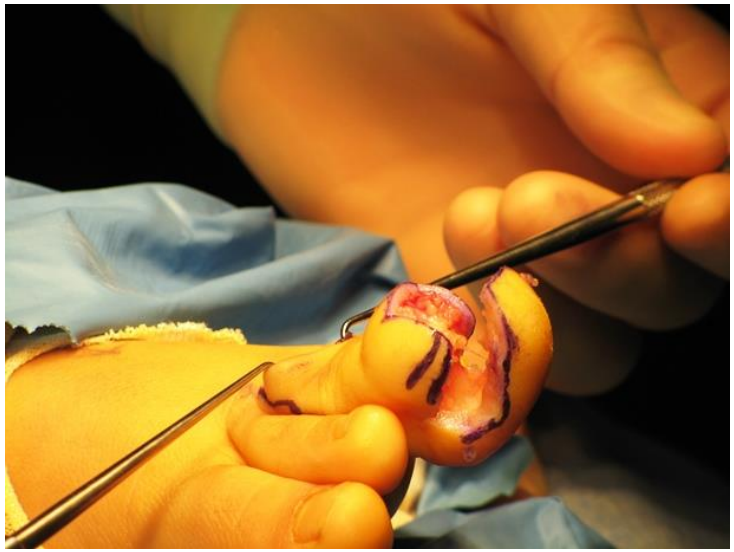
- 1st, 2nd, and 3rd digits most commonly involved
  - Highest incidence: 2nd
- Digit may deviate or hyperextend
- Sex predilection?
  - DeValentine et al.
    - Male = Female; Right = Left
  - Kalen et al.
    - Slight male predominance
    - 1.7:1 hands, 1.2:1 feet

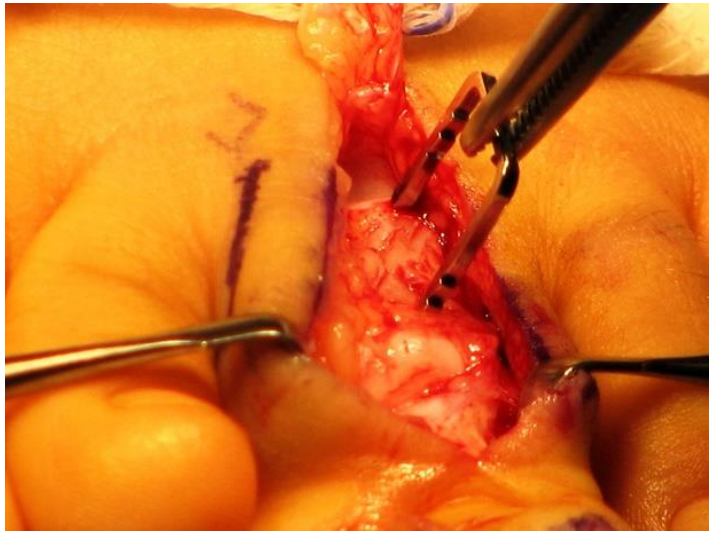
Treatment

- Varies based on type/extent of deformity and age of patient
- Shoe fitting is problematic in some patients
- Primary treatment is **SURGERY**

Surgical Technique

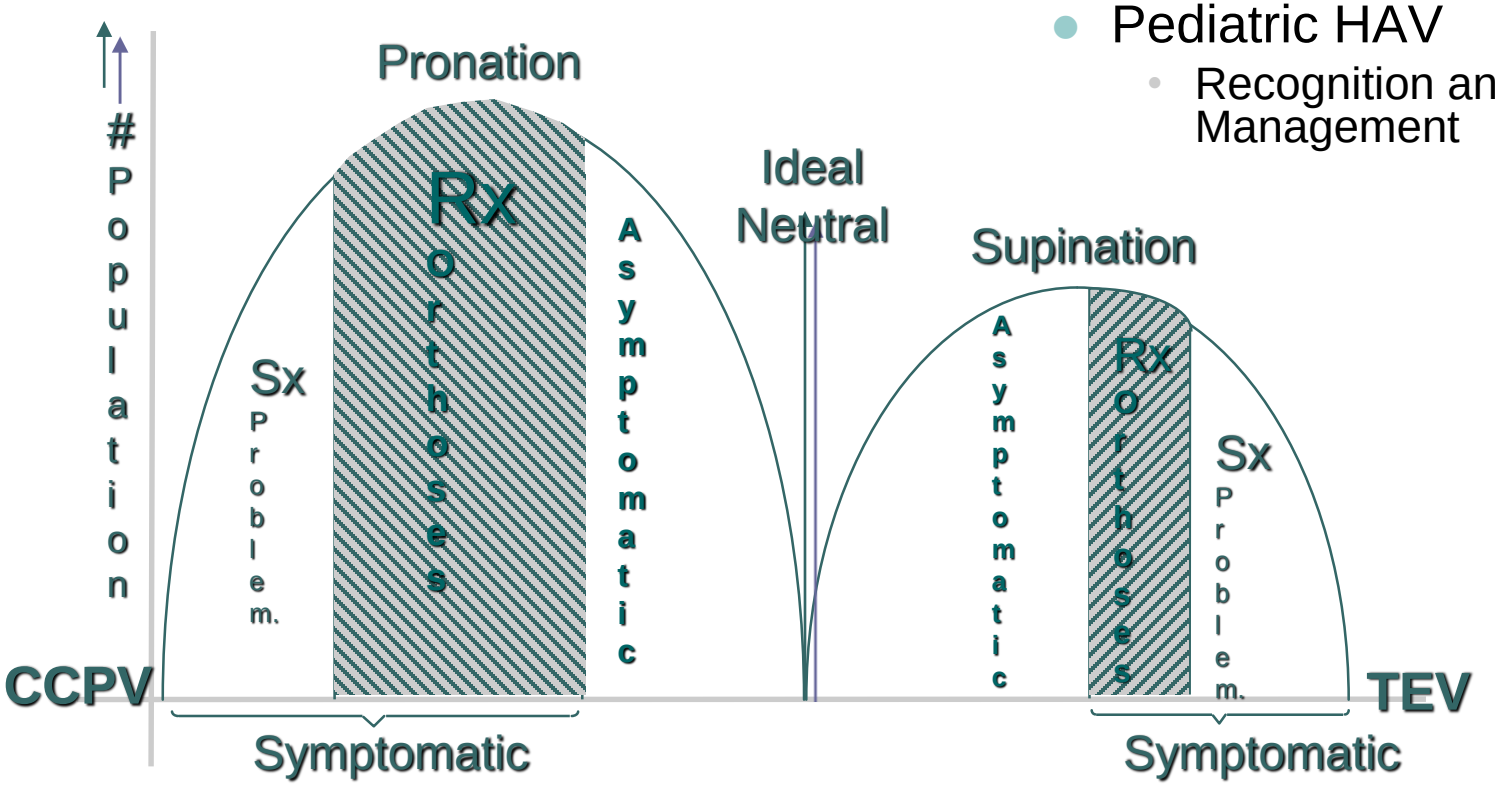
- Digital amputation (partial versus total)
- Ray resection
  - May be preferred to digital amputation with metatarsal involvement
- Digital salvage
  - Soft tissue procedures to reduce digital bulk
    - Excision of soft tissue is the mainstay of treatment in the static milder deformity
  - Osseous procedures (e.g., epiphysiodesis)





Podopediatrics

- Supination Deformities
  - TEV-Clubfoot
  - Cavus Foot
  - Metatarsus Adductus
- Pronation Deformities
  - CCPV: Vertical (or Oblique) Talus
  - Tarsal Coalition
  - Calcaneal Valgus
  - Pediatric Flat Foot
  - Pediatric HAV
    - Recognition and non-surgical Management



Pediatric Radiology: DP Angles

Angles	Birth	6-9 years	Adult
IMA	12°	10°	8-10°
Engel	30°	25°	Less than 21°
MA	25-30°	15-25°	Less than 15°
Talocalcaneal (Kite's Angle)	40-50°	20-40°	20-25°
Talar-First Metatarsal	Slightly medial	Parallel	Parallel

Pediatric Radiology: Lateral Angles

Angles	Birth	6-9 years	Adult
Tibiocalcaneal	70-75°	65°	55°
Talar Declination	Slightly above 1st metatarsal	Parallel	21°
Calcaneal Inclination	10-15°	15-20°	Less than 21°
Talocalcaneal	35-50°	30-40°	25-30°

Supination type Podopediatric Deformities

- TEV – Clubfoot
- Cavus Foot
- Metatarsus Adductus

Demographics

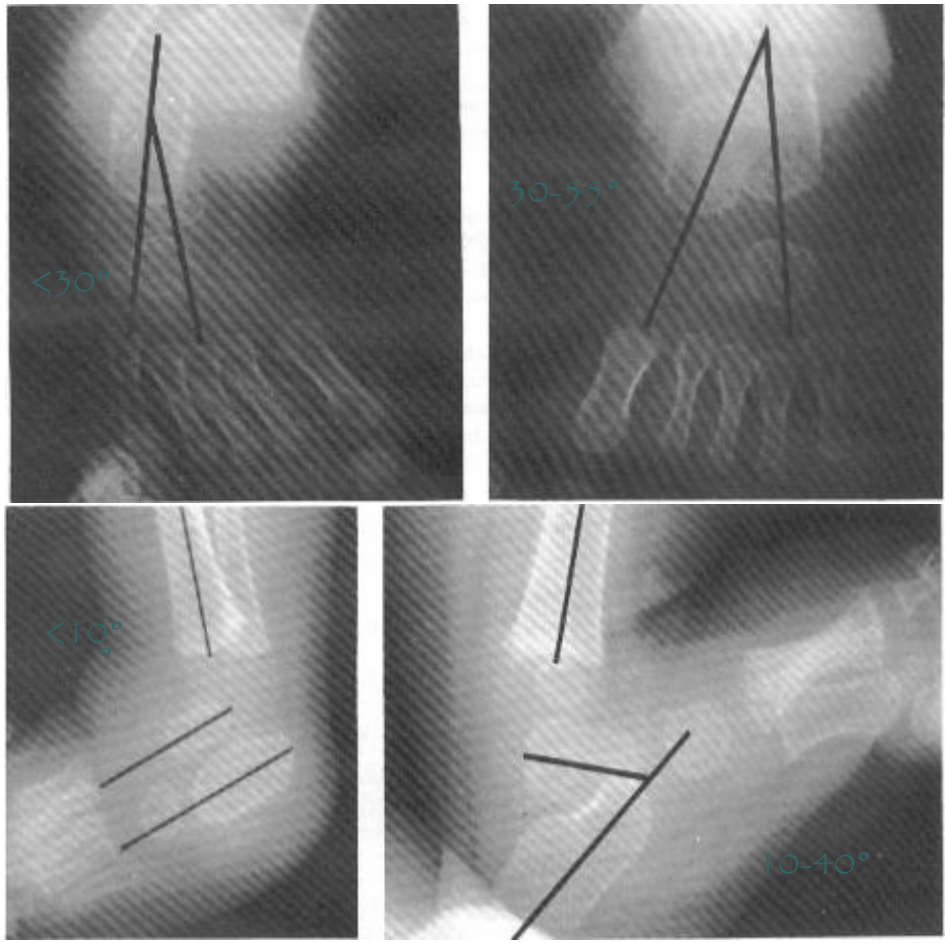
- **Incidence 1:1000 live births**
  - **1:500 among Japanese**
  - **1:250 among Hawaiian**
- **Bilateral in 50%**
- **Etiology (Various Theories)**
  - **(Shapiro)Germ plasm defect in talar development leads to soft tissue constraints**
  - **(Irani and Sherman) Primarily Soft Tissue abnormalities with neuromuscular units causing secondary bone changes**
  - **(Turco) medial displacement of Navicular and Calcaneus around talus**

Development (Rotation)

- Appendageal Long Axis Changes from embryonic inception to adult form
  - ~180° (Arm to Leg)
- Lower Extremity Foot goes through
  - ADduction
  - Extension (Dorsiflexion)
  - Medial Rotation Embryology of Bone

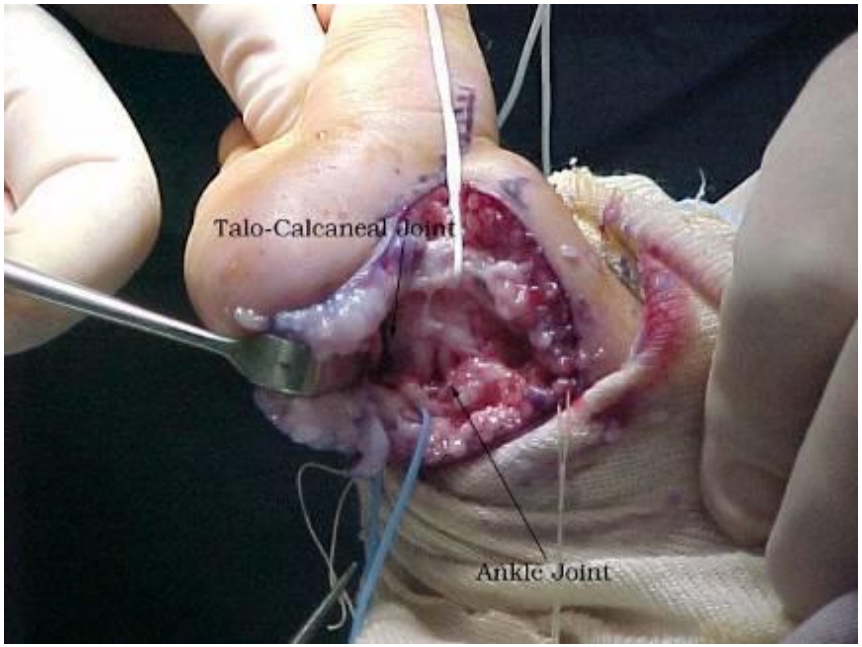
TEV – Radiographic Diagnosis

- Talocalcaneal Angle on Antero-Posterior Films
  - **Normally 30-55º, Decreased in TEV**
- **Talocalcaneal Angle on Lateral Films**
  - **Normally 25 - 50º**
  - **In TEV – decreases toward an angle of 0º**
- **Tibiocalcaneal Angle on Lateral Films**
  - **10 - 40º**
  - **In TEV – Angle is negative**
- **Talo-First metatarsal Angle (AP view)**
  - **Normally 15-20º**
  - **In TEV – Angle is negative (Adduction of forefoot)**



“Traditional” Thinking – J.H. Kite

- Kite’s method
  - Kite JH (1964) The clubfoot. Grune &Stratton; New York, London.
  - Did recommend casting first
  - Defined “irreducible” verses “reducible” clubfoot



Casting Success Rate with Kite's method

- **Reported between 1950's up into the 1990's**
  - **15% – 80% depending on researchers**
- **Emphasized the benefits of Casting (CORA @ CC Joint)**
  - **Manipulation Sequence**
    - **1st Correction of Forefoot Adduction (Beware Subluxing!)**
    - **2nd Correction of Heel Varus**
    - **3rd Correction of Hindfoot Equinus**
  - **Subluxations common**

"Traditional" Surgical Logic

- **"Resort to Surgery if casting fails…"**
  - **Casting failed > 50% of the time with the Kite Method**
  - **Led to the felonious idea of "Reducible vs. Irreducible" Clubfoot.**
    - **With early intervention virtually ALL true Clubfoot deformities are reducible <u>without major surgery</u>. The only exceptions to this are:**
      - **Arthrogryphosis Multiplex**
      - **Spina Bifida**
      - **Phaecomyelias**

Long Term Follow-up

- Ponseti Outcomes :
  - 50+ Year's worth of follow up
    - Ponseti, Smoley; *Congenital Clubfoot: The Results of Treatment*; JBJS-Am. Vol.45-A No.2 March,1963 pp 261-344
  - Well documented by several researchers
  - Consistent, Reliable Results, <u>when done properly</u>.

6 Weeks Old

31 Years Old

Core Literary References

- JE Herzenbert, C Radler, N Bor:*Ponseti Versus Traditional Methods of Casting for Idiopathic Clubfoot*; Journal of Pediatric Orthopedics, Vol. 22, No. 4, 2002 pp517-521
- M Colbern, M Williams: Evaluation fo the Treatment of Idiopathic Clubfoot by Using the Ponseti Method: Journal of Foot & Ankle Surgery; Volume 42, No.5 Sept/Oct.2003 pp 259-267
  - 57 Clubfeet w 54 resolved, 3 recurrences
- JA Morcuende, SL Weinstein, FR Dietz, IV Ponseti: Plaster Cast Treatment of Clubfoot: The Ponseti Method of Manipulation and Casting; Journal of Pediatric Orthopedics Part B; Vol 3 No 2, 1994 pp161-167

TEV Open Surgical Correction

Turco (1971)
- **Supine – Posteromedial and Lateral Incisions**

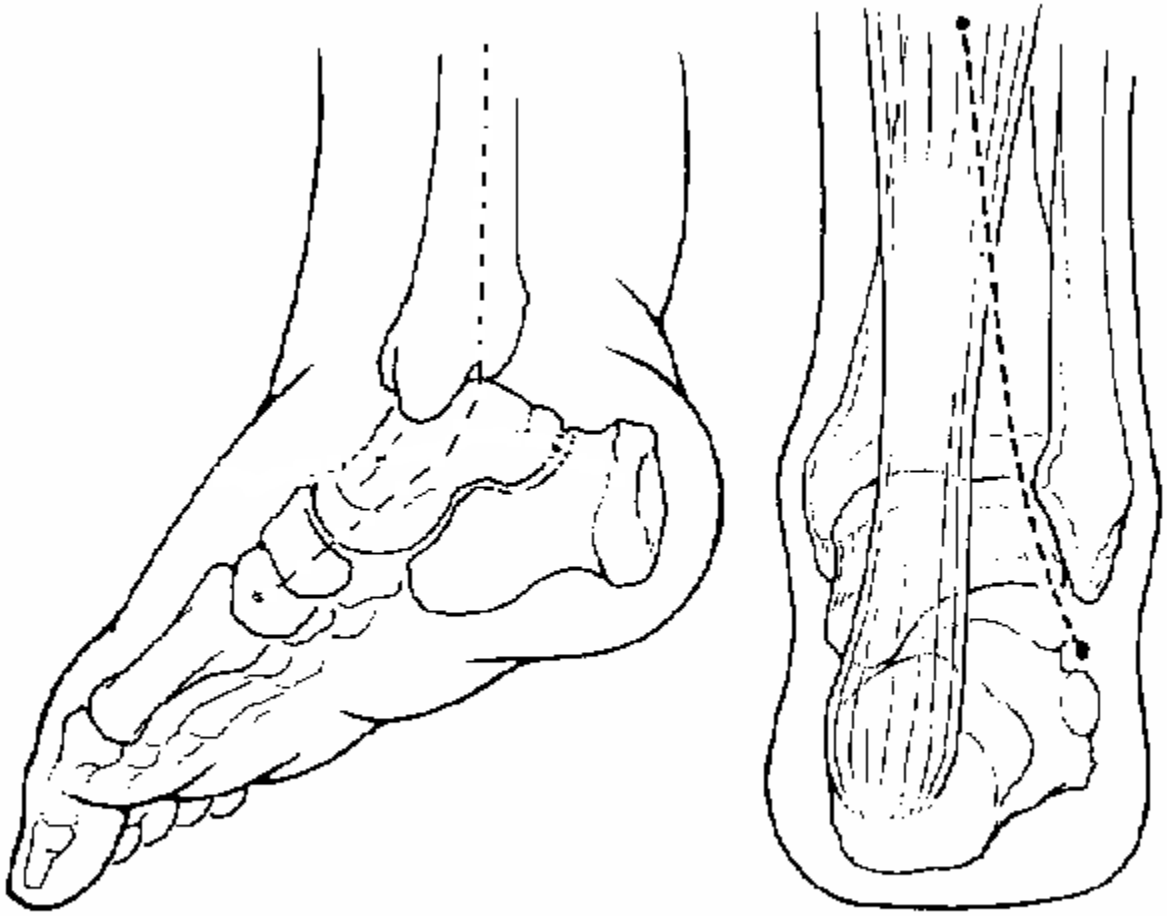
Cincinnati
- **Prone – Circumferential Incision**

McKay & Simons (1985)
- **Prone – Circumferential Incision**
- **Complete STJ release**

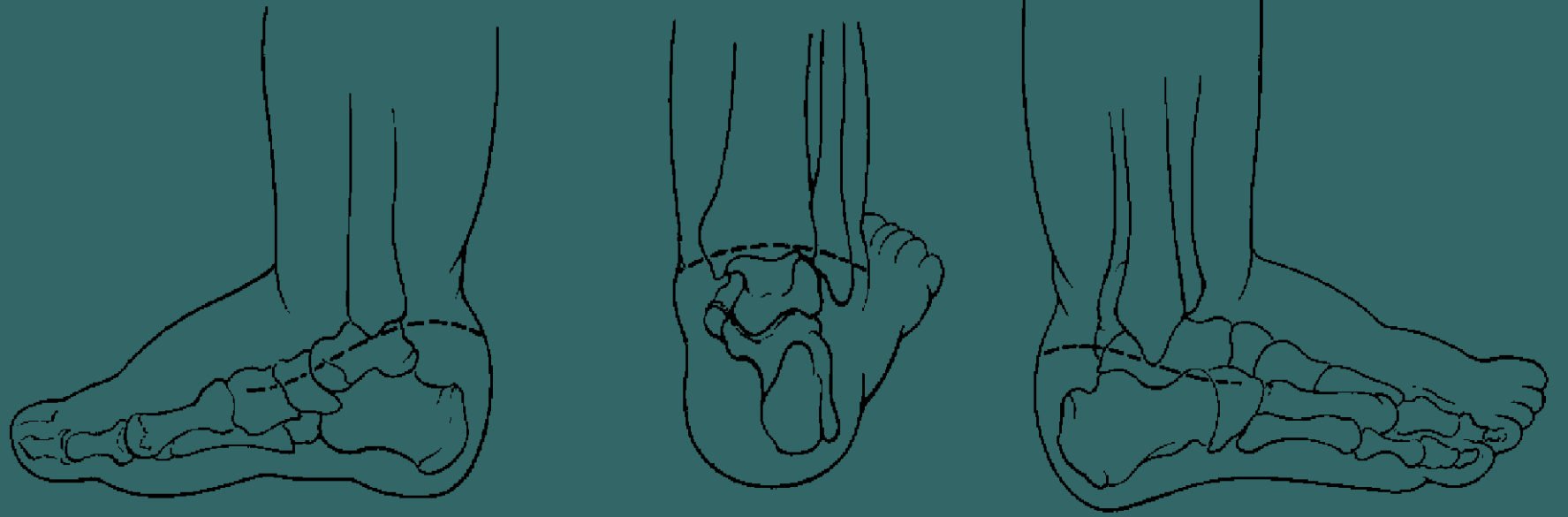
Carroll (1987)
- **Prone/Supine – Medial Longitudinal and Vertical Posterolateral Incision**
- **> 2 years of age**

Grant and Lehman (1991)
- Recommended Ilizarov technique

Turco Procedure

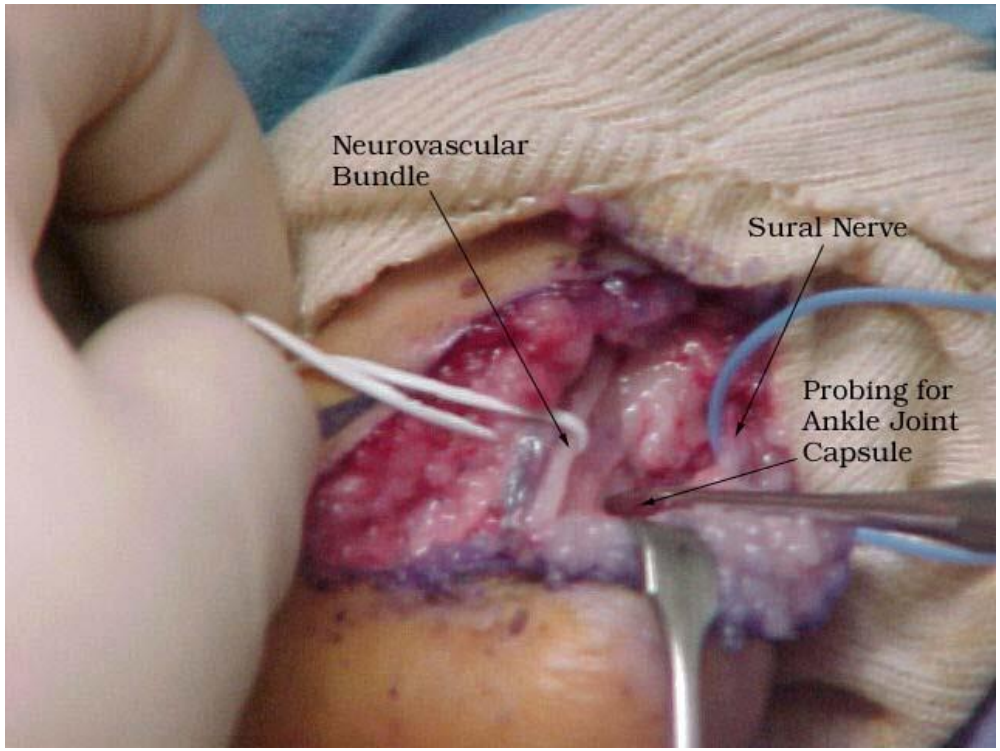


Cincinnati Procedure



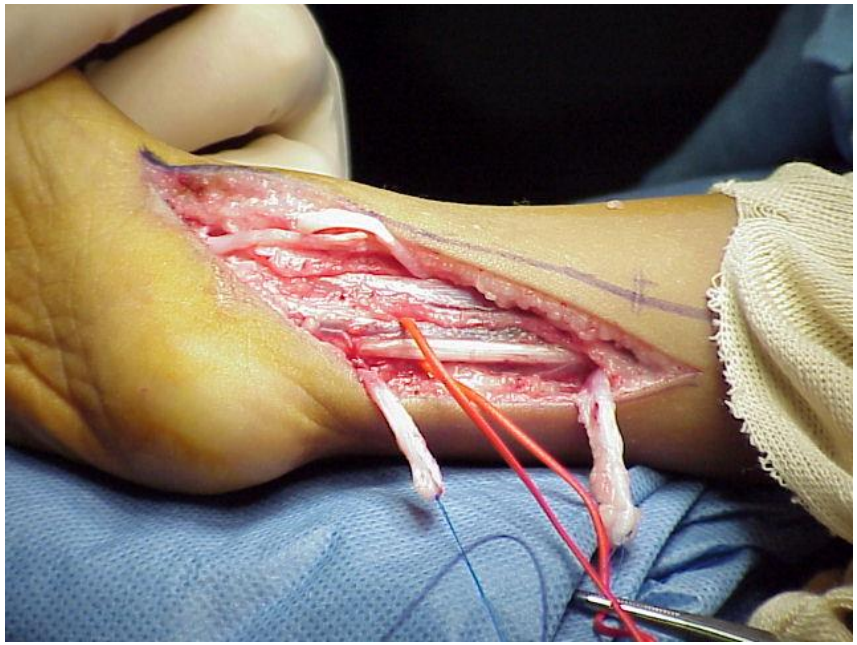
Posterior Release

- **Posterior Release (Beware Soft Tissue Structures)**
  - **Tendo Achilles**
  - **Posterior Capsule Syndesmotomy**



