

When Feet Don't Follow the Blue print: Congenital Anomalies of the Foot

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Learning Objectives

- 1 **Define congenital foot anomalies and understand their embryological basis**
- 2 **Normal Foot Anatomy — Bony Framework**
- 3 **Classify major congenital foot conditions systematically**
- 5 **Appreciate complications and long-term outcomes**

Congenital foot anomalies are structural or functional abnormalities of the foot that are present at birth, resulting from disruption in normal fetal development during pregnancy.

Normal Foot Anatomy — Bony Framework

Understanding normal osseous anatomy is the foundation for recognising deformity

HINDFOOT (2 Bones)

Bones:

- Talus (Astragalus)
- Calcaneus

MIDFOOT (5 Bones)

Bones:

- Navicular
- Cuboid
- 3 Cuneiforms (Med, Int, Lat)

FOREFOOT (19 Bones)

Bones:

- 5 Metatarsals
- 14 Phalanges (2+3+3+3+3)
- 2 Sesamoids (1st MTP)

Total: 26 bones in adult foot | Ossification of all tarsal bones complete by age ~12 years

Normal Foot Anatomy — Joints & Arches

KEY JOINTS

1

Ankle (Talocrural)

Hinge - Plantarflexion / Dorsiflexion

2

Subtalar (Talocalcaneal)

Gliding - Inversion / Eversion

3

Transverse Tarsal (Chopart)

Complex - Supination / Pronation

4

Tarsometatarsal (Lisfranc)

Plane - Limited gliding

5

Metatarsophalangeal (MTP)

Condylloid - Flex/Ext + Ab/Adduction

FOOT ARCHES

Medial Longitudinal Arch

Components: Calcaneus → Talus →
Navicular → Cuneiforms → MT 1–3