Common Surgical Goals

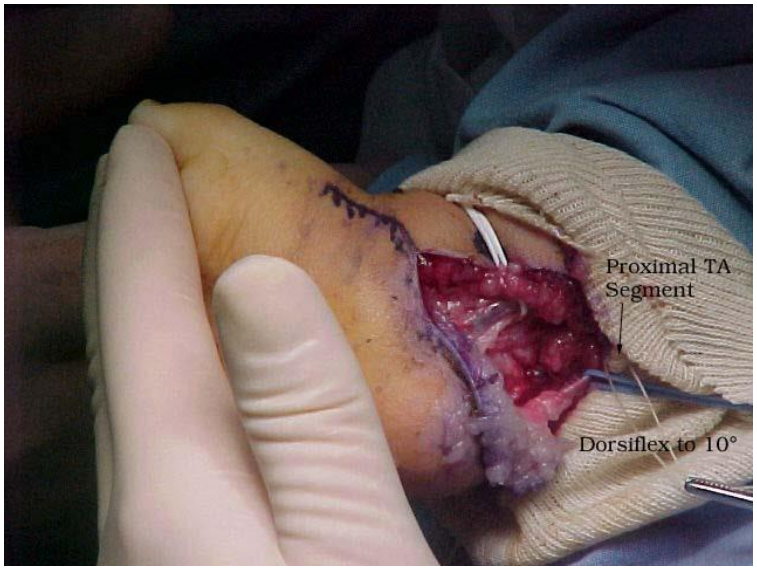
- Posterior Release
- Medial Release
  - Abductor Hallucis Reflection
  - Z Lengthening of Tibialis Posterior
  - Subtalar Release
  - Spring Ligament
  - Preserve Deep Deltoid ligament

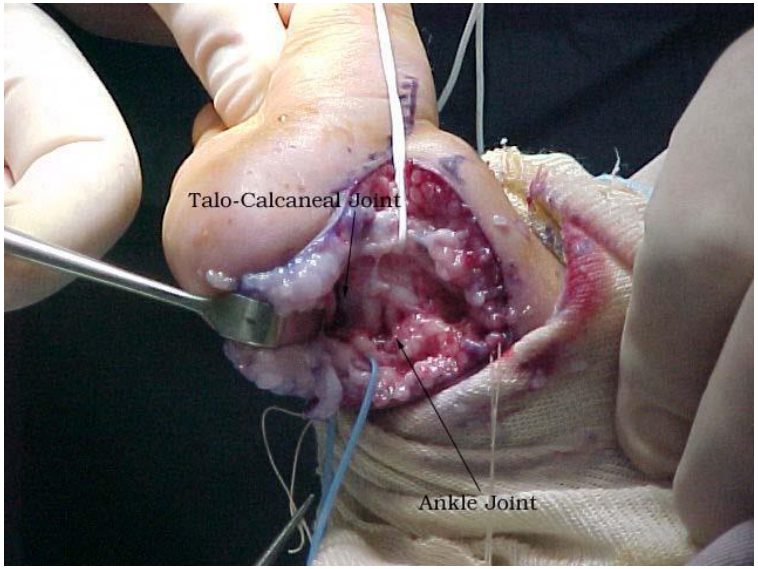


Medial Release

- **Posterior Release**
- **Medial Release**
- **Reduction of Sagittal, Frontal and Transverse planes**

Note: This is accomplished, essentially, by subluxation of the foot on the Tarsal joints



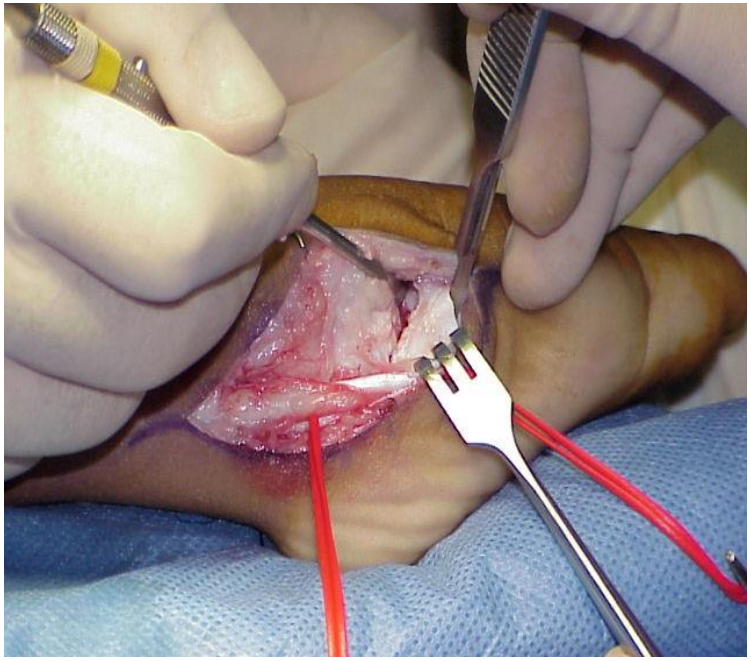


Common Surgical Goals

- Posterior Release
- Medial Release
- Plantar Release
  - Only in children > 3 years old

Common Surgical Goals

- Posterior Release
- Medial Release
- Plantar Release
- Lateral Release
  - Release of Lateral Talo-Fibular ligament**
  - Division of Posterior Calcaneo-fibular ligament
  - Division of STJ Capsule
  - Division of Interosseous Ligaments
  - Division of Bifurcate Ligament



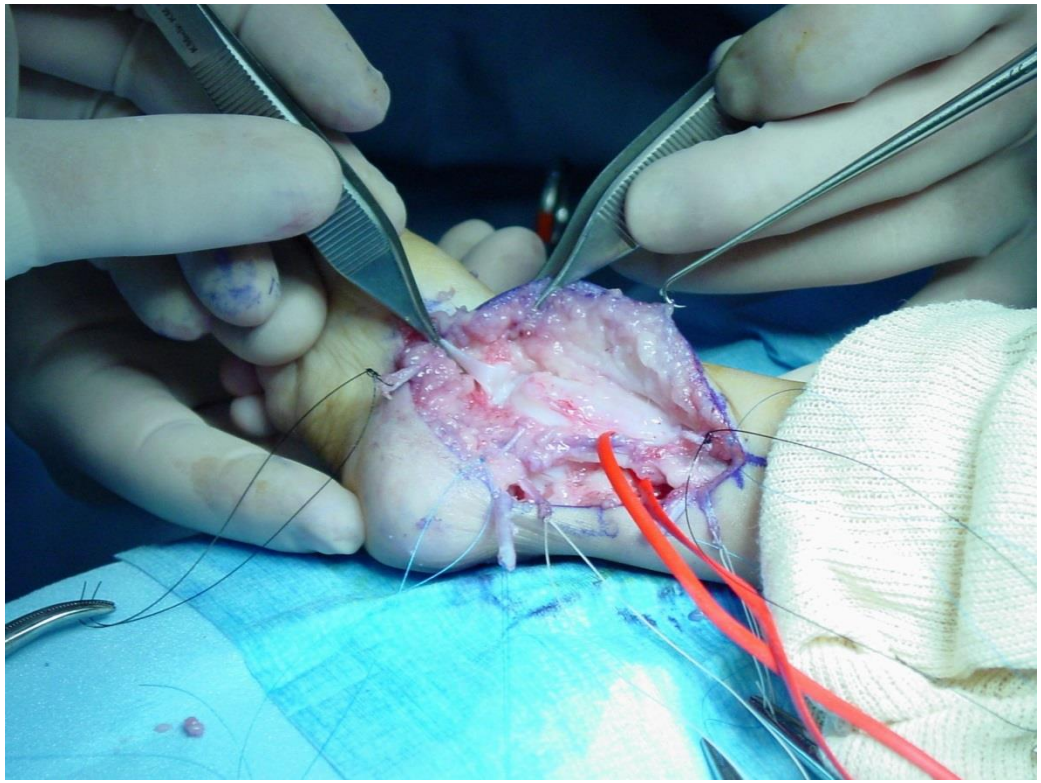
**Most often overlooked deforming force in open surgical interventions.

Common Surgical Goals

- Posterior Release
- Medial Release
- Plantar Release
- Lateral Release
- Fixation
  - Biaxial
    - Vertical – Up through Tibia
    - Horizonal – Through Head/Neck of Talus

Common Surgical Goals

- Posterior Release
- Medial Release
- Plantar Release
- Lateral Release
- Fixation
- Soft Tissue Repair
  - Tendon Lengthenings
  - +/- Tendon Transfers
    - FHL to Peroneus Longus
    - Peroneus Brevis to Dorsomedial Midfoot
    - STATT



Post Operative Care (Kite's Method)

- Cast for 6 weeks
- Therapy dependent on age
  - < 6 mos., manipulative
  - >2 years, Ambulatory assistance
- Night Splints until 4-7 years of age

Primum Non Nocere!!!

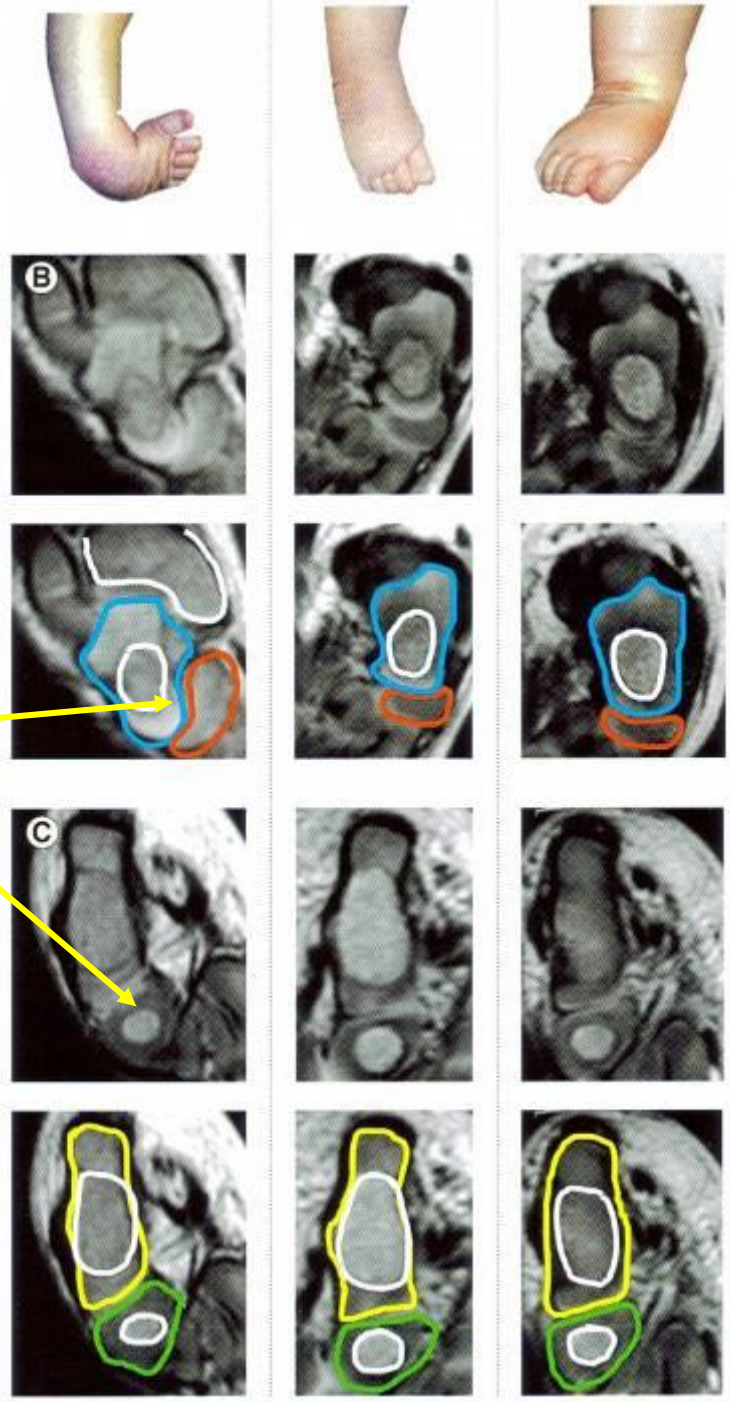
What the Literature Says

- Dobbs, Nunley, Schoenecker; *Long-term Follow-up of patients with clubfeet treated with extensive soft-tissue release*: JBJS Am. 2006 May; 88(5)986-996
  - Best study to date on Long-Term Surgical Outcomes of Clubfoot surgery.
    - 45 Patients (73 Feet)
    - Mean follow up - 30 years
  - Conclusions: “Many patients with clubfoot treated with extensive soft tissue release have poor long-term foot function”.
    - Less Surgery → Better Outcomes
    - More extensive surgery → Poorer Outcomes
    - Morbidity related to the amount of Surgery NOT severity of the initial deformity.
    - More aggressive surgical interventions resulted in consistently poorer quality of life outcomes.

Plastic Redirection (Ponsetti Theory)

- A Demonstrates three positions of correction in the same child.
- B Demonstrates MRI images of the same foot as “A” at the Talo-Navicular Joint
  - Ossification Center rotates within the reforming cartilaginous anlage.
- C Demonstrates Relationships at the Calcaneo-Cuboid Joint
  - Note: Abduction of Cuboid on Calcaneus

NOTE: The reason this correction is possible is because soft tissue tethering is preserved. This induces chondro-plastic changes within the Tarsus. If the capsular structures are cut (ie. Syndesmotimized), the tethering effect is lost and changes can only occur by subluxation.

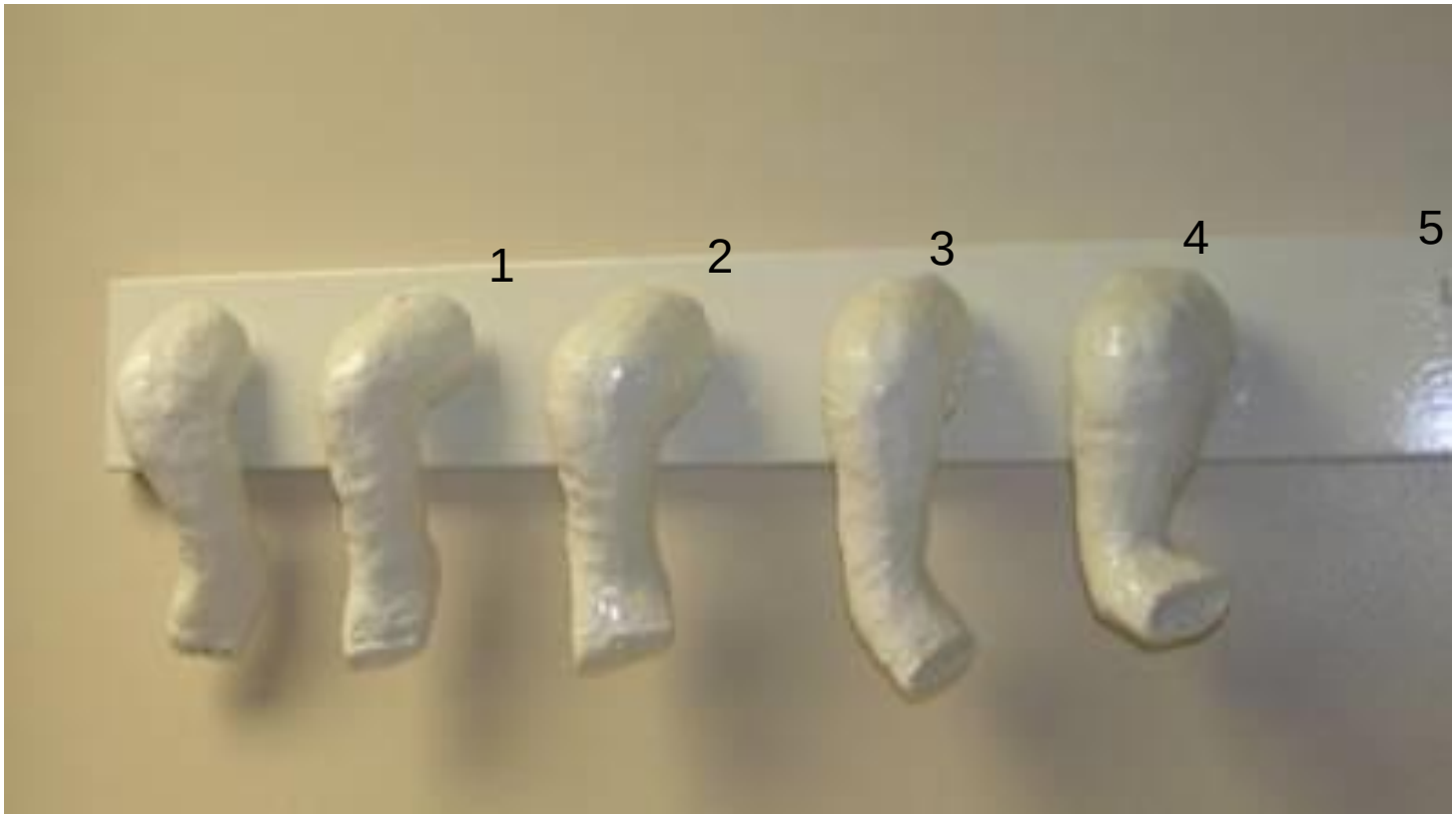


Conclusions

- NO MORE extensive Syndesmotomies for correction of Congential Clubfoot Deformities.
  - NO MORE Cincinnatti, Turco, etc… procedures
- Best consistent long-term outcomes result when the Ponseti method is administered by an experienced clinician, with appropriate follow-up.
- Minor Surgical Procedures DO aid in resolution:
  - Percutaneous TAL
  - PercutaneousTibialis Anterior Tendon Transfer for recalcitrant cases.

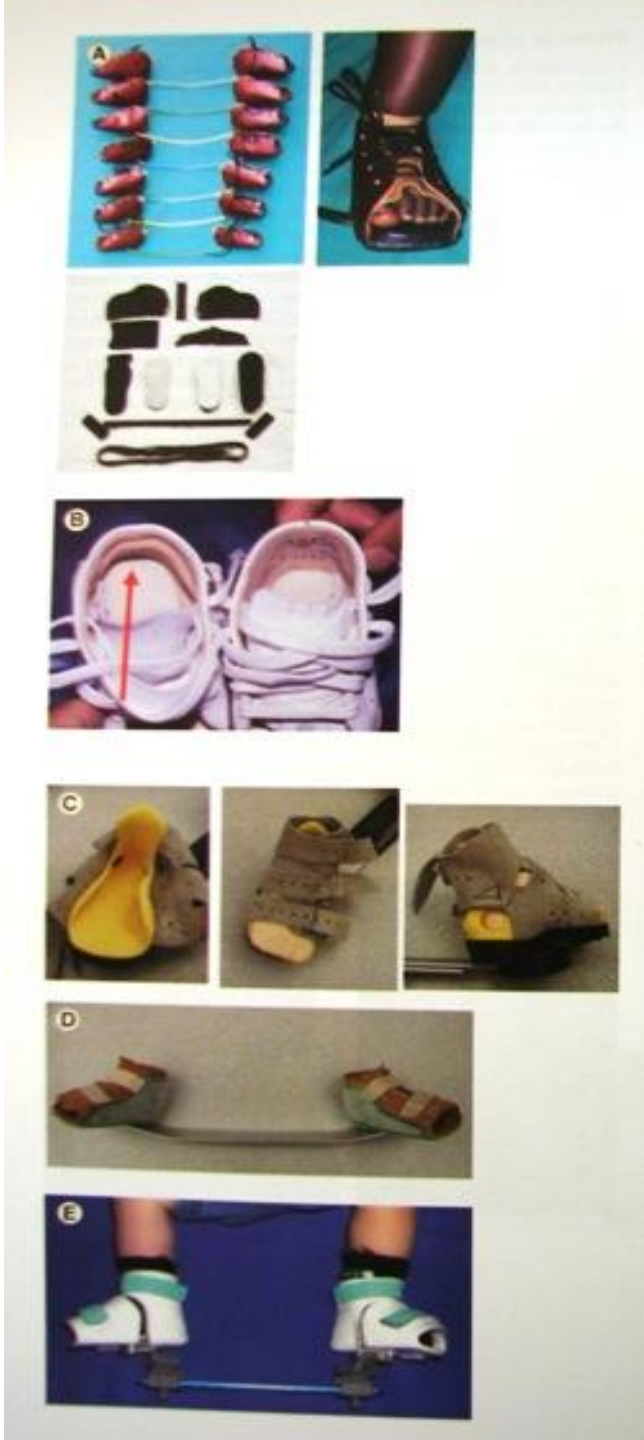
Casting Positions

- There are Five Reference Positions. Each of these must be achieved in sequence as the correction proceeds from deformity to reduction.



Abduction Bracing

- Steenbeek Foot Abduction Brace
- Markell Brace – United States
- John Mitchel Brace – United States
- Gottenburg Brace – Sweden
- Lyon Brace – France

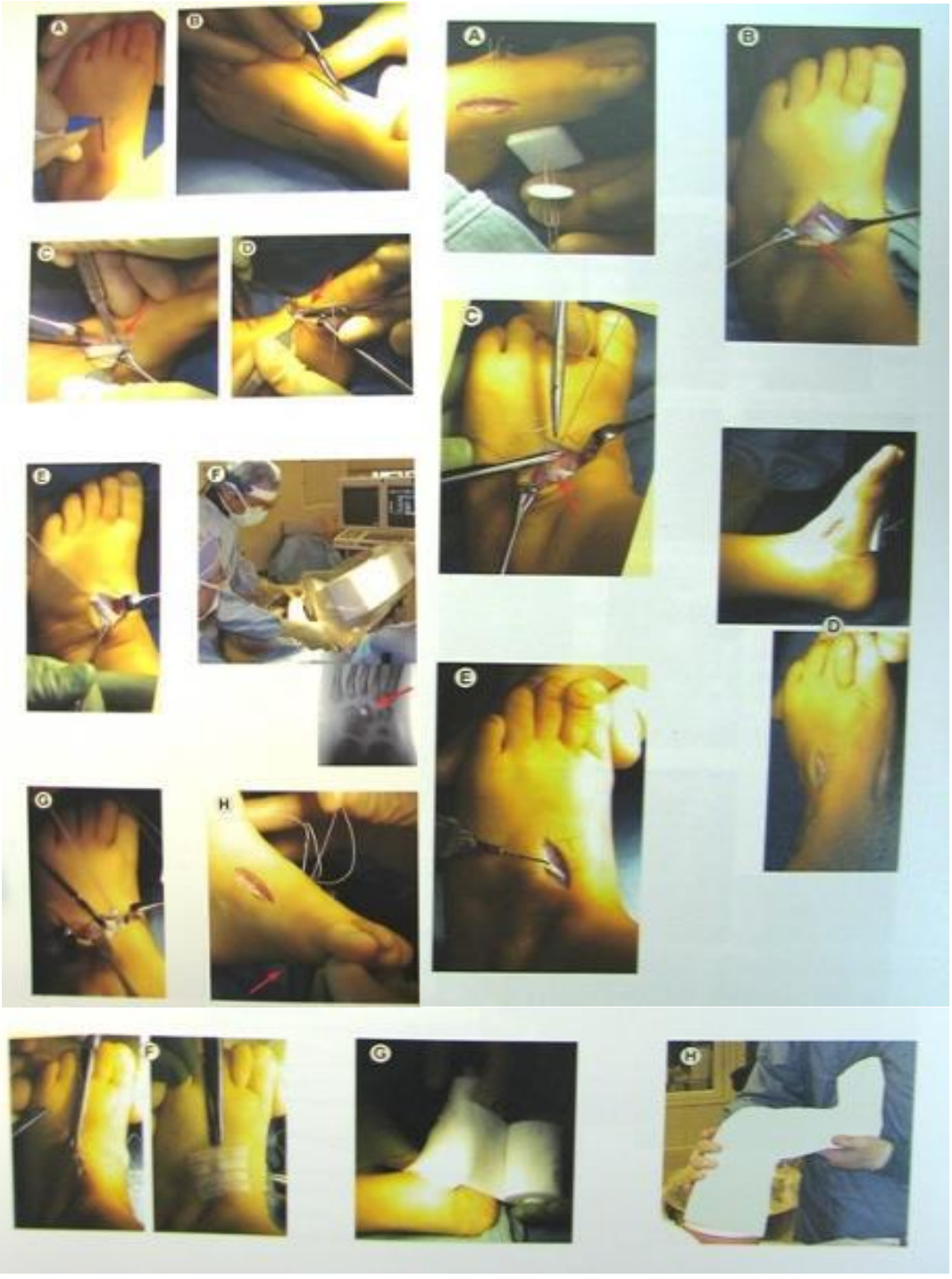


Percutaneous TA tenotomy

- After position 4 or 5
- Performed percutaneously
  - May be done under local anesthetic
- Releases final Equinus influence
- Place patient back in to position 5 after release.

Adjunctive Procedures

- Percutaneous Tendo-Achilles Tenotomy
- Tibialis Anterior Tendon Transfer
  - For reoccurrences or extreme deformities
  - Recast



Maintenance of Position

- Dispensing Abduction Brace
  - Correct Fit
  - Firmly in to place
  - Beware Construct!

Mature Clubfoot

- What to do about “Mature” Clubfoot
  - Start Ponseti Casting Therapy as soon as possible Post Partum
  - Ponseti reductions possible up to the age of 7 years (Morcuendi)
    - However, increasingly difficult beyond the age of 2 years.
  - What about > 7 years old?

Ilizarov Reduction of Mature Clubfoot

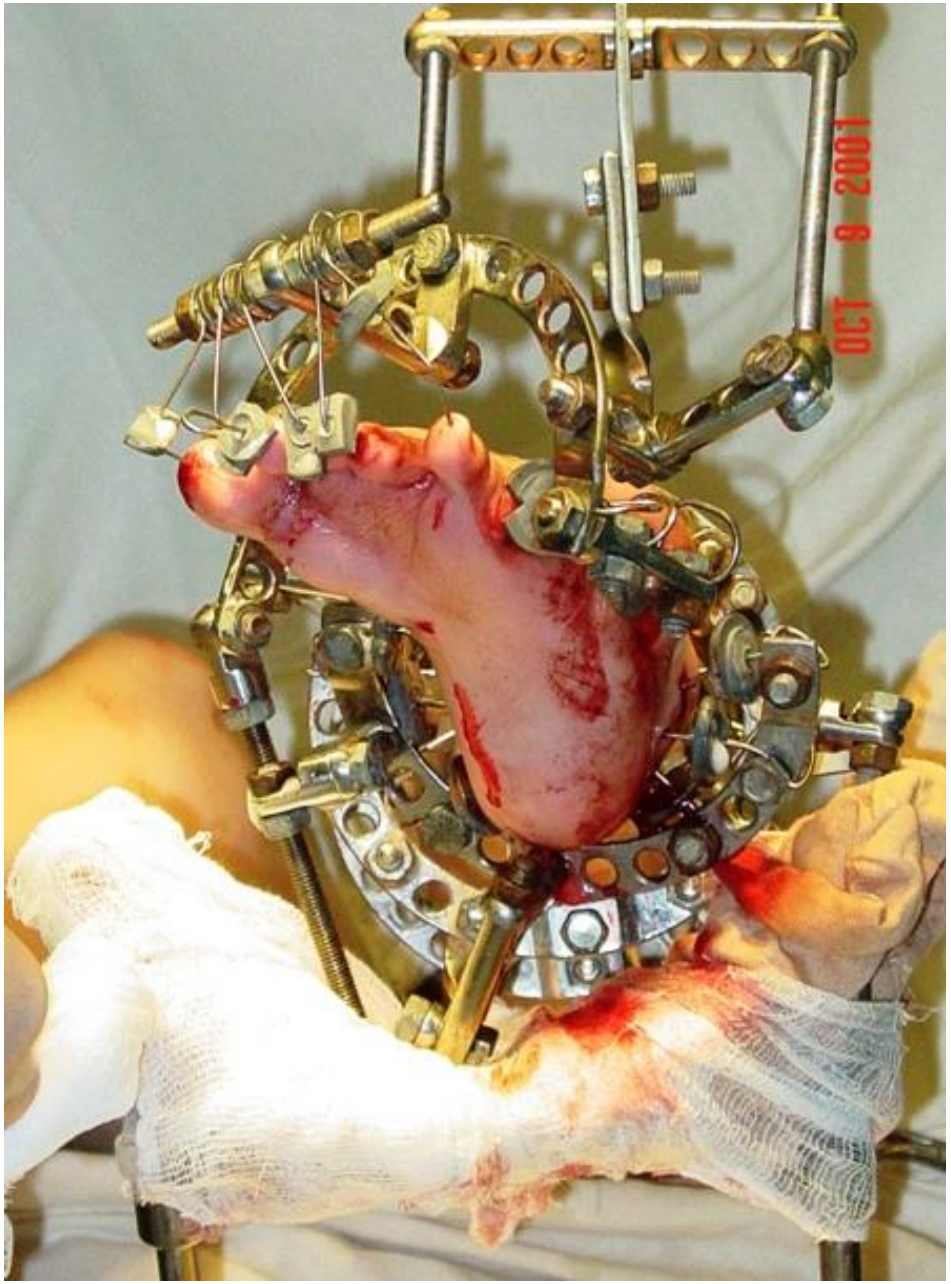
- 13 y/o ♂ with “an attitude”.
  - Left Side 1/19/2008
  - Frame Removed 7/18/2008
  - Right Side 1/16/2009
  - Final Correction 11/14/2009

Ilizarov Correction of Mature Clubfoot

- RISC Center – Kurgan Russia

Ilizarov Correction of Mature Clubfoot

- Correction of all TEV w Percutaneous TAL
  - Newborns
  - Mature
- Emphasize “Overcorrection”
  - Rearfoot to Leg
  - Forefoot on Rearfoot
  - Toes on Forefoot

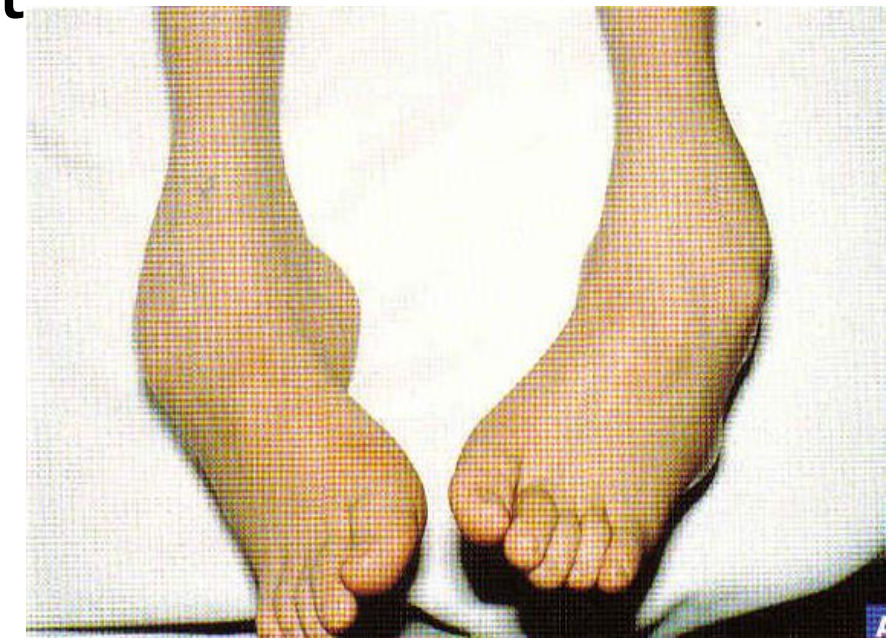


Other Surgical Procedures

- In neglected or recurrent clubfoot:
  - Talectomy
  - Triple arthrodesis
  - Pan-talar arthrodesis

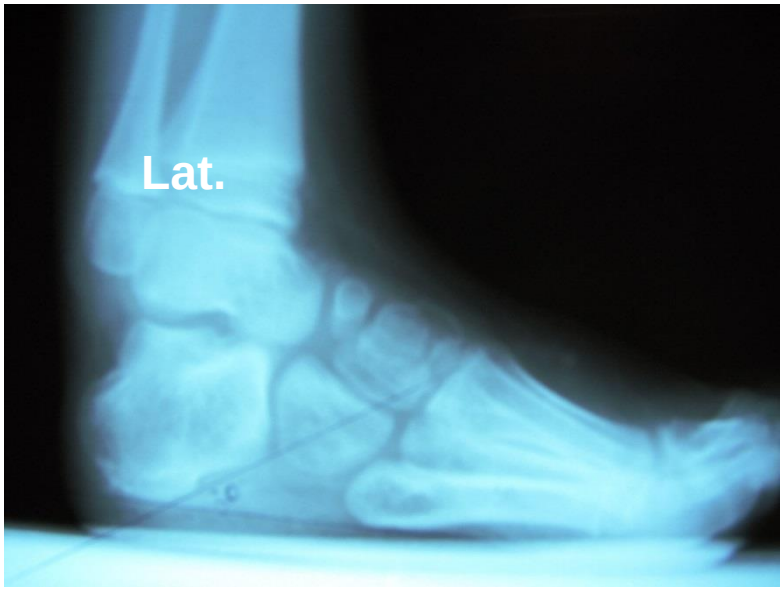
Pediatric Cavus Foot

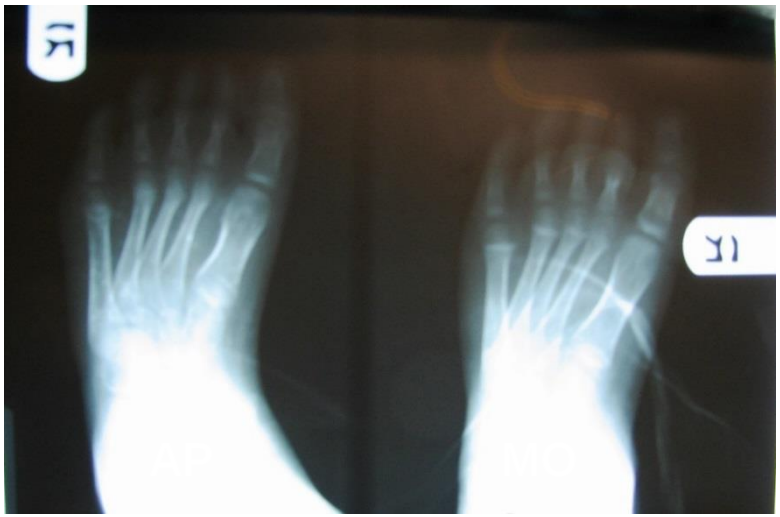
- Fixed deformity of forefoot on rear foot
- Clinical presentation- high medial arch, equinus, varus heel, claw toes
- 2/3 have distinct underlying neuromuscular condition:
  - Peroneal muscular atrophy
  - Poliomyolitis
  - Spina bifida
  - Duchenne muscular dystophy
  - Friedreich's ataxia
  - Cerebral palsy
  - Polymyelitis



Pediatric Cavus Foot

- The child with a pes cavo-varus deformity presents with:
  - High plantar arch
  - Varus heel
  - Clawing of toes
  - Callosities (not always present)
- Electrophysiological studies: on all ped patients with cavus
  - NCV,EMG, muscle biopsy
- Radiographs
  - Lateral view: CIA angle (high), Talar declination angle (low)
  - AP, MO – MA angle (high)



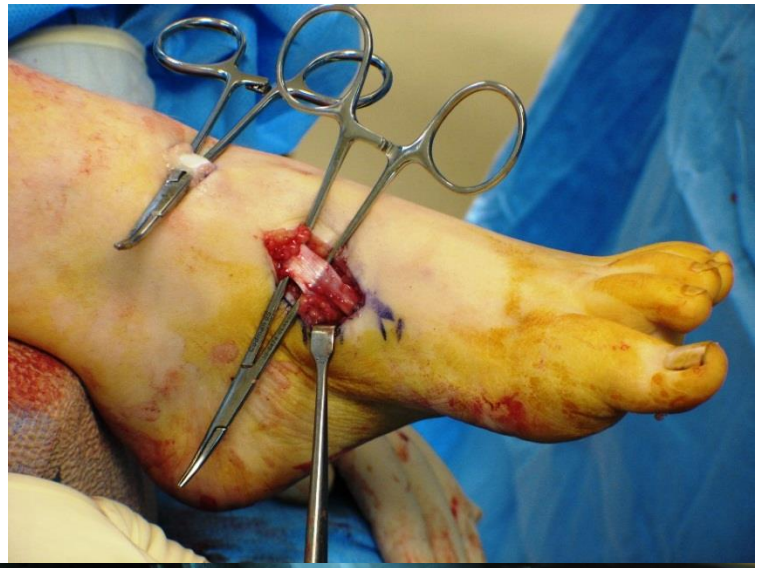


Pediatric Cavus Foot

- Understand Level of Deformity
  - Posterior – High CIA
  - Midfoot
  - Anterior
    - Anterior Local Cavus (Plantarflexed 1st Metatarsal)
    - Anterior Global Cavus (Rigid Forefoot Valgus)
- Treatment
  - Early: stretching, Orthoses
  - Late: surgery to address each component- cavus, varus heel, toes

Surgical Tx of Pediatric Cavus Foot

- Plantar Soft Tissues Release
  - Steindler Stripping
  - Westin Stripping
- Rearfoot Reduction
  - Dwyer Calcaneal wedge
  - Koutsugiannis
  - Silver
- Midfoot Reduction



Metatarsus Adductus Definitions

- Is a ***uniplanar deformity***
- Positional or structural transverse plane deformity of the metatarsals at the tarsometatarsal (LisFranc's) joint level

Synonyms

- Metatarsus varus (uniplane deformity)
- Metatarsus adductovarus (biplane deformity) - Kite
- Metatarsus supinatus (triplane deformity)

Incidence

- 1:1,000 live births
- Left >>> right foot
- No sex predilection
- Slightly less common than clubfoot (TEV)

Etiology

- Abnormal intrauterine position?
  - Due to increased intrauterine pressure
- Arrest of ontogeny or fetal development?
- Hereditary?
- Muscle-tendon anomalies?
  - Hyperactive abductor hallucis muscle
  - Abnormal insertion of the tibialis anterior or posterior muscles
- Medial cuneiform anomaly?

Diagnosis

- Clinical findings
  - Most important

- Radiographs
  - DP view
  - Metatarsus adductus angle is the most significant angular relationship in the diagnosis of metatarsus adductus

Clinical Findings

- C-shaped foot
  - Convex lateral border
  - Concave medial border
  - Appears to have “high arch”
- Prominent 5th metatarsal tuberosity (older child)
- Adduction of metatarsal 1-5 in transverse plane
- Possible FF varus

- May see separation of great toe
- Heel-forefoot bisection is not parallel
- Lack of abduction past midline
  - “*abduction stress test*”
- Muscle hyperactivity
  - Tibialis anterior hyperactive

Metatarsus Adductus

- Classified into:
  - Mild (flexible)
  - Moderate
  - Severe (rigid)

- Mild to moderate most common

- Farsetti, Weinstein, & Ponseti- The Long Term Functional and Radiographic Outcomes of Untreated and Non-operatively Treated Metatarsus Adductus

  - 31 patients (45 feet) with metadductus were followed for an average of 32 years and 6 months
  - Examined clinically & radiographically
  - 12 patients (mild-mod) no tx
  - 20 patients tx with casting

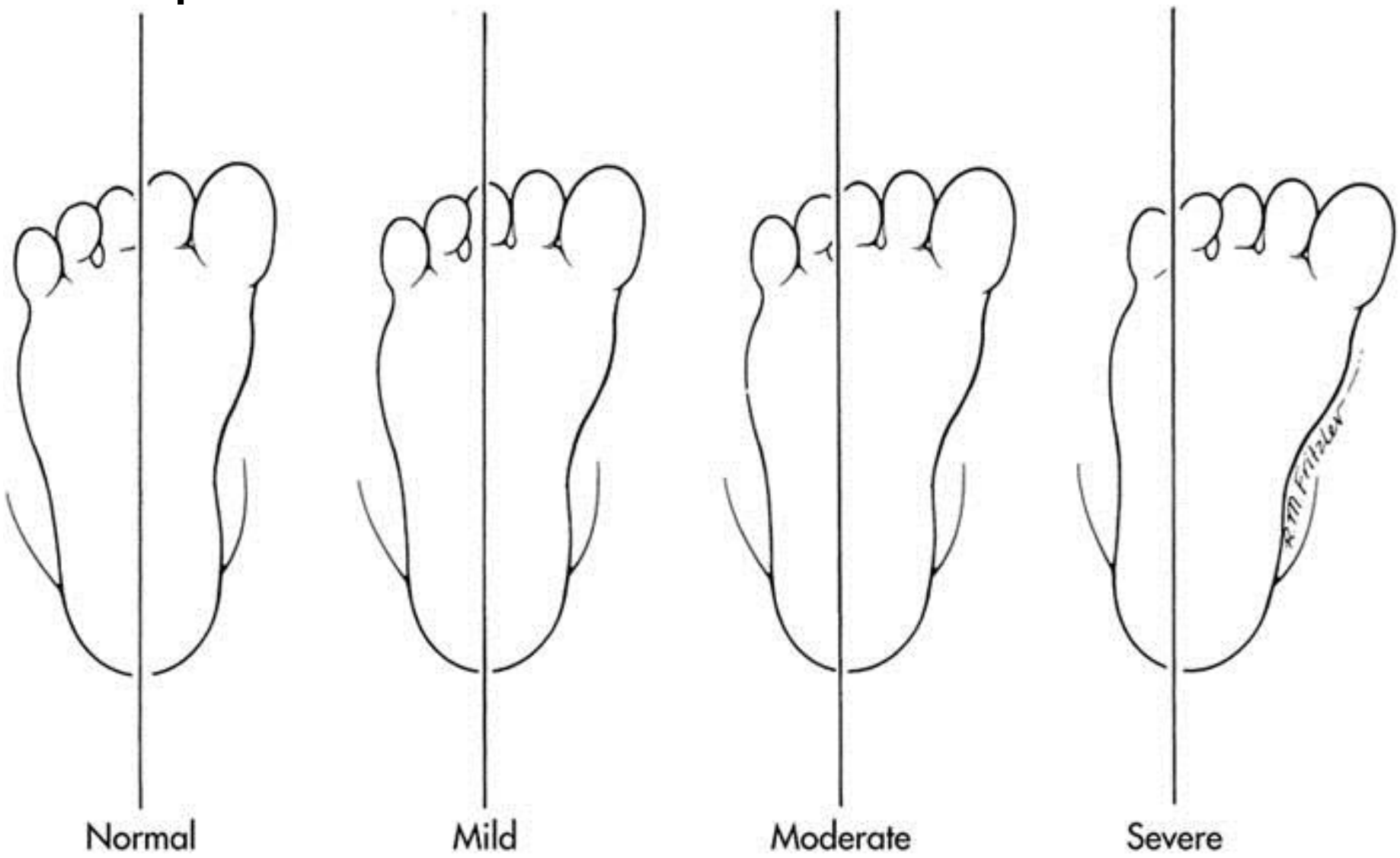
JBJS, Vol 76-A, No2, February 1994

Farsetti, Weinstein, & Ponseti- The Long Term Functional and Radiographic Outcomes of Untreated and Non-operatively Treated Metatarsus Adductus

- Results: Good in all 16 of the untreated feet,and in 26 (90%) of the 29 feet that were treated conservatively
- No poor results reported
- Radiographs revealed an obliquity of the medial cuneiform-metatarsal joint
- HAV not common, no one had Sx

JBJS, Vol 76-A, No2, February 1994

Bleck Grading System



Compensated Juvenile MA

- Rearfoot is pronated
- Develop a collapsing flexible pes planovalgus
- Not a “true” MA
- Positional deformity

Compensated Adult MA

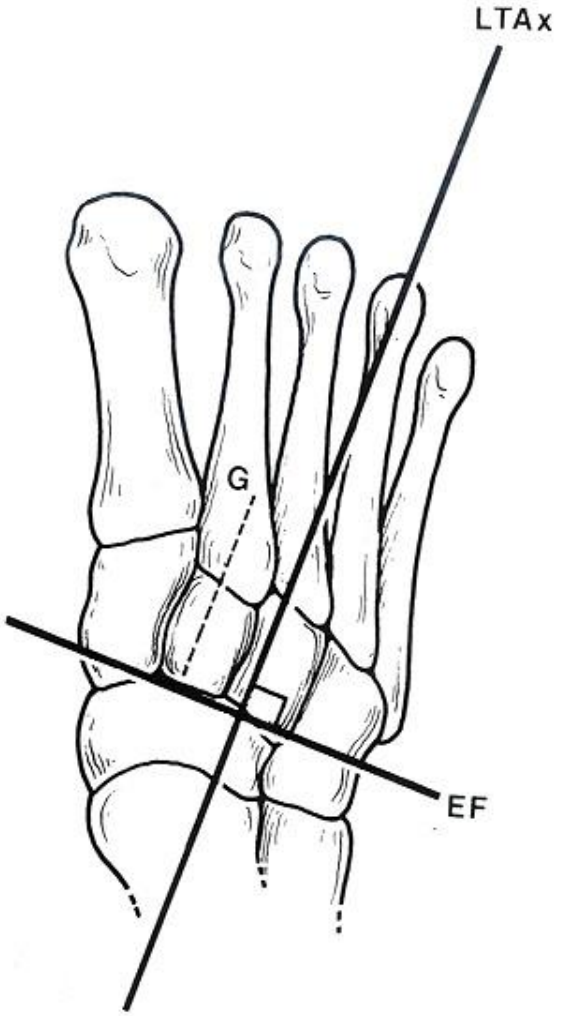
- Skewfoot
- Z-foot
- Serpentine foot
- Juvenile bunions
- Flexor stabilization hammertoes
- Tailor’s bunions
- Splay foot

Uncompensated Adult MA

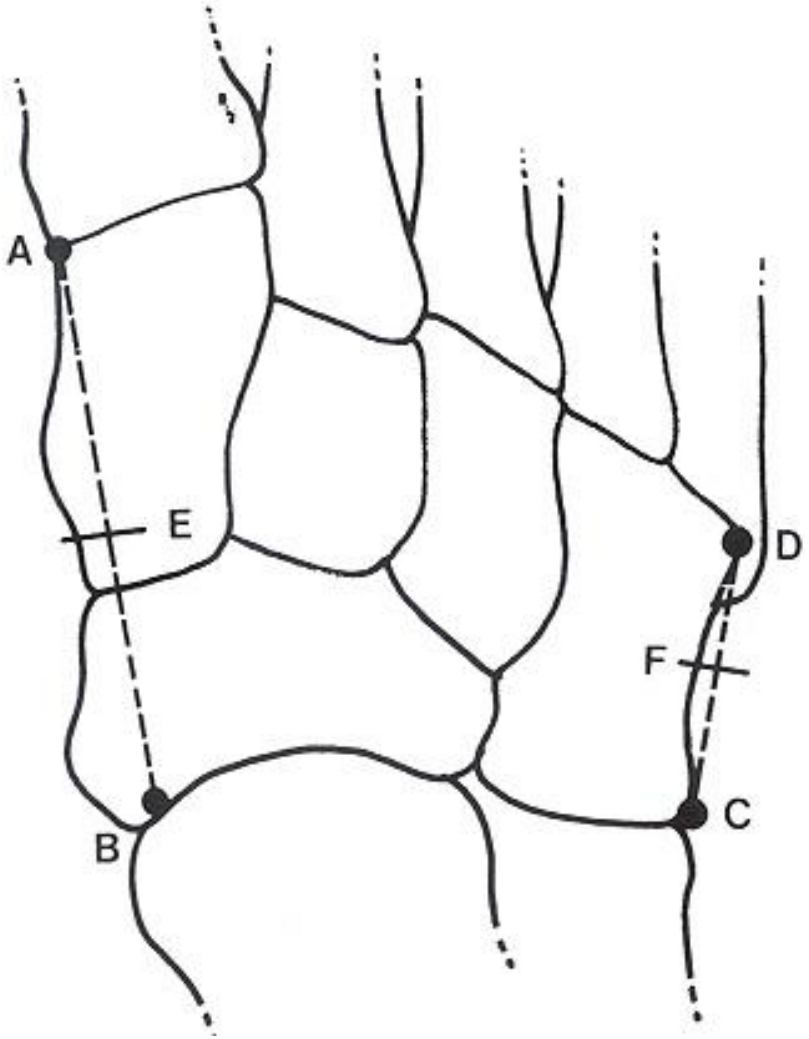
- **Cavus foot type**
  - aka “cavo adductovarus”
- Rigid forefoot valgus
  - Tripod effect
  - Rigid forefoot valgus
- Extensor substitution hammertoes
  - Dynamic swing phase induced hammertoes

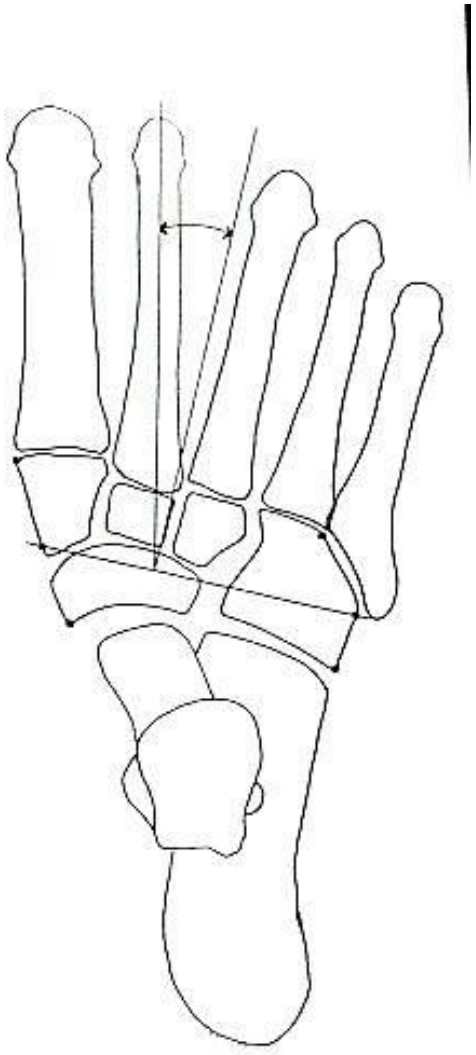
MA Angle

- Lesser tarsus axis with bisection of 2nd metatarsal axis
- Normal: less than 15°
- Yu and DiNapoli [1989] perceive that metatarsus adductus angles of:
  - 15-20 degrees indicative of a mild deformity
  - 21-25 degrees representative of a moderate deformity
  - Values > than 25 degrees signifying severe deformity



MA Angle





Radiographic Findings

- DP view
- Lateral view
- Stress DP view

- Must differentiate MA from TEV

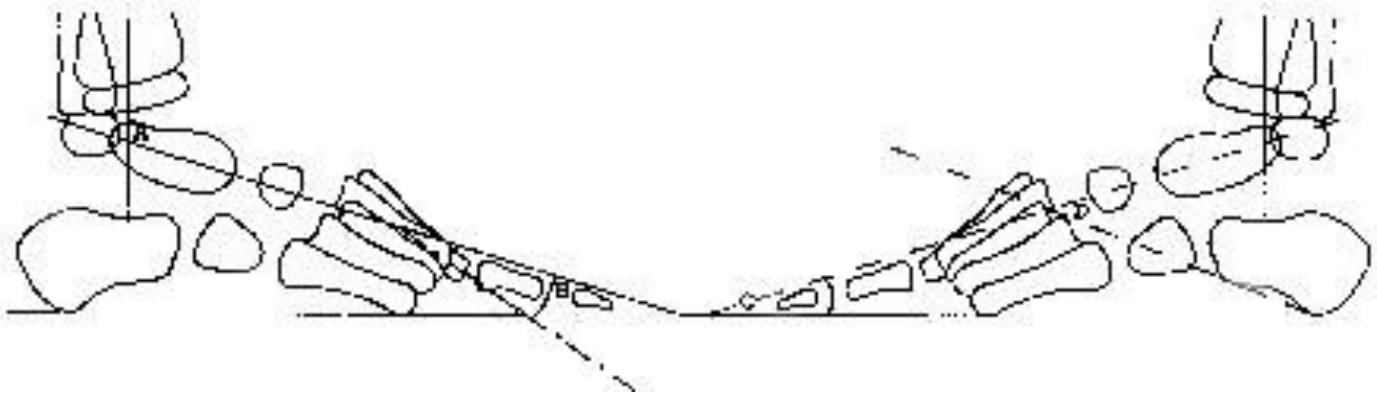
- Difficulty: navicular ossifies by 3.5 years of age

DP View in MA

- Increased MA angle (> 15°)
- Increased 2nd metatarsal-cuneiform angle (>24°)
- Medial deviation of talar axis
- Anterior break in the cyma lime
- Increased Kite's angle (talocalcaneal)

Lateral View in MA

- Decreased calcaneal inclination angle
- Decreased talar declination
- Posterior break in cyma line



MA versus TEV

Metatarsus Adductus

- Navicular lateral
- Increased Kite's angle (> 24°)

Clubfoot

- Navicular medial
- Decreased Kite's angle (< 15°)

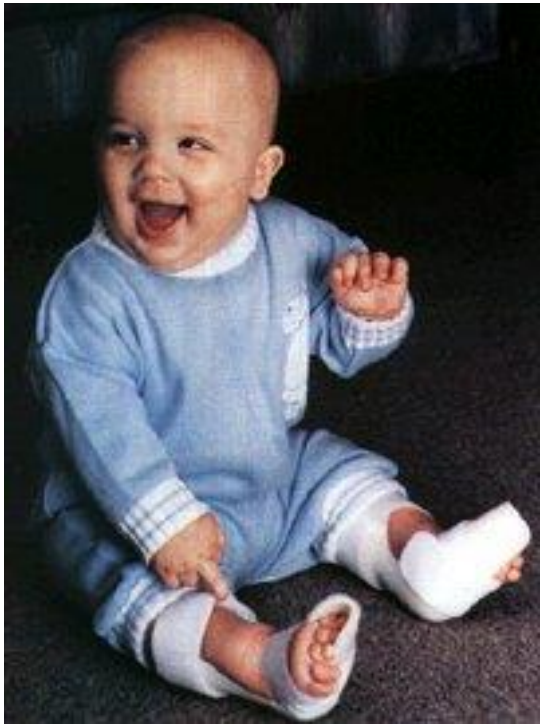
Conservative Treatment

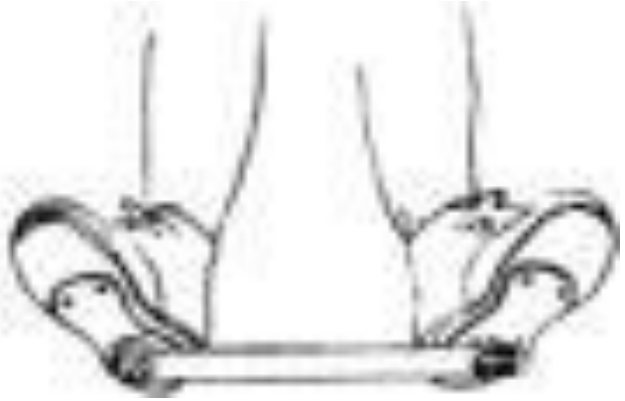
- Surgical correction of metatarsus adductus is only advocated in the pediatric patient after 2 years of age, following unsuccessful results with conservative treatment modalities

- Includes stretching and manipulation, alteration in sitting and sleeping positions, functional orthoses, serial casting, splints, braces and shoe therapy

Conservative Treatment

- Soft tissue manipulations/stretching/ exercise
  - Less than 3 weeks old
- Serial casting
  - 3 weeks to 24 months
- Unibar or Ganley splints
- Bebax brace
- Wheaton brace
- Straight last shoes
- Orthotics
- Change in habits





- Orthotic Therapy

Surgical Management

- Soft tissue or osseous procedures may be performed
- Various approaches depends on:
  - Age of the individual
  - Osseous growth
  - Severity of the deformity
  - Existence or lack of other deformities

Surgical Management

- Soft Tissue Ligamentous releases
  - i.e. Heyman Herndon Strong (HHS)
  - 2-5 years old
- Osseous procedures
  - Greater than 6 years old
  - Why 6 years old?
    - Growth Plates

Indications for Surgery

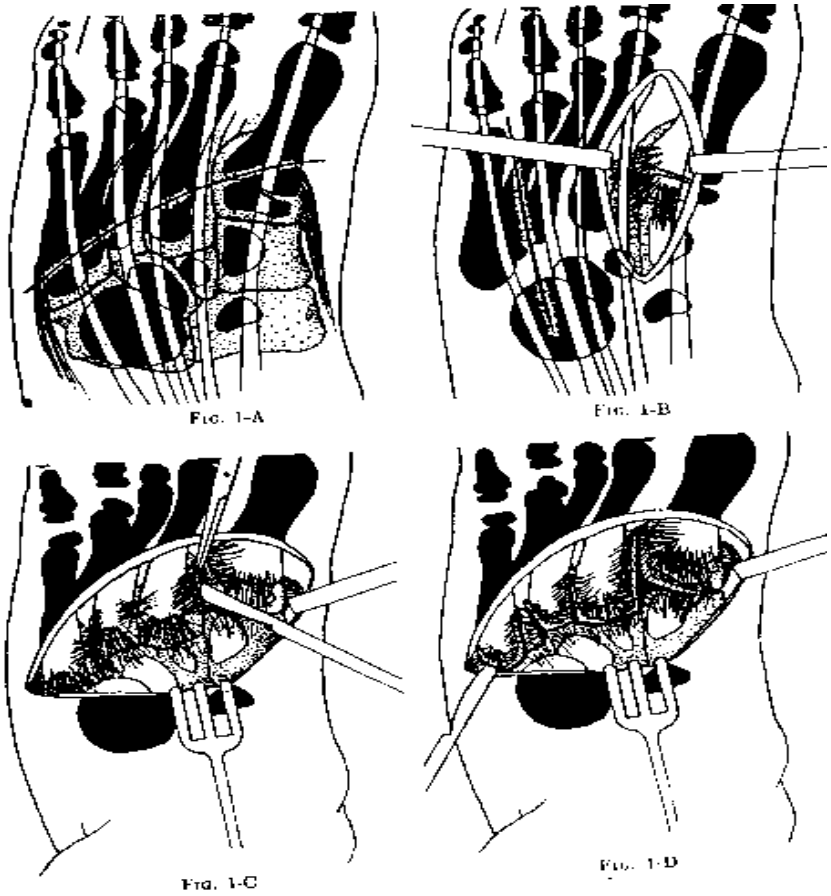
- Failure to respond to conservative therapy
- Residual deformity of clubfoot
- Newly diagnosed MA after age of 6

Soft Tissues Procedures

- Tenotomies
- Capsulotomies
- Chondrotomies
- Ligamentous releases
- Tendon transfers and releases

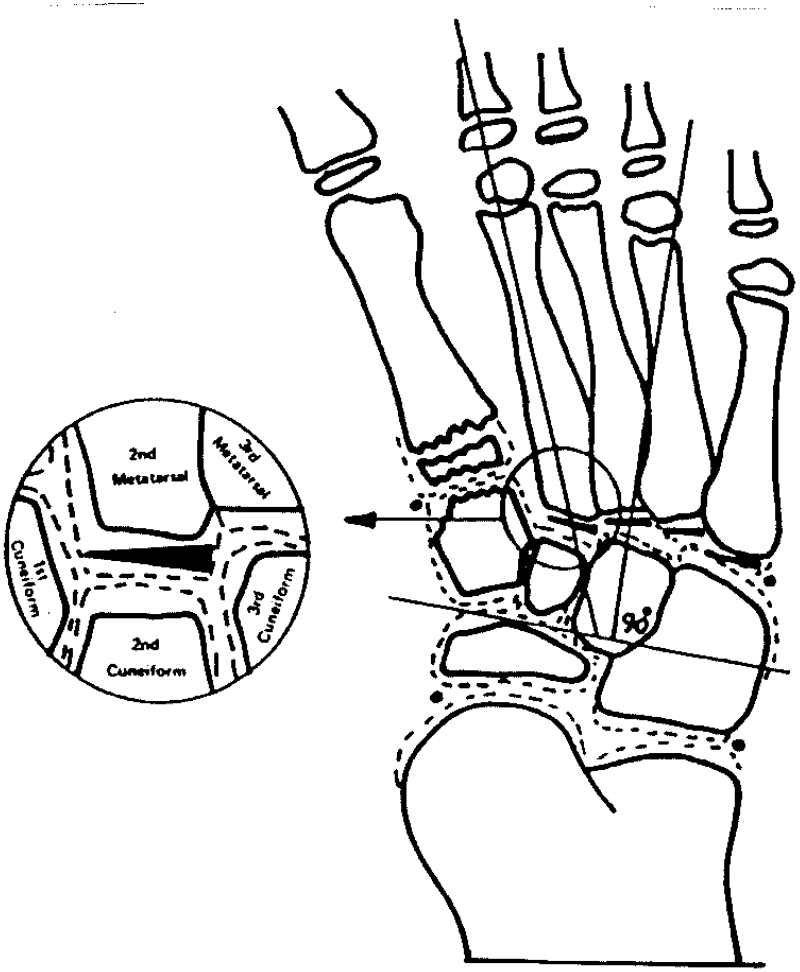
HHS (1958)

- Heyman, Herndon & Strong procedure
- **Age**: 2-6 years old
- “Anterior capsulotomies”
- Complete mobilization of tarsometatarsal and intermetatarsal ligaments
- ***Must preserve plantar-lateral ligaments***
- K-wire fixation
- Cast immobilization for 3 months



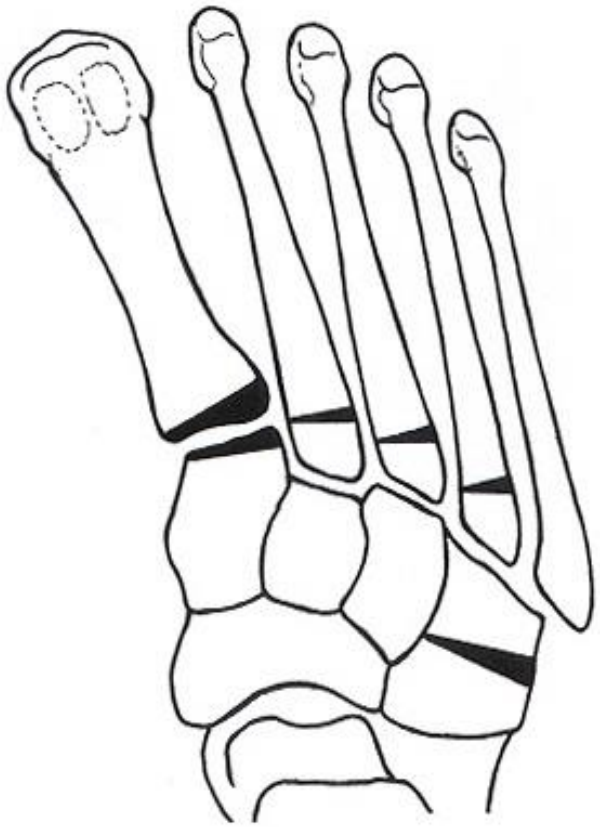
Wedge Chondrotomies

- Johnson procedure (1978)
- **Age**: 6-8 year olds
- Closing base wedge osteotomy of 1st metatarsal
- Take out cartilage off bases of 2-5



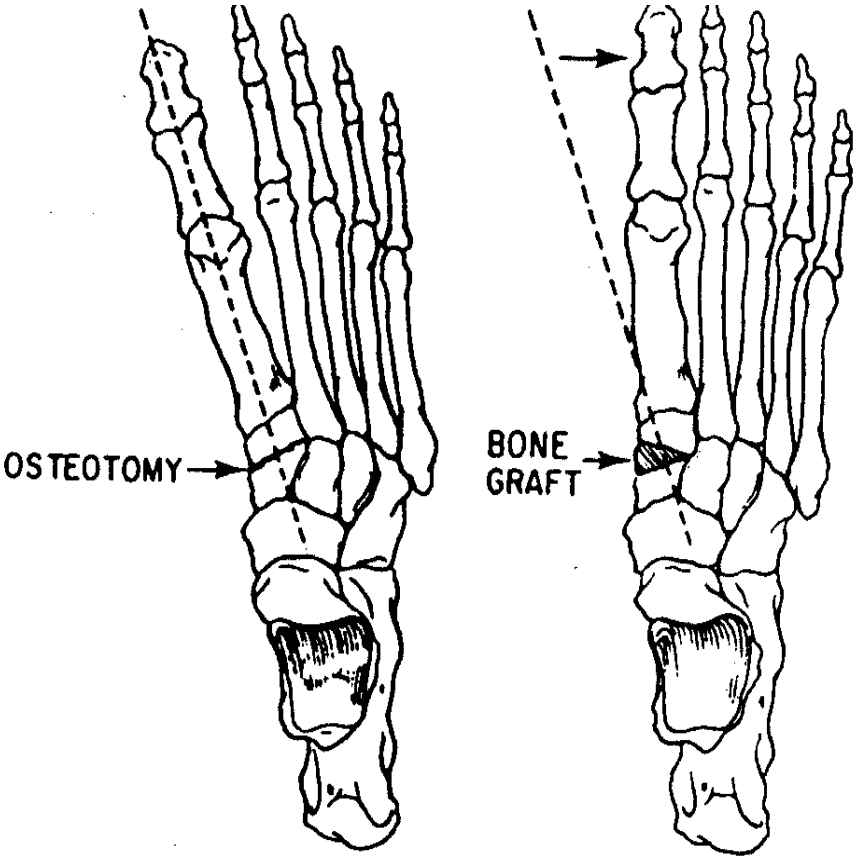
McCormick and Blount (1949)

- Recommended after skeletal maturity
- 1st metatarsal cuneiform arthrodesis
- Closing wedge resection out of cuboid
- Lateral wedge osteotomies of bases of metatarsals 2, 3, 4



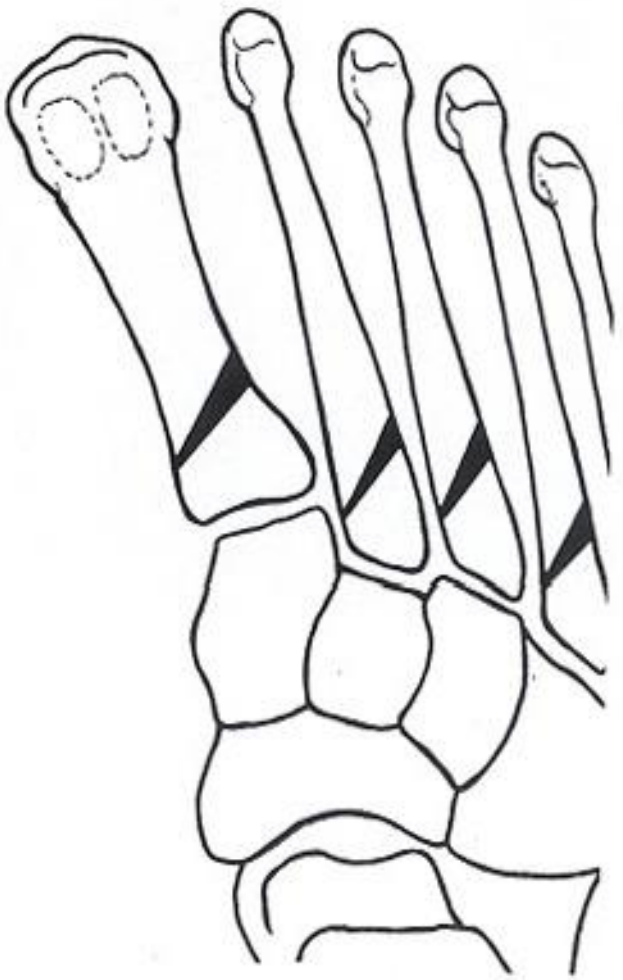
Fowler Procedure (1951)

- Opening wedge on medial cuneiform with insertion of bone graft
- Used for transverse plane correction
- Performed on patients greater than 12 years old



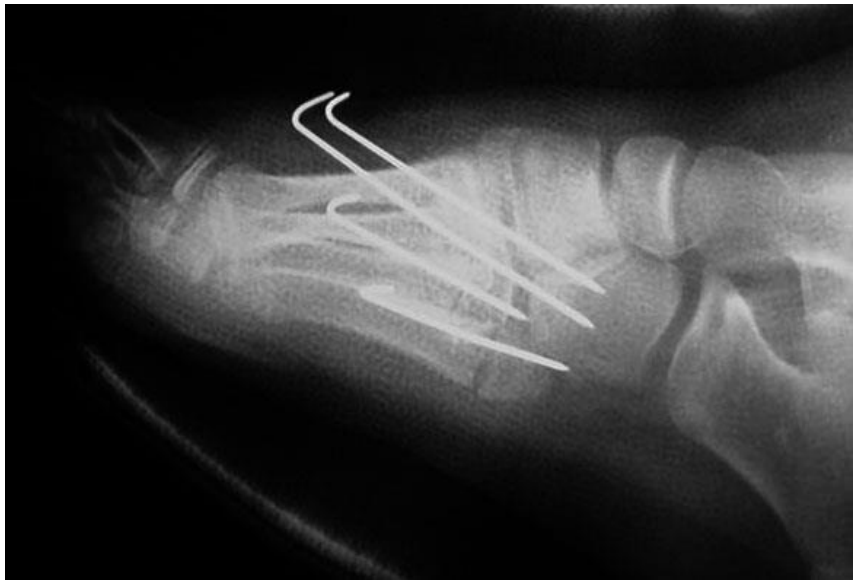
Steytler and Van der Walt (1966)

- V-shaped osteotomies
- Wedge osteotomies of all the metatarsal bases
- Osteotomies were not fixated
- Felt osteotomies were more stable and would prevent inadvertent displacement of the distal fragment



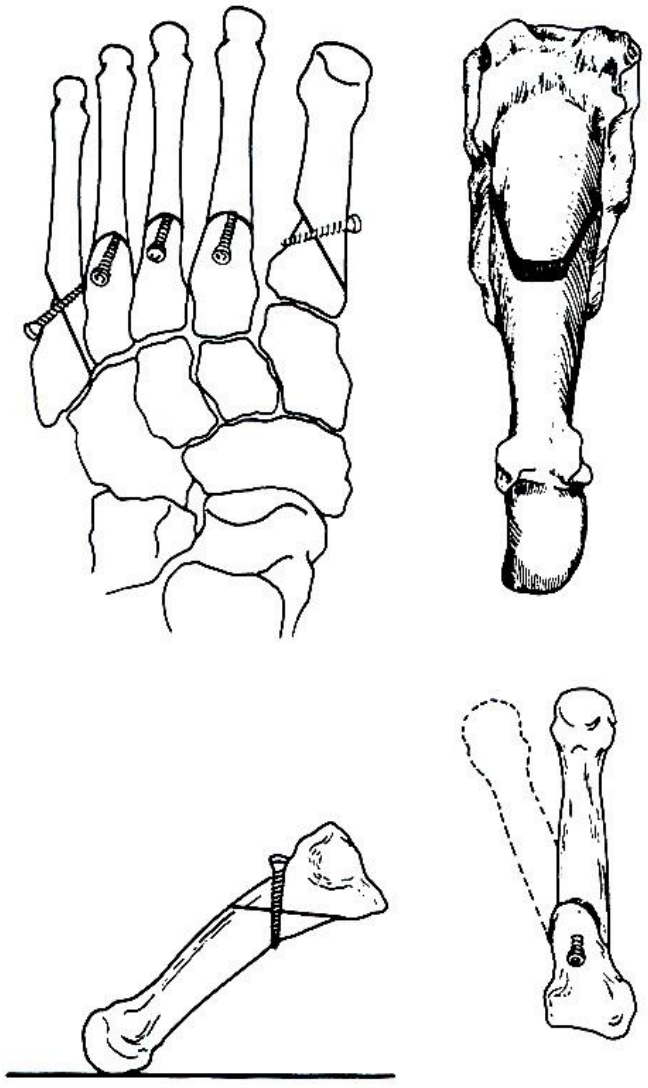
Berman and Gartland (1971)

- Crescent or dome shaped osteotomies of <u>all</u> metatarsal bases
- May fix only 1st 5th and 3rd metatarsal ostetomies
  - Vassal Principle



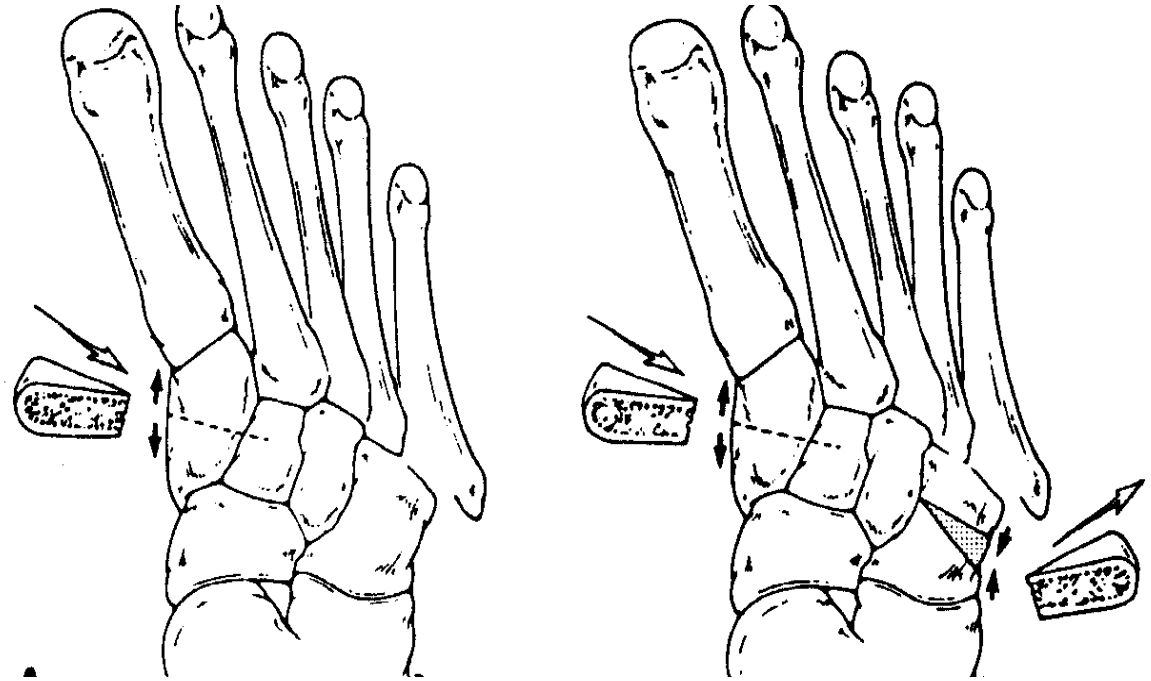
Lepird Procedure

- Oblique closing wedge ostetomies of 1st and 5th metatarsal bases
- Metatarsal rotational osteotomies of 2nd, 3rd, and 4th metatarsals
- Central 3 metatarsals performed in transverse plane
- Fixed with screws



Grumbine Procedure (1981)

- Opening wedge on medial cuneiform with cuboid decancellation



Summary Recommendations

- **0-2 years old**:
  - Soft tissue manipulations, strechthing, exercise, serial casting
- **2-5 years old**:
  - HHS procedure
- **6-8 years old**:
  - Johnson wedge chondrotomy
- **Greater than 8**:
  - Various osseous procedures
  - Lepird, Fowler (Grumbine)

Pediatric Pronation Deformities

- CCPV: Vertical (or Oblique) Talus
- Tarsal Coalitions
- Calcaneal Valgus
- Pediatric Flat Foot
- Pediatric HAV
  - Recognition and non-surgical Management

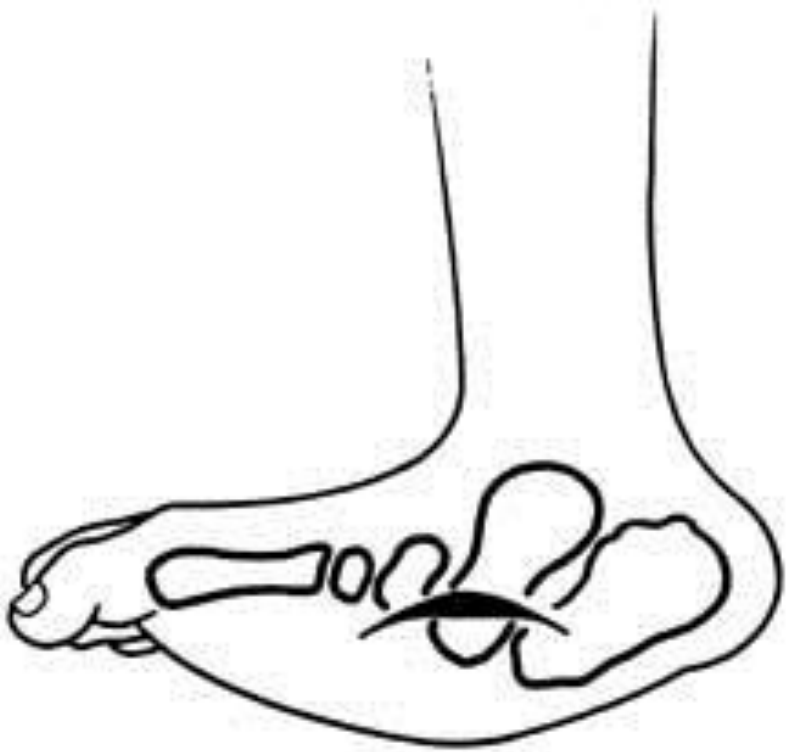
Congenital Convex Pex Valgus (Vertical Talus)

- Extremely rare congenital pedal disorder
- Presents as *rigid, rocker-bottom flatfoot* deformity
- Multifaceted deformity:
  - Abnormalities of talar position (vertical)
  - Talocalcaneonavicular joint dislocation
  - Both ligamentous & musculotendinous changes
- ***Hallmark is dorsal dislocation of the navicular on the talar head and neck***
- Confusion has arisen because of alternative terminology used in the past

NOTE: In true CCPV, thick plantar skin surface wraps around back of the foot.

Synonyms

- Vertical talus
- Congenital valgus flatfoot with talonavicular dislocation
- Congenital rigid rocker bottom foot
- Congenital convex pes valgus
- “Reverse clubfoot”

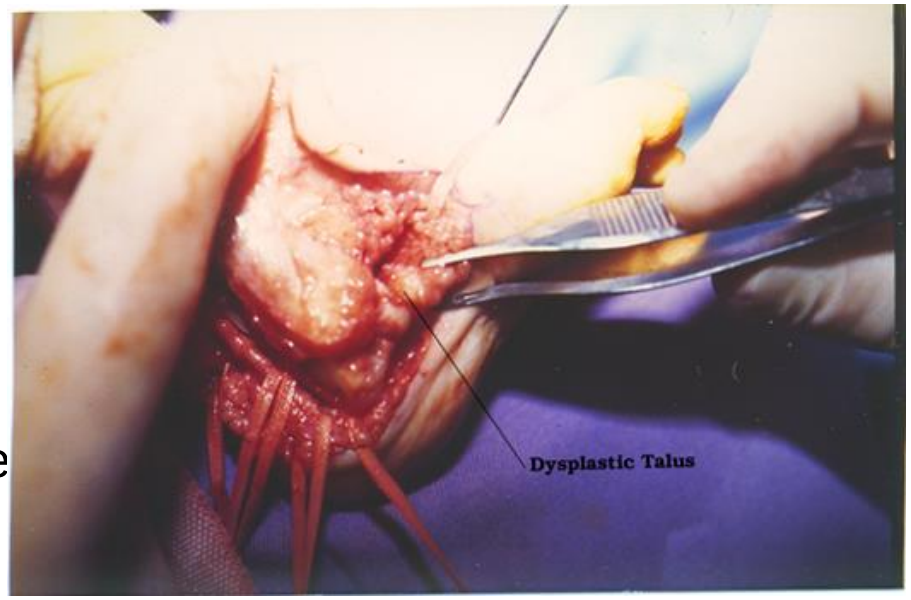


Incidence

- Very rare condition
- Reported incidence of congenital convex pes valgus is <0.5% of all live births
  - Less than 800 reported in the literature
- More cases have been reported in males than in females
- Male : female ratio equal (Crawford, 1983)
- 50% have bilateral involvement
- Right >>> left when unilateral

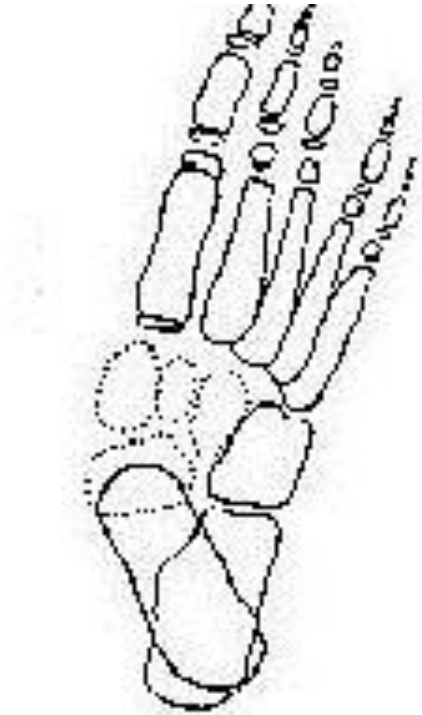
Congenital Vertical Talus

- Etiology still is uncertain :
  - Recent literature indicates a single gene expression aberrancy may be at issue
  - Possibly multifactorial
  - Possibly idiopathic or associated with secondary conditions (usually autosomal dominant)
- Higher incidence with various congenital anomalies and neuromuscular diseases (10-50%):
  - Myelomeningocele
  - Arthrogryposis
  - Trisomy 13 – 15
  - Trisomy 21 (Down's syndrome)
  - Marfan's syndrome
  - Spina bifida
  - Cerebral Palsy
- **Peg-leg gait** (awkward gait with limite forefoot push-off)



Osseous Pathology

- **Calcaneus**:
  - Valgus and equinus
  - No anterior talocalcaneal articulation
  - Dorsolateral subluxation of the calcaneocuboid joint
  - Sustentaculum tali blunting
  - Posterior STJ abnormalities
- **Talus**:
  - Fixed in a vertical position
  - Medial angulation
  - Associated hypoplasia of the talar head and neck
- **Navicular**:
  - Rigidly articulates with the dorsal cortex of the talar neck



Vertical Talus

Soft Tissue Contracture

- Contracted ligaments:
  - Tibionavicular
  - Dorsal talonavicular
  - Bifurcate
  - Interosseus talocalcaneal
  - Posterior talofibular
  - Calcaneofibular
- Posterior ankle and subtalar joint capsules are contracted
- Medially, elongation of the spring ligament and plantar medial capsule of the talonavicular joint must be addressed

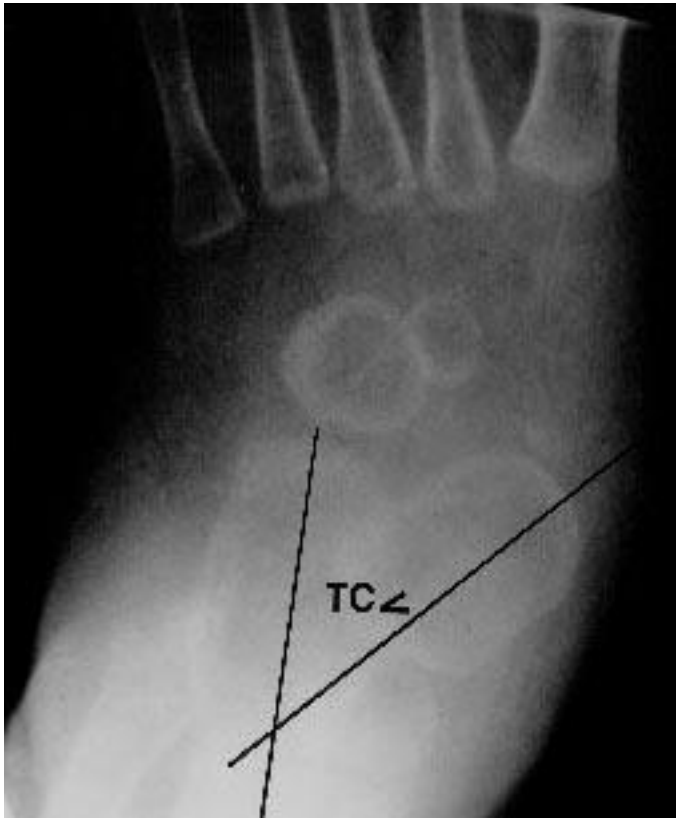
- Contracted muscles:
  - Tibialis anterior
  - Extensor hallucis longus
  - Extensor digitorum longus
  - Peroneus brevis
  - Peroneus longus
  - Achilles tendon
- Anterior displacement above the malleoli of the tibialis posterior and peroneal tendons may contribute to a dorsiflexed foot position

Radiographic Findings

- Standing DP and lateral view
- Special “forced” views:
  - Lateral plantarflexion view
  - Lateral dorsiflexion view
- DP view:
  - Increased talocalcaneal angle
  - Forefoot abduction
- Lateral view:
  - Calcaneus in equinus
  - Vertical position of the talus
  - Dorsal displacement of forefoot on talus

Vertical Talus:
DP Radiograph

- Increased TC (Kite's angle)
- Forefoot abduction



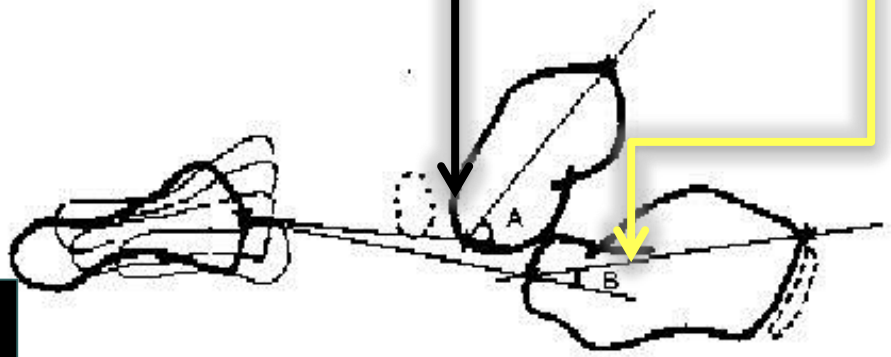
Vertical Talus:
Normal Lateral Radiograph

- Calcaneal equinus
- Vertical position of the talus
- Dorsal displacement of forefoot on talus
- Rocker-bottom appearance

Lateral Plantar Flexion View

- Talar-metatarsal axis [**A**] = a line bisecting the talus and the longitudinal axis of the metatarsals
  - Normal = 3 degrees
  - Increased with vertical talus
  - Differentiates vertical talus from oblique talus
    - Normal: aligned in lateral and lateral plantar flexion views
    - Oblique talus: malaligned in lateral view and aligned in the lateral plantar flexion view
    - Vertical talus: malaligned in both the lateral and the lateral plantar flexion view

- Calcaneal-metatarsal axis [B] = a line bisecting the long axis of the calcaneus with the longitudinal axis of the metatarsals
  - Normal = -10 degrees
  - Increased with vertical talus



***NOTE**: Because of lack of navicular bone ossification in infants, longitudinal axis relations among the talus, calcaneus, 1st metatarsal, and cuboid bones must be assessed*

Radiographic Findings

- Lateral dorsiflexion view:
  - Assess the degree of fixed equinus of the calcaneus

Vertical Talus:

Lateral Dorsiflexion View

Vertical Talus:

Lateral Dorsiflexion View

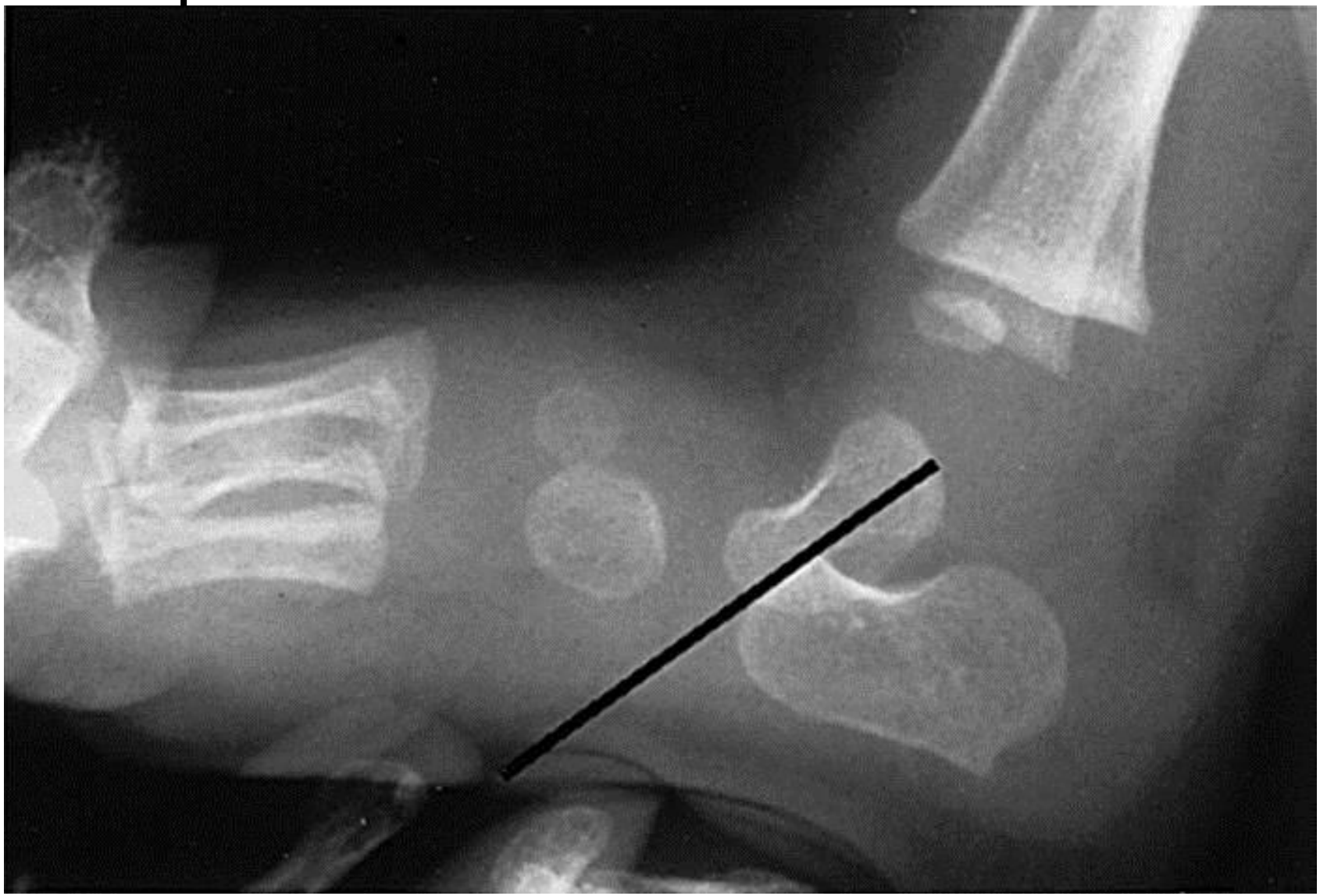
Vertical Talus:
Lateral Plantarflexion View

- Irreducibility of the deformity by forced plantar flexion lateral views (**Eyre-Brook test**) distinguishes this condition from flexible plantarflexed talar deformities

- Often considered the most important radiograph

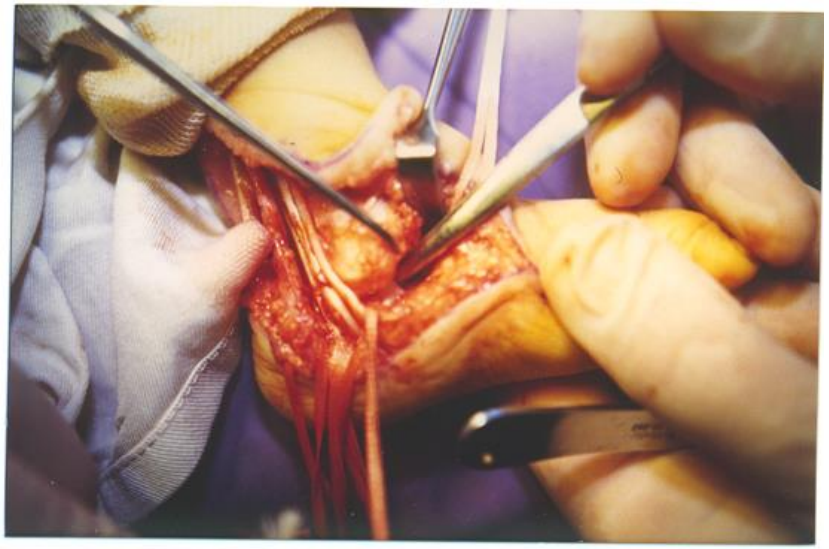
Vertical Talus:

Lateral Plantarflexion View



Treatment

- Goal is to reduce and maintain the anatomic relationship of the navicular and calcaneus to the talus
- Patient age as well as degree and severity of deformity dictate the treatment course
- **Serial casting**:
  - Start at birth continue for 3 to 4 months ONLY
  - Stretches soft tissues for preparation of future surgery
  - Usually a surgical deformity at some level!

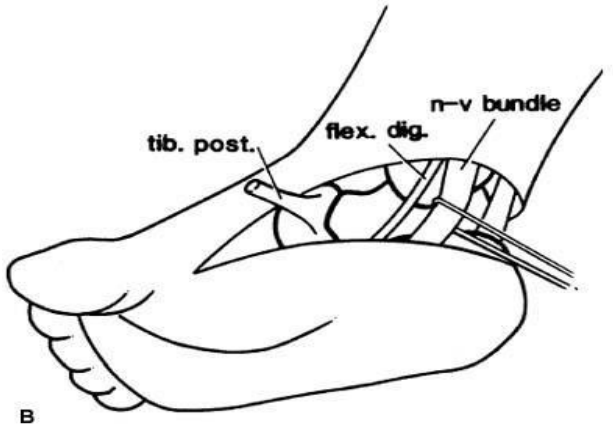


Conservative Therapy- CCPV

- **Casting**:
  - Start soon after birth continue for 3 to 6 months
  - Reduce talonavicular dislocation
  - Elimination of forefoot varus
- **Position of foot in casting** (reverse Ponsetti series)
  - Start at position # 5 and move successively toward position #1
- Morcuendi demonstrated successful resolution of CCPV with reverse Ponsetti series
- However, open surgical correction is sometimes necessary

Surgical Treatment

- Soft tissue procedures (6-12 months):
  - Cincinnati incision
  - Posterior capsulotomy, tendon lengthening (EHL, EDL, Tib Ant. & Achilles tendons)
  - Reduce talocalcaneal & talonavicular joints & hold with multiple K-wires
- Late treatment requires bony procedures:
  - 2 - 6 years = Grice-Green subtalar arthrodesis
  - > 6 years = triple arthrodesis



When to Perform Surgery?

- Tachdjian advocated surgery as early as three months

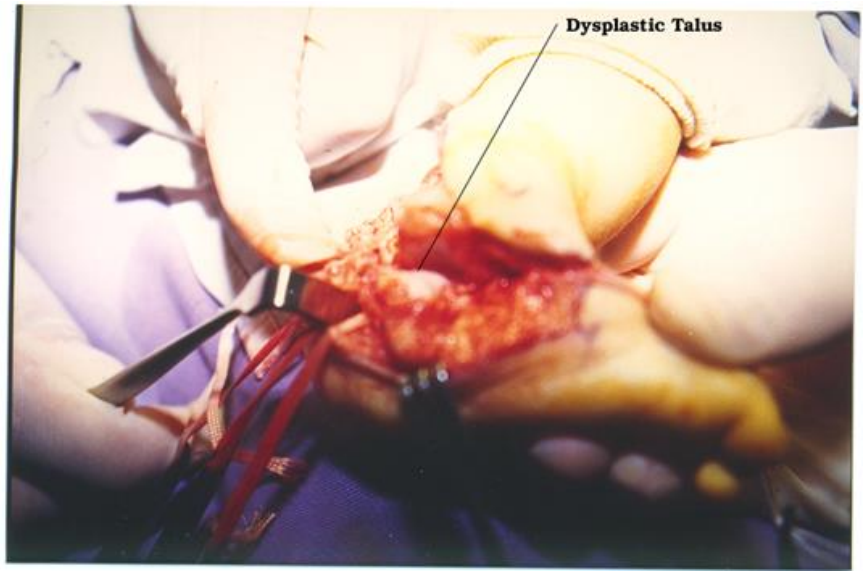
  If reverse Ponsetti reduction has failed

- Prognosis for a good to excellent result is much better if surgery is attempted before three years of age

- After 4 years of age, osseous adaptation has occurred and multiple procedures are often required

4 Surgical Approaches

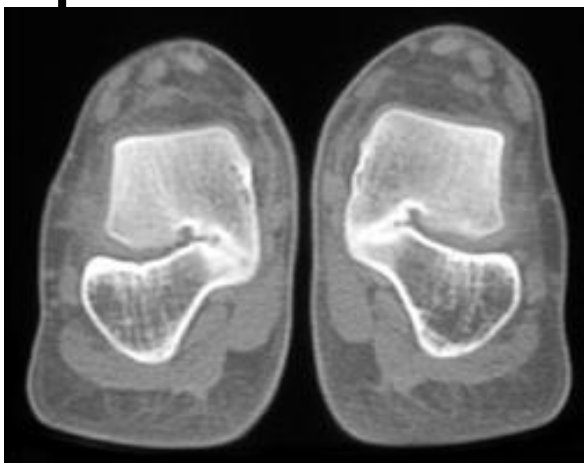
- **Talar procedures**:
  - Complete talectomy
  - Excision of head and neck of the talus
- **Navicular procedures**:
  - Navicular excision
  - Dorsal wedge excision
- **Talonavicular joint procedures**
  - Open reduction with K-wire fixation
  - Open reduction with peroneus brevis transfer to talar neck
- **Tarsal stabilization procedures**:
  - Triple arthrodesis
  - Subtalar arthrodesis



Tarsal Coalitions

- Relatively rare anomaly
- Presents with varying degrees of fusion and/or restricted movement between two or more tarsal bones
- Union may be:
  - Osseous (***synostosis***)
  - Cartilaginous (***synchondrosis***)
  - Fibrous (***syndesmosis***)

Types

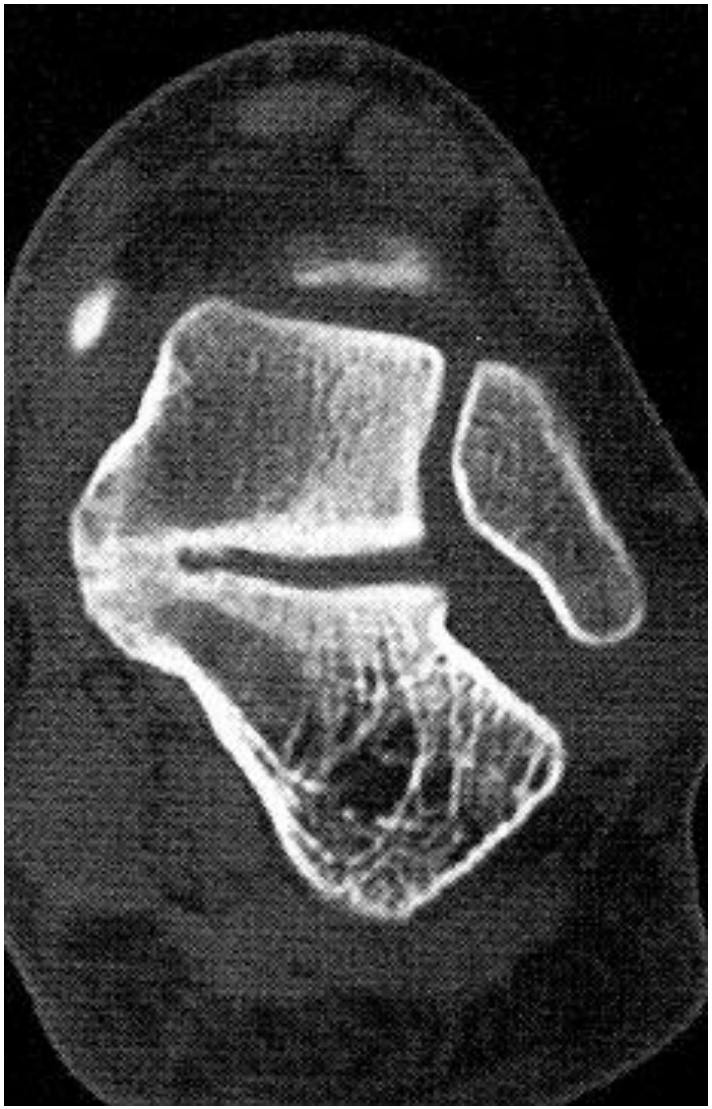


- A tarsal coalition represents a union between two bones of the tarsus via a bar or bridge
- Two locations may exist:
  - Intra-articular
  - Extra-articular

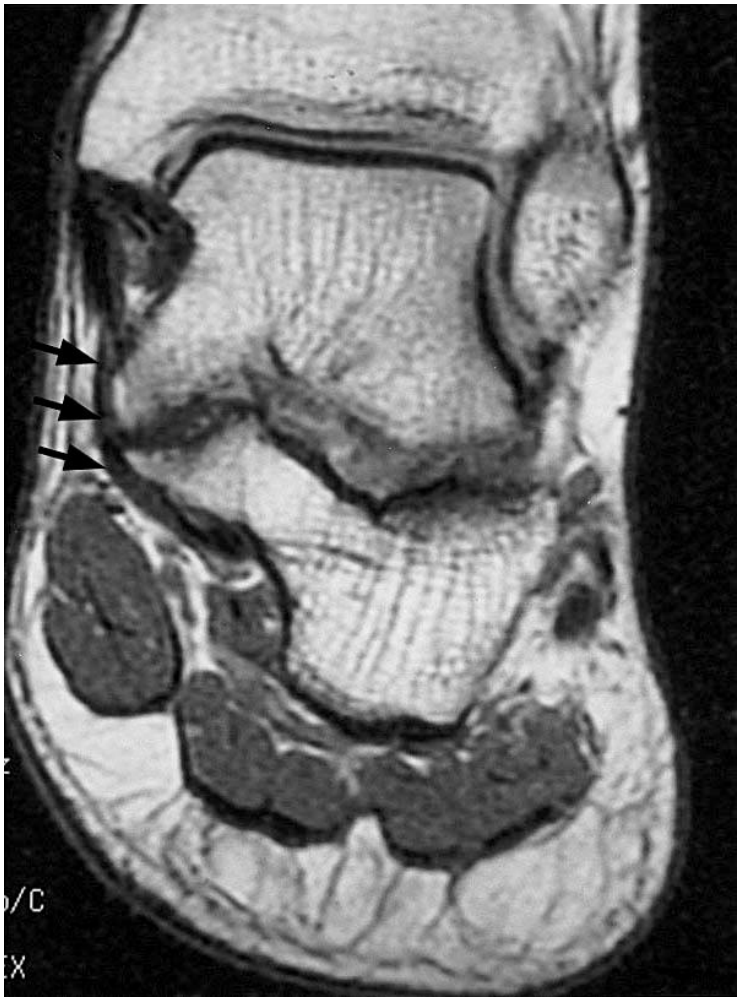
Classifications

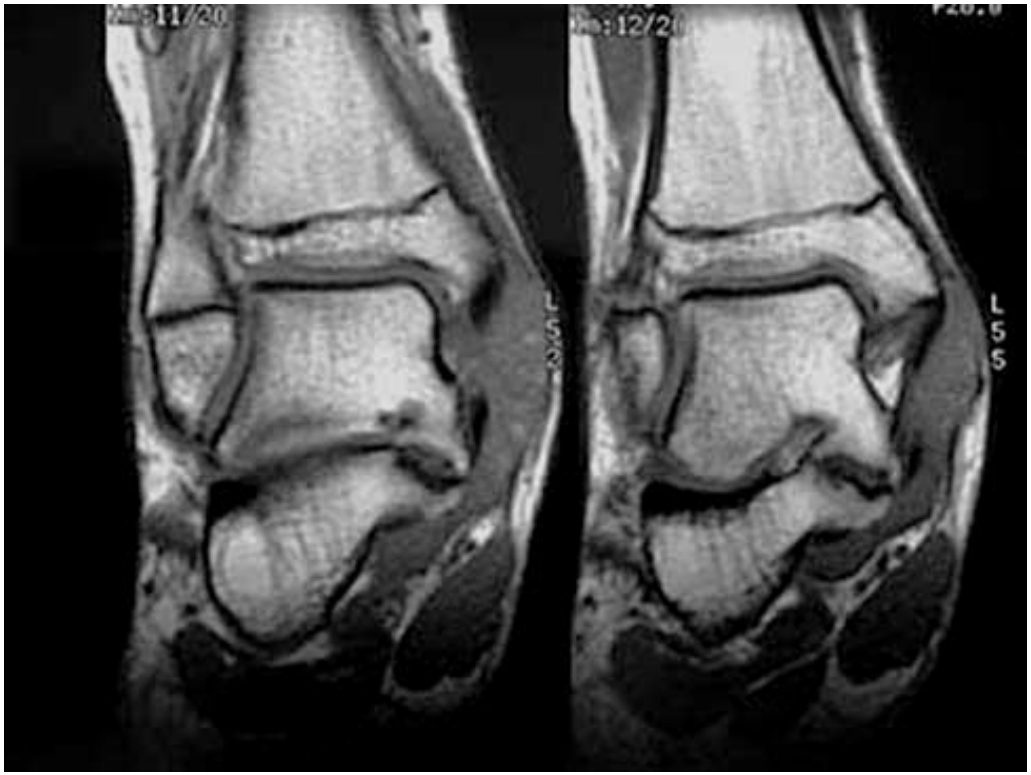
- Tarsal coalitions have been classified in the literature as being:
  - Congenital or acquired
  - Complete or incomplete
  - Intra-articular or extra-articular (Buckholtz)
  - Symptomatic or asymptomatic
  - Anatomic location (Downey)

Osseous Type Coalition



Syndesmotic Type

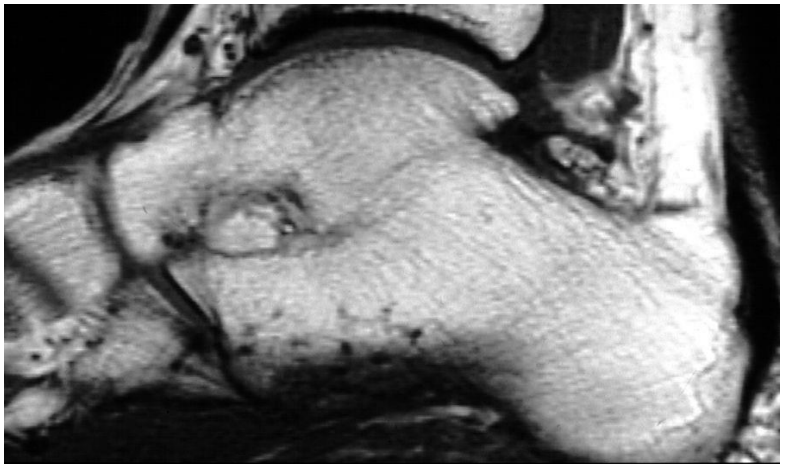




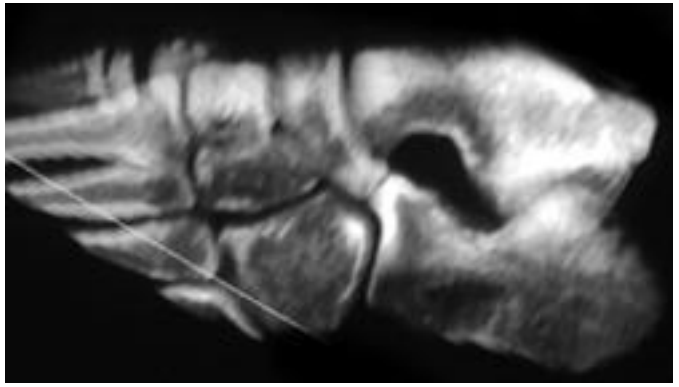
Fibrous Type

Location

- **Intra-articular**
  - May be present between two osseous segments that fuse within an anatomical joint with destruction of the existing joint (TC coalition)

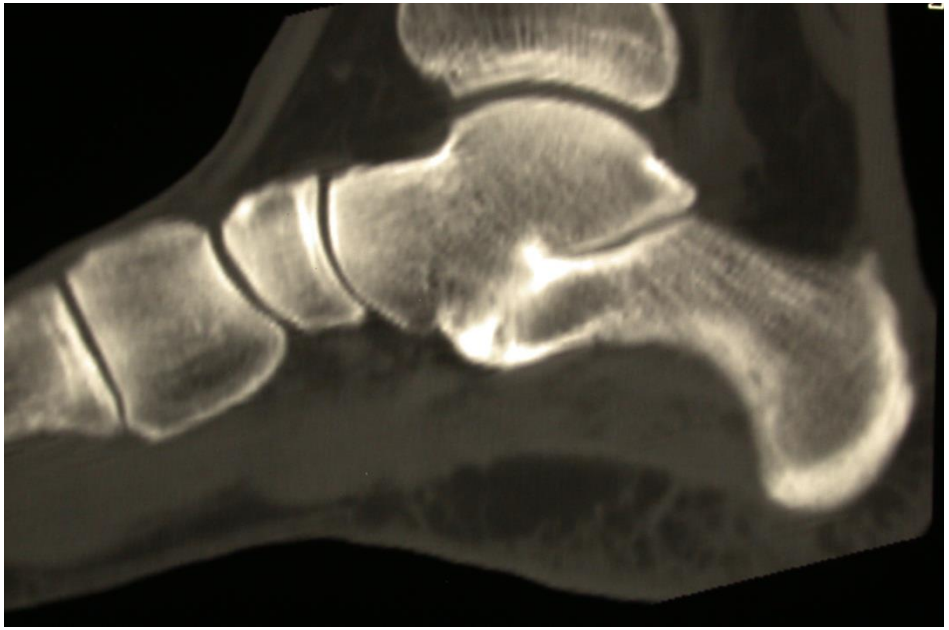


- **Extra-articular**
  - A bar or bridge that fuse two tarsal bones outside an anatomical joint (CN bar)



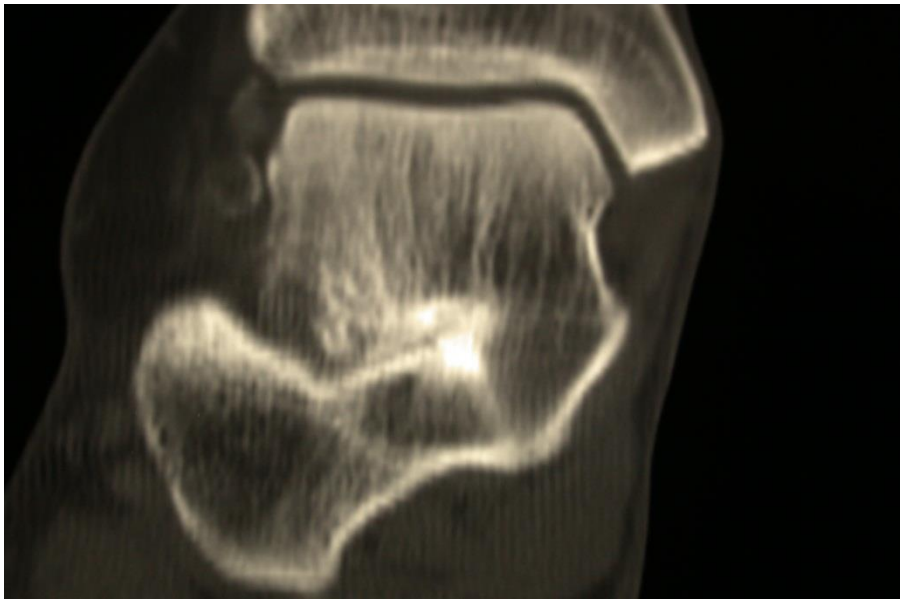
Present Etiology

- Basically, two categories of etiologies are thought today
  - Congenital (90-95%)
  - Acquired



Acquired Coalitions

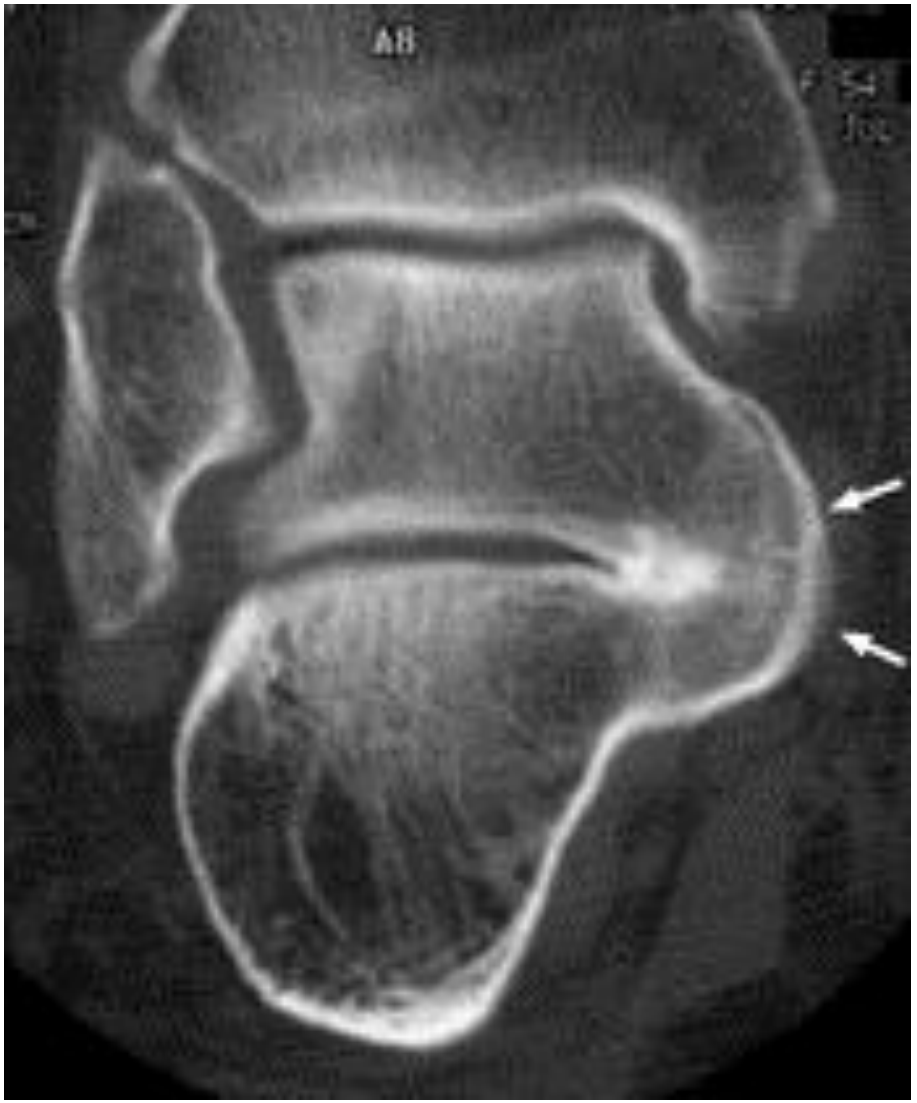
- Traumatic - most common cause of tarsal coalitions (i.e. Essex-Lopresti joint depression fractures)
- Metabolic (i.e. juvenile RA)
- Infectious (i.e. tubercular OA)
- Neoplastic



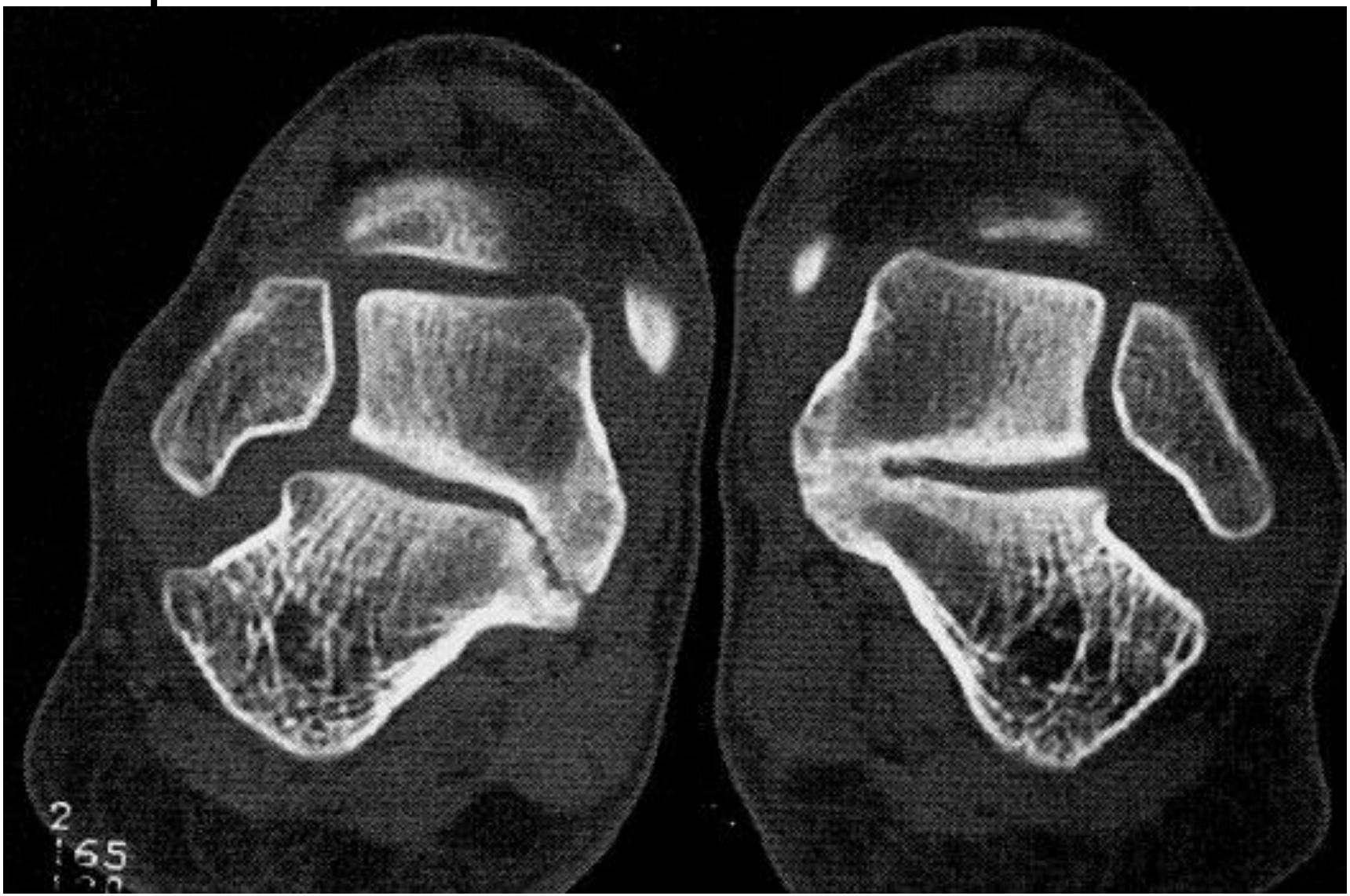
Incidence

- Less than 1- 2% incidence
- No race preference
- 50% bilateral
- Males > females; may due to skewed populations like military recruits
- 90% talocalcaneal & calcaneonavicular coalitions
  - Talocalcaneal coalitions are most common, but often asymptomatic
    - Harris Beath Study
  - Symptomatic Talo-Calcaneal coalitions tend to be middle or anterior facet
  - Calcaneo-Navicular coalitions are the most common symptomatic coalitions
- 9% talonavicular & 1% other
- No literature reporting talocuboid coalition

Talocalcaneal Coalition



Medial Facet Coalition



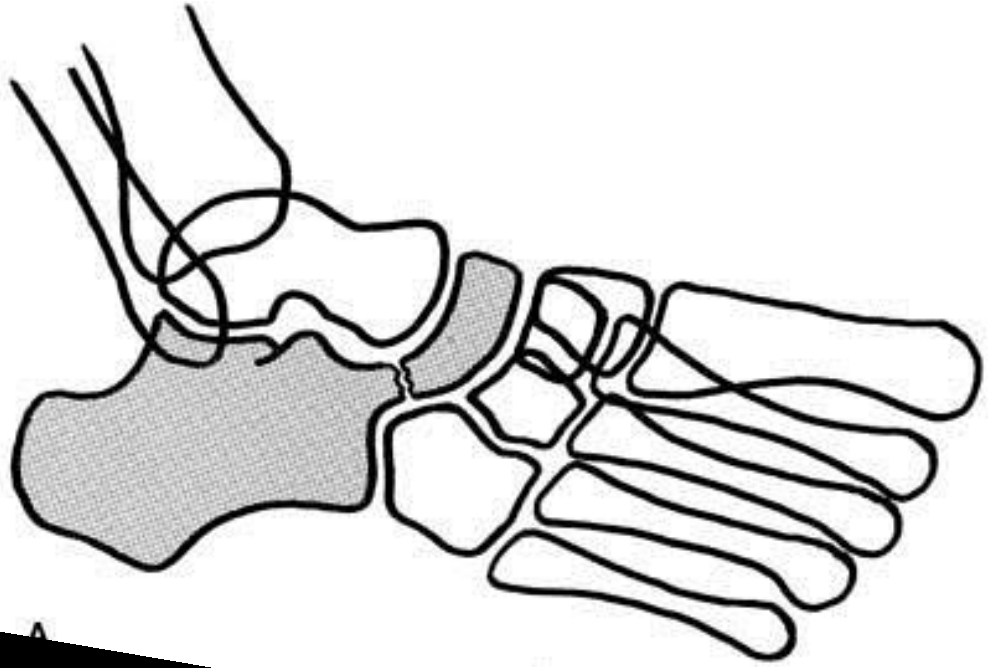
Talocalcaneal Coalition

Normal STJ Joint

Abnormal STJ Joint

Calcaneonavicular

CN Bar



Talonavicular Coalition

Talonavicular Coalition

Associated Disorders with Coalition

- Symphalangism = ankylosis of phalangeal joints
- Simon (1994 : J. Ped. Ortho.) - 34% clubfoot patients have tarsal coalitions
- Peroneal spastic flatfoot
  - Esp. Calcaneo-Navicular
- Simmons (1965) - "tibialis spastic varus feet”
- Tibial dysplasia
- Lower bone densities than normal patients

Clinical Findings

- Clinical appearance of tarsal coalition is variable
- 20% asymptomatic & incidental finding on X-ray (Jack et al)
- Pain related to onset of age: TN->CN->TC
  - TN : 3-5 years
  - CN : 8-12 years
  - TC : 12-16 years
- Insidious onset most commonly

Clinical Findings

- Some patients recall traumatic event to beginning of pain, i.e. ankle sprain
- Aching sensation localized to area
- Pain increased with activity & decreased with rest
- Limited motion and decreased TROM at STJ
- Muscle spasm - peroneal spasm or anterior tibial spasm

Diagnosis

- Harris & Beath:
  - Conventional radiograph
- Isherwood:
  - Internal oblique view (difficult to reproduce)
- Conway & Cowell:
  - Tomograms (difficult to interpret)
- Goldman:
  - Bone scintigraphy
  - Non-specific and no detail

Diagnosis

- Reshick:
  - Arthrograms (invasive & difficult to interpret)
- Smith & Staple (1983) :
  - Computed tomography study of choice
  - Coronal plane for STJ coalitions
  - Transverse plane for talonavicular & calcaneocuboid coalitions
- Jay (1990):
  - MRI study of choice
- STJ Range of Motion (< 10°) (Weed, Seibel)

Radiographic Signs

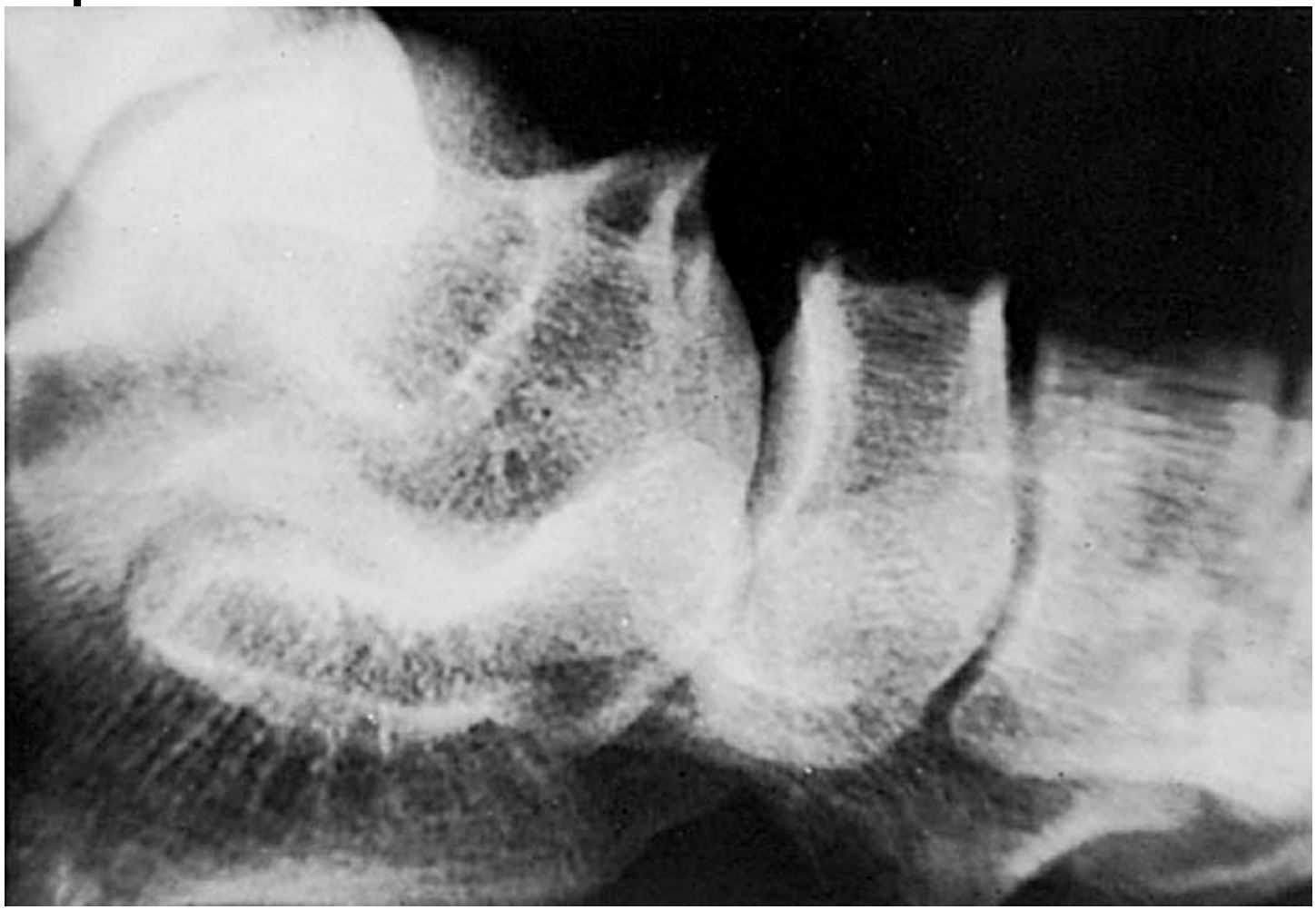
Talo-Calcaneal

- Anterior superior talonavicular joint beaking
- Halo effect of talocalcaneal articulation
- Flattening & broadening of lateral talar process
- Loss of STJ clarity via loss of middle and posterior STJ's
- Ball-and-socket ankle joint

Calcaneal-Navicular

- Anteater sign
- Comma sign

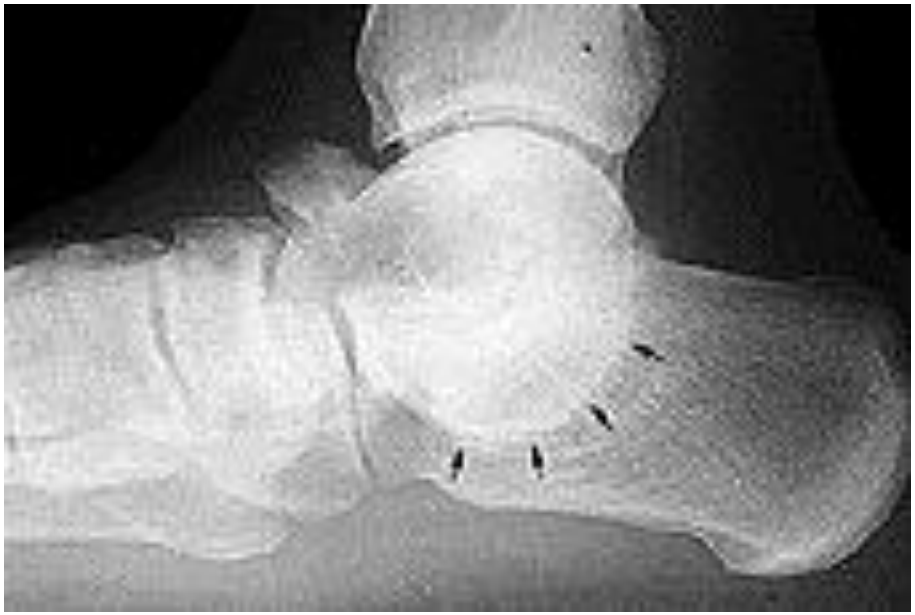
Talonavicular Beaking



Halo SignHalo Sign

Normal Lateral

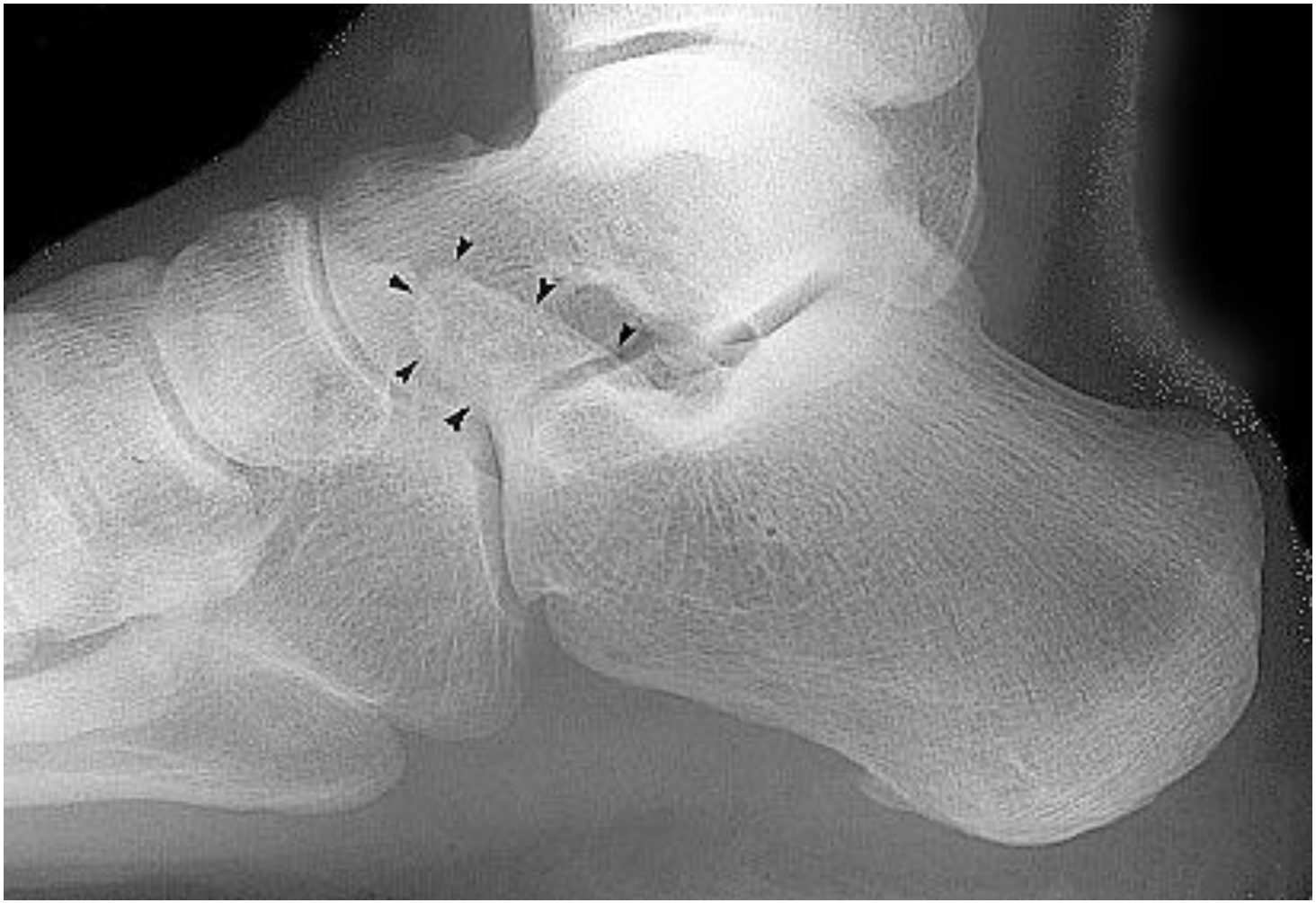
Abnormal Lateral



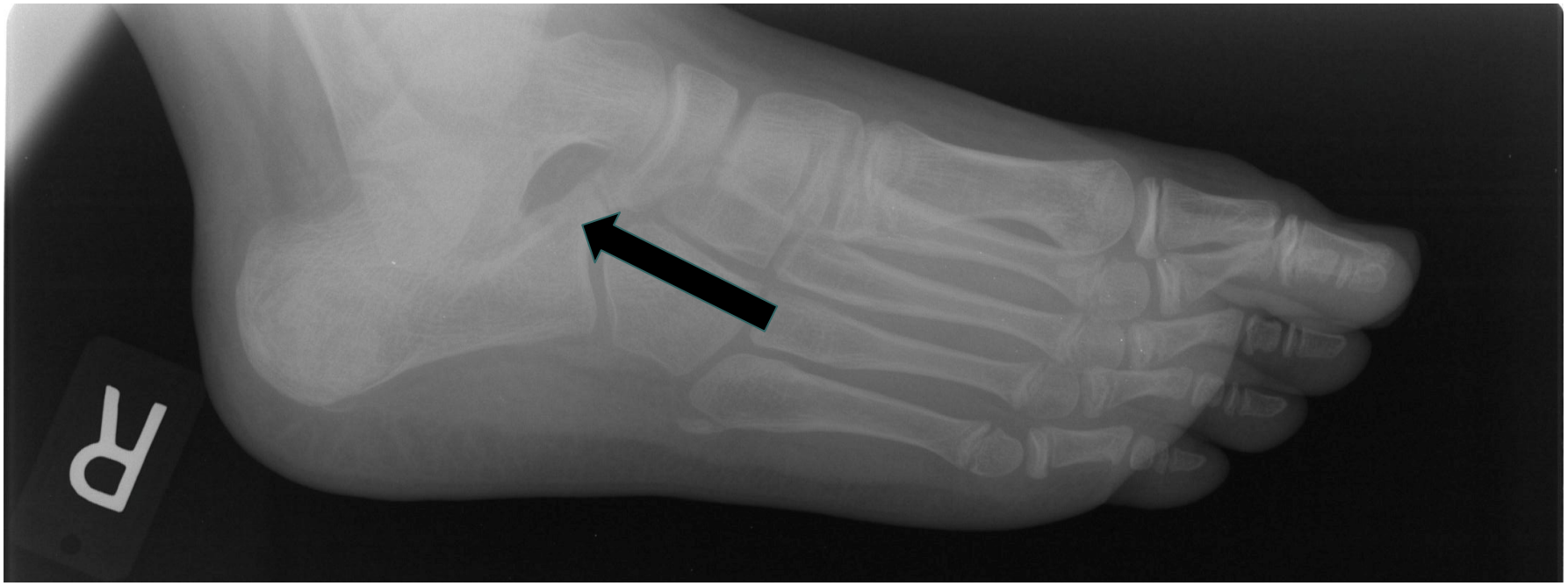
Loss of STJ Clarity

Ball-and-Socket Joint

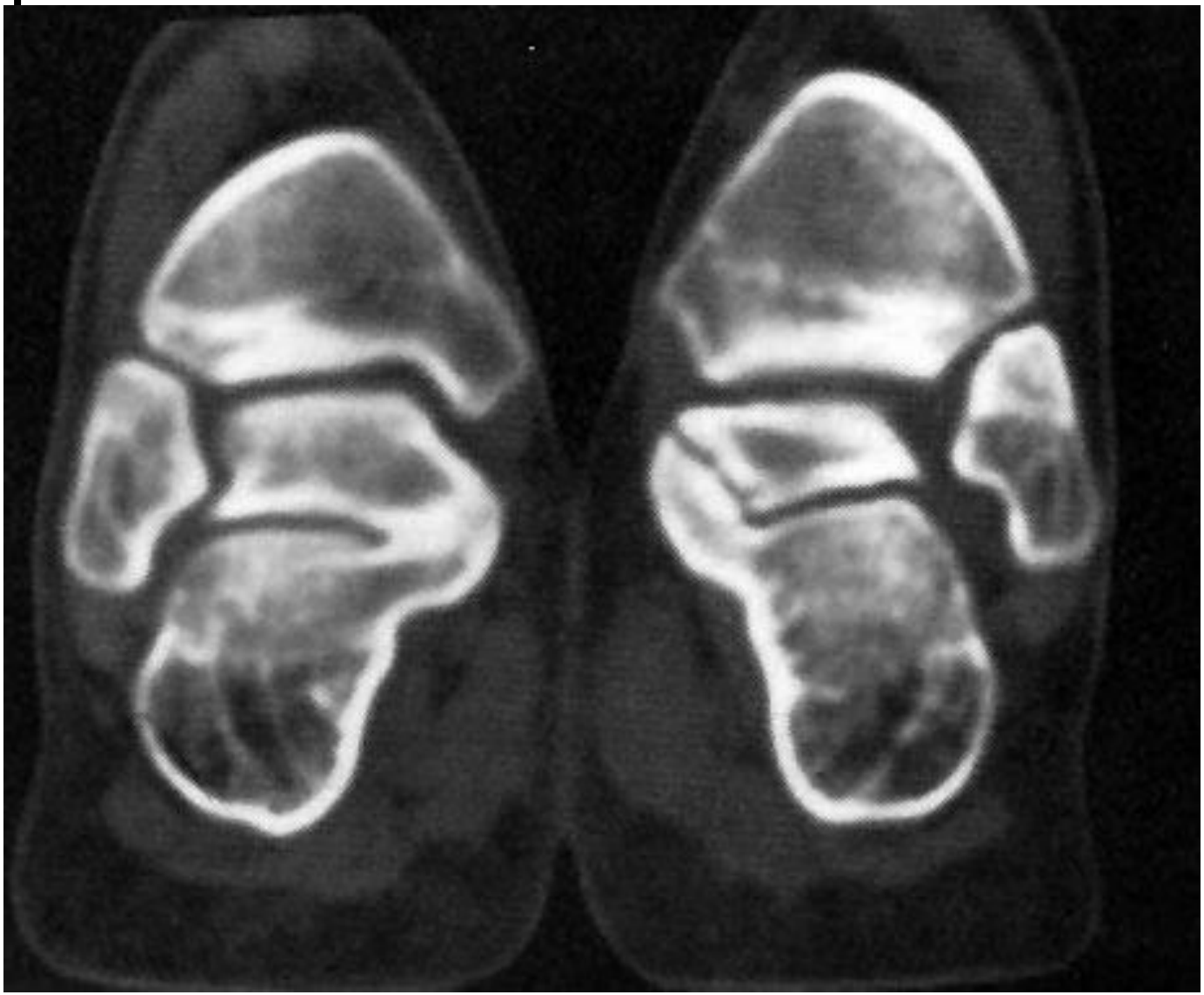
Anteater Sign



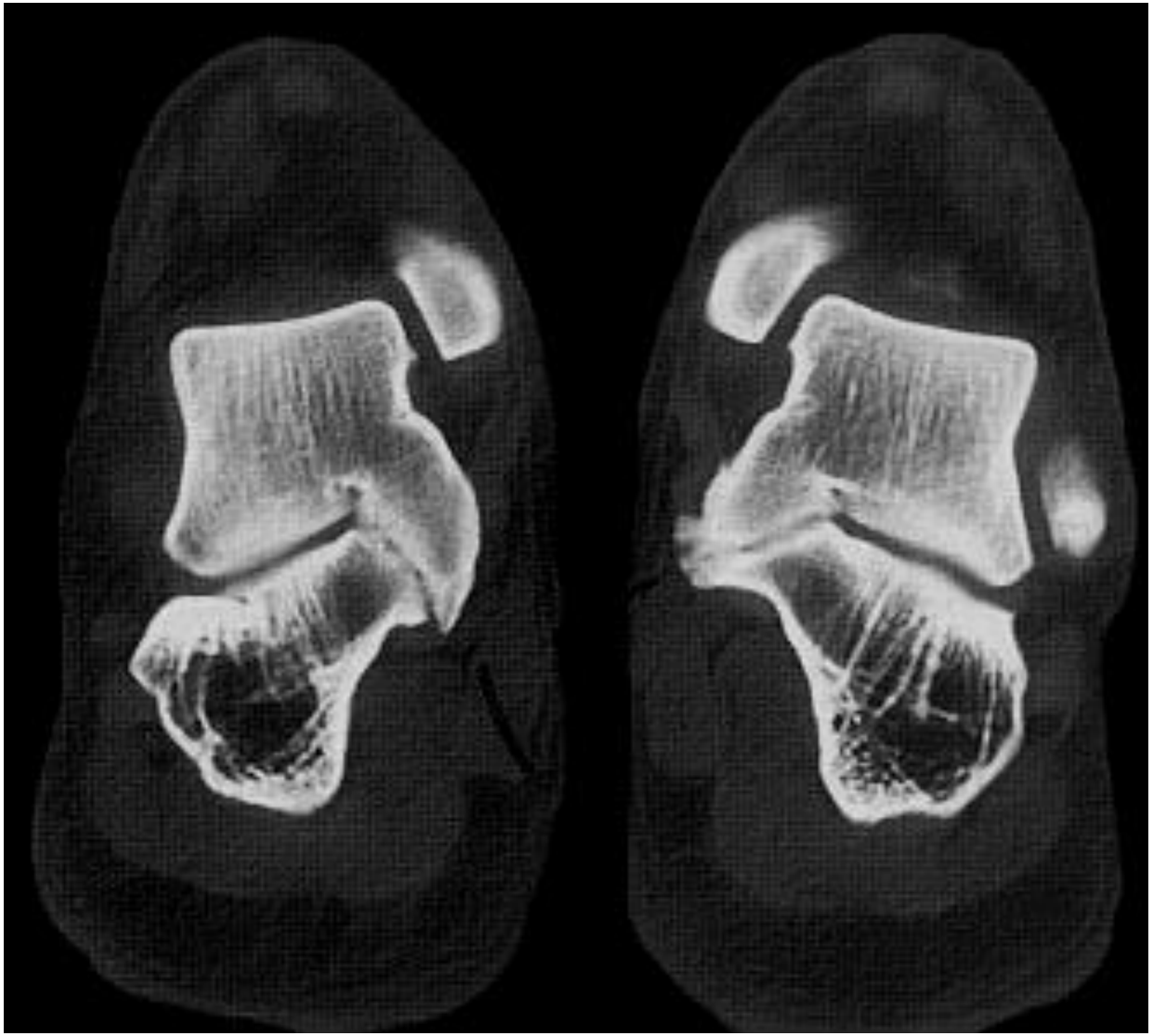
Comma Sign



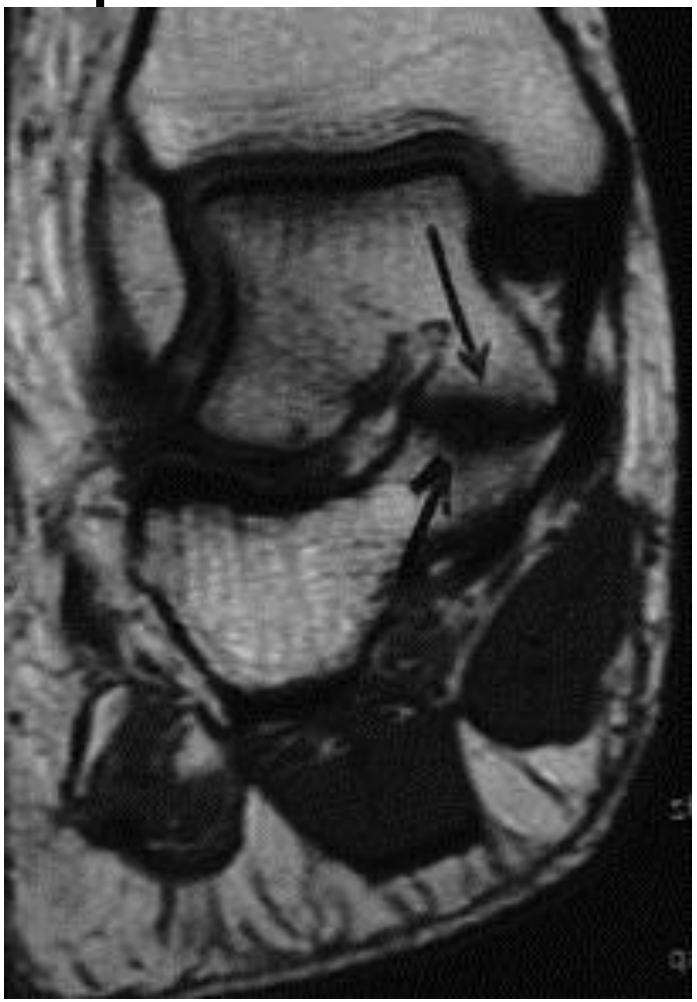
CT Scan



CT Scan



MRI

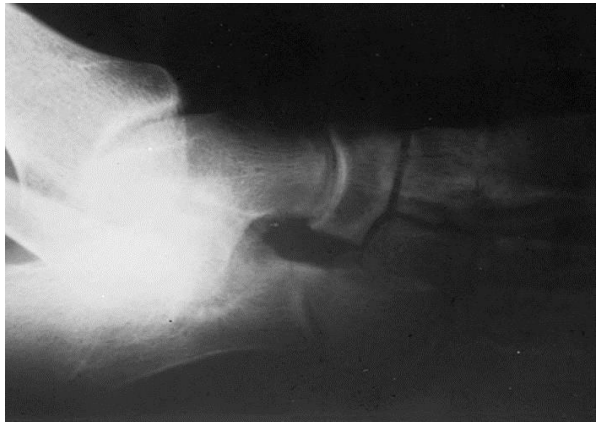


Conservative Treatment

- Conservative treatment of tarsal coalitions basically has gone unchanged for many years
  - All attempts are geared to decrease motion of the painful joints
- Orthotic devices with flat posts or long posts to decrease STJ motion
- BK casting 3 to 6 weeks
- NSAID’s
- Intra-articular steroid injections
- Physical therapy

Surgical Treatment

- C-N Bar
  - Badgley bar resection
- T-C Coalition
  - Triple arthrodesis
  - Middle facet bridge resection
  - Fat pad tarsi arthroeresis
  - STJ fusion interpostion
  - Resection with sinus
  - Grice-Green extra-articular arthrodesis
  - Resection with extra-articular arthrodesis



Talipes Calcaneovalgus

- Most common congenital foot malformation
  - Postural deformity
  - Present at birth
- Characterized by marked dorsiflexion and valgus position of the foot in relation to the leg
- Most cases, the deformity is highly responsive to conservative therapy consisting of manipulation and serial casting

Clinical Description

- Dorsal surface of the foot is resting or in close proximity with the anterolateral surface of the leg
  - Foot is “up and out”
- Limitation of both plantarflexion and inversion
- Difficult to bring the foot into a neutral position
- Concavity over the sinus tarsi
- Redundant skin folds laterally that blanch upon inversion
- Medial ankle skin will appear stretched and taut

Etiology of TCV

- **Extrinsic factors**:
  - Fetal position – usually breech birth
  - Tight uterus
  - Sleeping habits
  - Sitting position – reverse “W”
  - Early walking or crawling
- **Intrinsic factors**:
  - Neuromuscular
  - Ligamentous laxity syndromes

DP View Findings

- Midtarsal joint generally demonstrates altered alignment due to the valgus position of the foot
- Increase in the talocalcaneal angle
- Decreased talonavicular congruity
- Medial angulation of the talar head and neck

Lateral View Findings

- Plantarflexion of the talus
  - Not true plantar flexion but rather manifestation of the remaining portion of the foot being in a dorsiflexed attitude with respect to the talus
- Talar bisection will fall inferior to the plantar aspect of the cuboid
- Significant dorsiflexion of the calcaneus
- Superimposition of the metatarsal bones

Differential Diagnosis

- Congenital vertical talus
  - “Rocker bottom flatfoot deformity”
- Congenital medial posterior bowing of the tibia (Congenital Tibial Pseudoarthrosis).
- Spinal dysraphism
  - Meningomyelocele

VT Versus TCV: Difference

VT Findings

- Foot is at 90° with respect to the leg or in a position of equinus
- Calcaneus is in a position of equinus
- Often can not reduce to neutral position

TCV Findings

- Foot in a marked dorsiflexion and contact with leg
- Calcaneus is dorsiflexed
- Valgus alignment of the heel

Conservative Treatment

- Dependent upon severity of the deformity followed by diagnosis and the degree of flexibility or rigidity

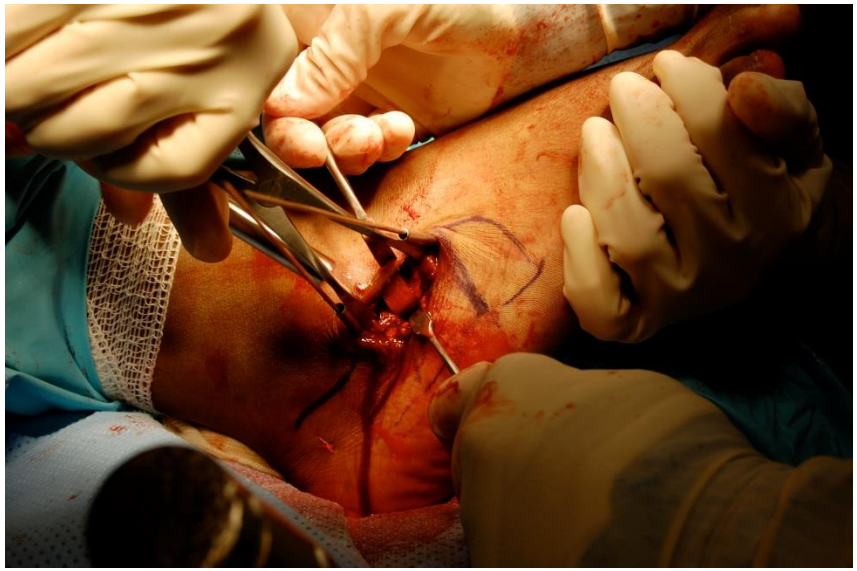
- For mild-to-moderate deformity:
  - Daily passive manipulation and stretching exercises
  - Plantarflexion and inversion manipulation of the foot to a neutral position
  - Should be performed by the parents several times daily
  - All of the manipulation is to stretch and lengthen the short anterolateral and dorsolateral structures of the foot, ankle and leg (*i.e.*, tendon, capsule, ligaments, skin)
  - Exercises should be performed 20 to 30 times in four daily sessions

Conservative Treatment

- For severe cases of TCV
  - Require serial casting in addition to manipulation
  - Always perform manipulation first
- Never correct deformity on first visit
  - Danger of skin necrosis to the dorsum of the foot due to the extreme contracture of the skin
- Cast should be changed at 1-week intervals
- Several months of casting may be required until satisfactory and complete correction is achieved

Surgical Treatment

- Only for residual deformity
- Evans advocated the use of a calcaneal osteotomy with insertion of a bone graft for the correction of this deformity
- lateral column lengthening by transverse osteotomy in the calcaneus 1.5 cm proximal and parallel to the calcaneocuboid joint.
- Soft tissue tendon lengthening and releases are also recommended



Pediatric Flatfoot

- Lay term used to describe a group of conditions whose common feature is a flattened medial longitudinal arch
- All early walkers present with a flatfoot
- Persistent flatfoot with symptoms (including other areas, i.e. hip,knee)

Pes Valgus Deformities

- Pes Valgus deformity
  - everted heel position
  - abduction of the forefoot
  - collapse of the medial column

- Patient's foot is maximally pronated thru the gait cycle with little supination. Ankle equinus is often present.

- Compensation occurs with early heel off, and collapse of the medial column.

Biomechanics

- Pes Valgus Deformity consists of a maximally pronated STJ during WB

- In Pes Valgus the STJ is pronated with the calcaneus everted
  - **the T-N** + C**-C joints become divergent from each other with their axes being parallel**.

Pediatric Flatfoot

- Two types
  - Structural flatfoot
  - Functional flatfoot

Structural Flatfoot

- Tarsal Coalition
- Congenital Vertical Talus
- Arthritides
- Trauma
- Iatrogenic

Structural Flatfoot

- The most important types in this category are:
  - Congenital vertical talus (CVT)
  - Tarsal coaltions

Functional Flatfoot

- Ligamentous Laxity
  - Ehlers-Danlos Syndrome
  - Marfan’s Syndrome
- Accessory Tarsal Navicular
- Os Tibiale Externum
- Compensatory (knee, hip, etc)
- Neuropathy

Functional Flatfoot

- Myopathy
- Muscle Spasm
- Congenital pes calcaneovalgus

Functional Flatfoot

- These foot types function with a flattened medial longitudinal arch but have sufficient form to retain an arch when non-weight bearing are extremely common in children

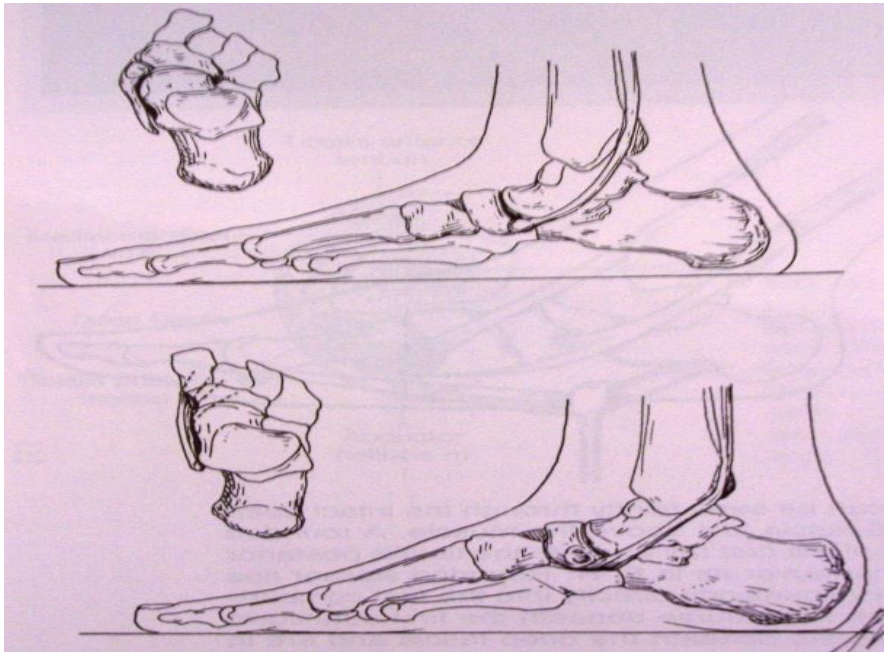
Conservative Treatment

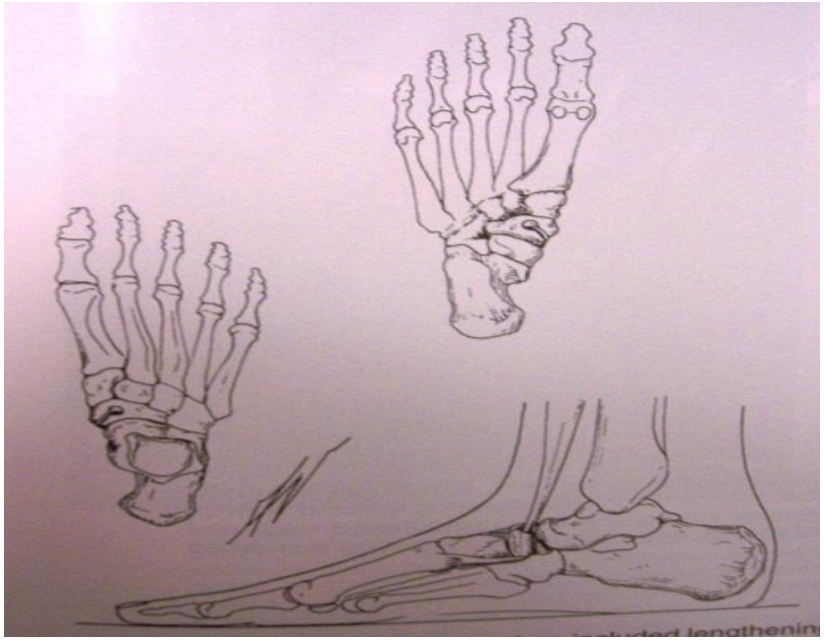
- Congenital **Calcaneovalgus-** (limited plantarflexion of the ankle joint and everted positioning of the foot) most common forerunner of Pes Valgus

  - **Pediatrics (>1yr old) – Casting** performed with forefoot and ankle in equinus and rearfoot in an inverted position.
  - **Splinting** is performed after casting to maintain corrected position.(Ganley Splints)
  - **Peds(1-3yrs)**- Ganley splints can be used at night (not feasible for WB). Orthotic and Shoe management used for WB.
  - **Peds(3yr- adolescence)**- Splinting at night, use of orthotics for WB.

Soft Tissue Procedures

- Most soft tissue procedures for correction of pes plano valgus deformity are specific for the medial column.
  - Kidner Procedure
    - resection of the accessory navicular/tuberosity, as well as transposition of the insertion of the tibialis posterior tendon to the underside of the navicular.
  - Young Procedure
    - Lengthening of the Achilles tendon, rerouting of the tibialis anterior tendon through a slot in the navicular without detaching the tendon from its insertion, tibialis posterior reattachment beneath the navicular.





Osseous Procedures Medial Column

- **Hoke Arthrodesis**
  - Fusion of the navicular to the medial and middle cuneiforms, in conjunction with an Achilles tendon lengthening. The procedure has fallen out of favor.

- **Talonavicuar Arthrodesis**
  - Fusion of the T-N joint provides effective limitation of pathologic motion by blocking all MTJ motion and nearly all STJ motion. Can be used in conjunction with Evan's calcaneal osteotomy to reduce forefoot supinatus. An Achilles tendon lengthening can be done to combat ankle equinus.

- **Subtalar Joint Arthroereisis**
  - The concept is to block or limit excessive STJ motion. Limitation of STJ motion is a1chieved by an implant inserted into the sinus tarsi. The implant limits plantarflexion and medial displacement of the talus.

Calcaneal Osteotomies

- **Extra-articular Osteotomies**
  - should be reserved for situations in which the use of an arthroereisis would be inappropriate, or when an arthroereisis may be insufficient to produce the desired correction. (eg **Baker-Hill Procedure)**

- **Anterior Calcaneal Osteotomy**
  - **The Evans osteotomy is the preferred choice for transverse plane dominant pes valgus deformity. This procedure preserves joint motion achieves correction in the transverse plane, limits excessive heel valgus, and provides stability of the both rearfoot and midfoot.**

- **Posterior Osteotomies**
  - Useful in the least prevalent type of pes valgus deformity- the frontal plane dominant foot. These procedures shift the ratio of available supination to pronation in the STJ in favor of pronation. They can also be used in conjunction with medial column procedures.

Extra-articular Osteotomies

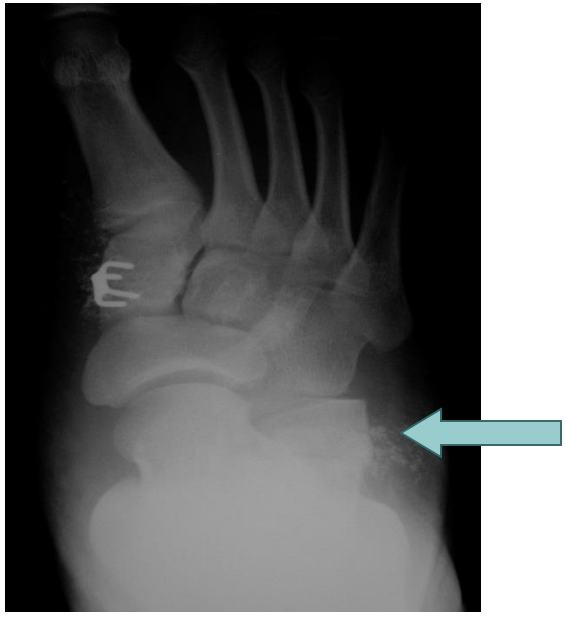
- **Chambers Procedure**
  - Placing of bone graft under the sinus tarsi to block translocation of the talus on the calcaneus. Often used with an Achilles tendon lengthening. This procedure is rarely performed today.

- **Selakovich Procedure**
  - Opening wedge osteotomy of the sustentaculum tali. Tightening of the redundant spring ligament as well as re-positioning of the TP can accompany procedure.

- **Verticolateral approach** to perform a horizontal osteotomy inferior to the posterior facet of the STJ.

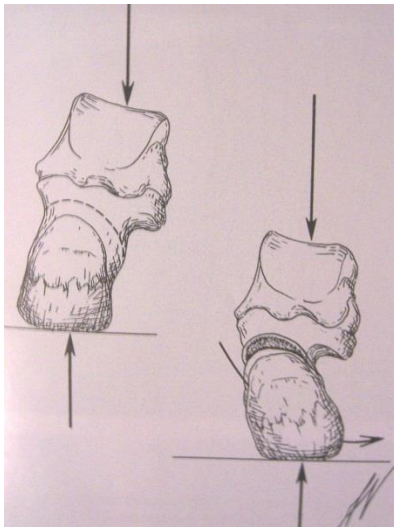
Anterior Calcaneal Osteotomy

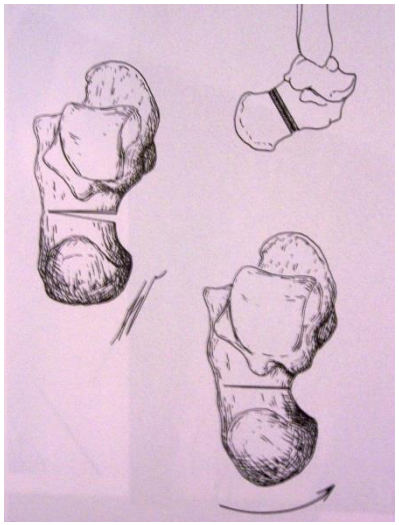
- **Evans Procedure**
  - Linear incision over the C-C joint with an osteotomy of the calcaneus parallel and 1.5cm proximal to the C-C joint. Bone graft is inserted to lengthening the lateral column and re-alignment of the MTJ.



Posterior Osteotomies

- **Varus-Producing Osteotomies**
  - **Dwyer Procedure**
    - medial closing base wedge osteotomy. It is more commonly performed as a lateral opening wedge with bone graft.
  - **Silver Procedure**: lateral opening base wedge with graft.
- **Medial Displacement Osteotomy**
  - **Koutsogiannis Procedure**
    - transpositional osteotomy with fragment shifted medially. This procedure increases the supinatory moment arm of the Achilles.





Rearfoot Arthrodesis

- Arthrodesis is used in cases of severe degenerative join disease
  - 3-plane deformity with pain
  - paralytic deformity
  - tarsal coalitions (intra-articular)
  - rupture of the TP tendon

- Less common due to sophistication of the calcaneal osteotomy, arthroereisis, and muscle tendon balancing.

Pediatric HAV

- Recognition and non-surgical Management
- Epiphysiodeses not reliable
- Avoid Open Growth plates

12 y/o with Juvenile HAV

Pediatric HAV

- Recognition and non-surgical Management
- Epiphysiodeses
- Avoid Open Growth plates

12 y/o with Juvenile HAV

Juvenile Hallux Valgus

- Heredity
  - -Coughlin 72% Family history with a presence of maternal transmission
- More common in flexible pronated foot
- Important to remember
- Bunion < 10 y/o = Inherited
- Open Epiphysis
  - Girls until 14 years old
  - Boys until 16 years old

  - Pique-Vidal C, et al. Halluxvalgusinheritance: Pedigree research in 350 patients with bunion deformity. JFAS 46(3):149-154, 2007.

Juvenile Hallux Valgus

- Radiographic Evaluation
- WB DP, Lateral and Sesamoid Axial
- IM, MA, Hallux Abductus and Sesamoid position
- Metatarsal shape, Interphalangeal sesamoid position, First metatarsal length, Accessory Bones

Pediatric Radiology: DP Angles

Angles	Birth	6-9 years	Adult
IMA	12°	10°	8-10°
Engel	30°	25°	Less than 21°
MA	25-30°	15-25°	Less than 15°
Talocalcaneal (Kite's Angle)	40-50°	20-40°	20-25°
Talar-First Metatarsal	Slightly medial	Parallel	Parallel

Pediatric Radiology: Lateral Angles

Angles	Birth	6-9 years	Adult
Tibiocalcaneal	70-75°	65°	55°
Talar Declination	Slightly above 1st metatarsal	Parallel	21°
Calcaneal Inclination	10-15°	15-20°	Less than 21°
Talocalcaneal	35-50°	30-40°	25-30°

Juvenile Hallux Valgus

Juvenile Hallux Valgus

Juvenile Hallux Valgus

- Conservative Care Options
- Orthotics
  - Control of pronatory forces
- Shoe Selection
  - Fit and Function
- If Flexible; Treatment with Toe Spacers ????
  - Compliance

Juvenile Hallux Valgus

- Relationship with Metatarsus Adductus
- Ferrari et al: overview of 100 xrays and found a combined Met Adductus in 55% of the pateints

- Ferrari J et al. A radiographic study of the relati onship between metatarsus adductusand hall uxvalgus. JFAS 42(1):9-14, 2003.

Juvenile Hallux valgus

- Indications for Surgery
  - Pain
  - Significant Deformity
  - Chronic Paronychia
  - Treatment of Global Pathology

Juvenile Hallux Valgus

- Contraindications
- Patient Expectation
- “I don’t like the way it looks”
- That includes the parents
- Beware of patient status and if both parents are involved
- Infection

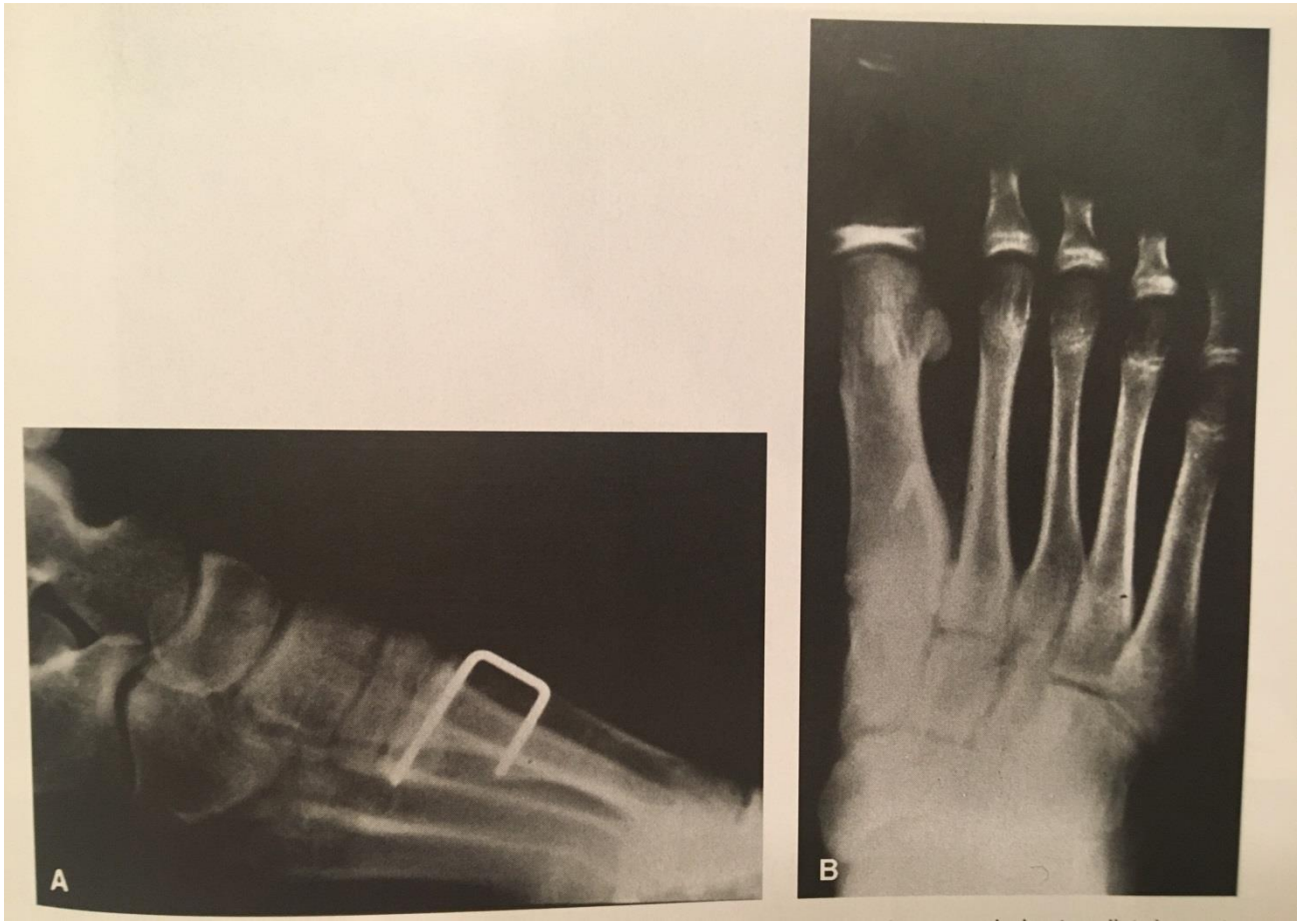
Juvenile Hallux valgus

- Procedure Options
- **Distal**
- Austin Bicorrectional
- **Midshaft**
- Opening Base Wedge; Closing Base Wedge
- **Hemiepiphysiodesis**
- Growth Plate Closure
- Timing: Females 10-12 Males 12-14
- **Lapidus**
- Beware of the grwoth plate and hypermobility

Distal Head Procedures

Midshaft

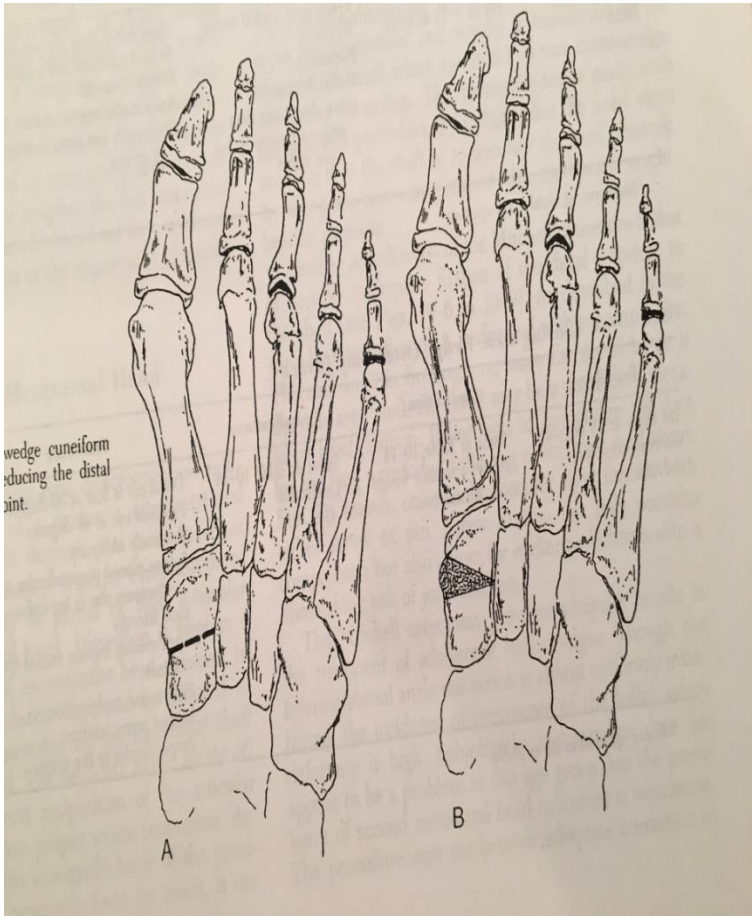
Epihysiodesis



Lapidus

Juvenile Hallux Valgus

- **Opening Wedge of the Cuneiform**
  - Total avoidance of growth plate with reduction of the distal angle of the MC joint
- **Soft Tissue Procedures**
  - Release of the Adductor from base of proximal phalanx with capsulorraphy
  - Recurrence



Congenital Curly Toe

- Very common referral
- Overlapping toes
- Partial or complete syndactyly

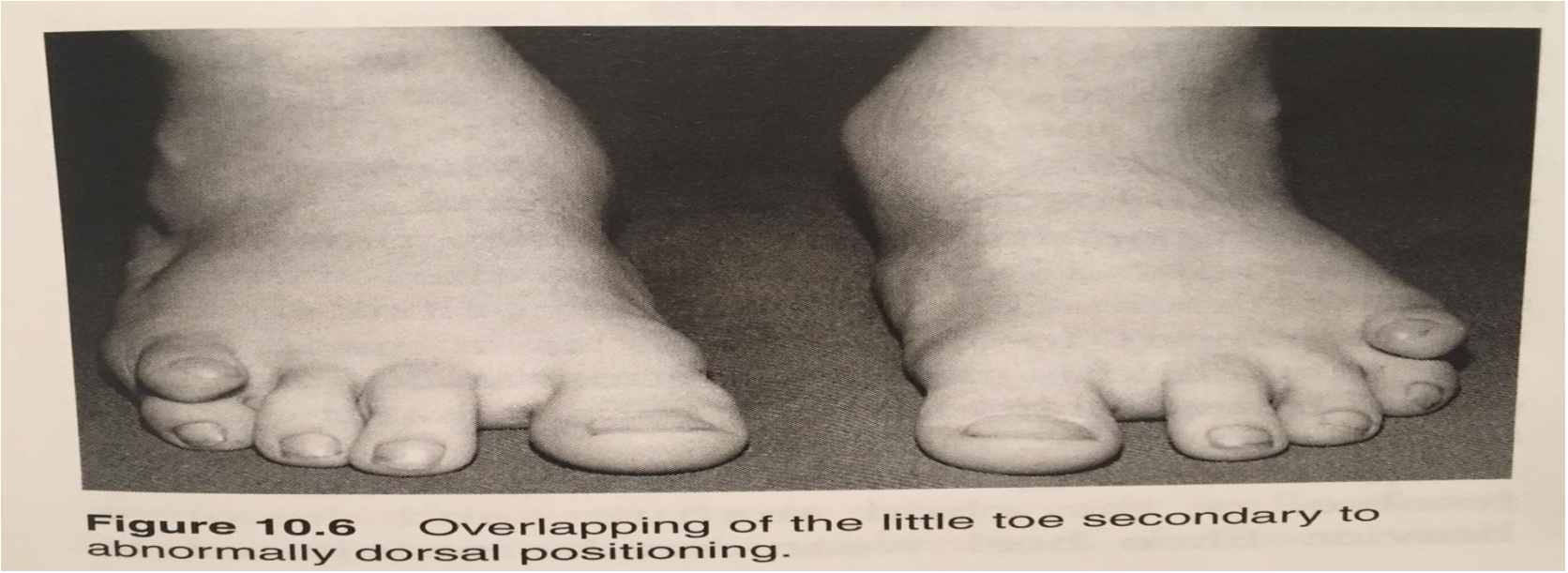


Figure 10.6 Overlapping of the little toe secondary to abnormally dorsal positioning.

Curly Toes

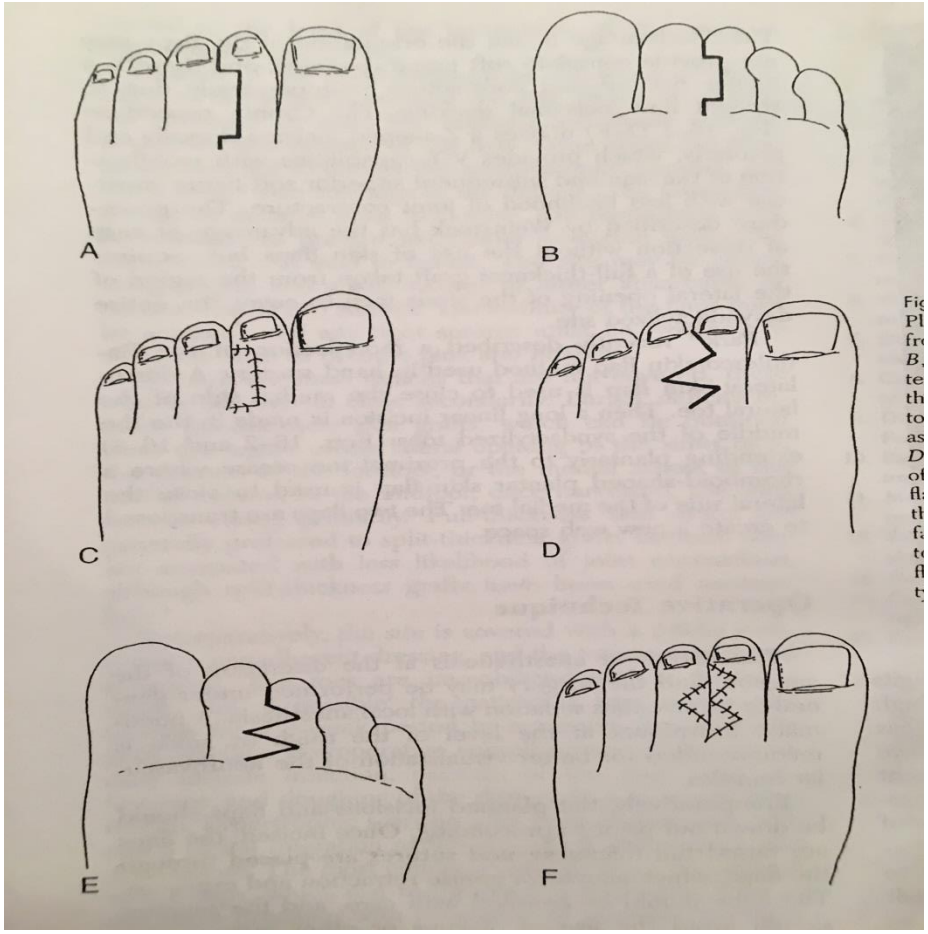
- Mobile vs. Rigid deformity
- Are they causing trauma
- Rarely persists to adulthood
- If in fixed flexion:
  - Treatment:
  - Flexor Tenotomy with pin fixation

Curly Toes

Syndactyly

- Very Common
- Congenital in nature
- May be acquired by trauma
- 1:1000
- Males>females
- Occurs at 6-8 weeks (Remember early lectures)
- No significant functional alteration
- Correction is purely cosmetic

Desyndactylization

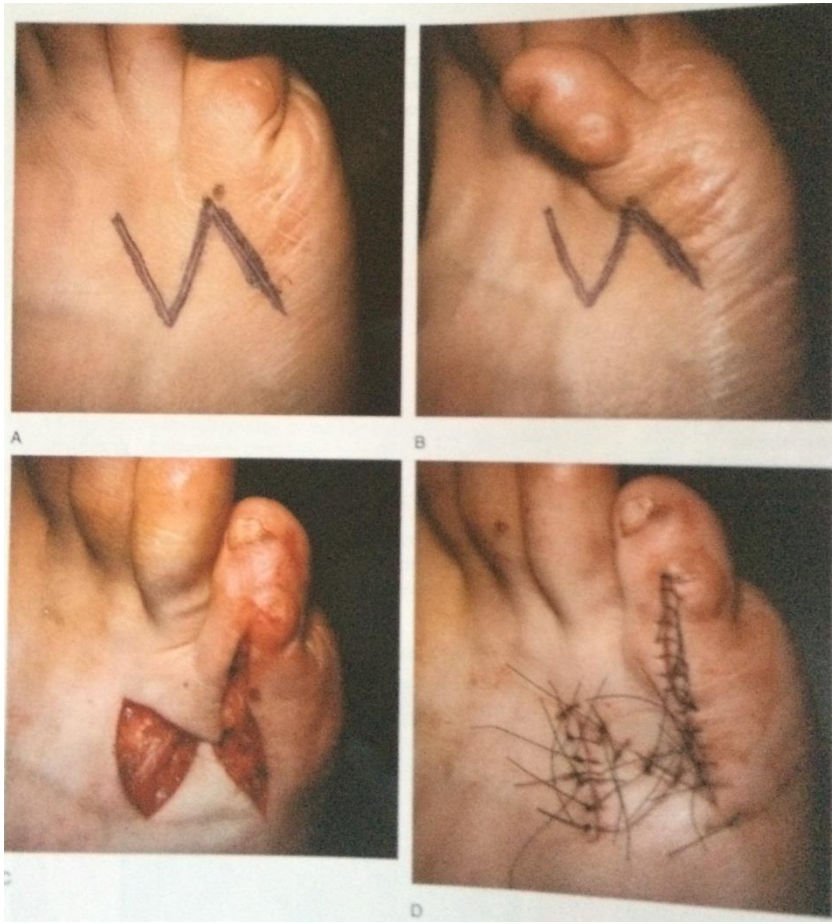


Varus Fifth Digit

- Pain in shoes
- Overlapping abuts the top of the shoes
- Corns and Callouses
- Asses proper reduction
- Function not always improved
- Poor Cosmesis
- Wider Shoes
- Reduction of hammertoe with plastic approach
- Amputation?

Varus Fifth Digit

Varus Fifth Digit



Hammertoes

- Claw Toes
- DF at MPJ; PF at IPJs
- Hammertoe
- DF at MPJ; PF at PIPJ
- Mallet Toe
- PF of DIPJ
- Intrinsic failure of musculature
- Familial?
- Flexor Tenotomy with K-wire in pediatrics

Hammertoes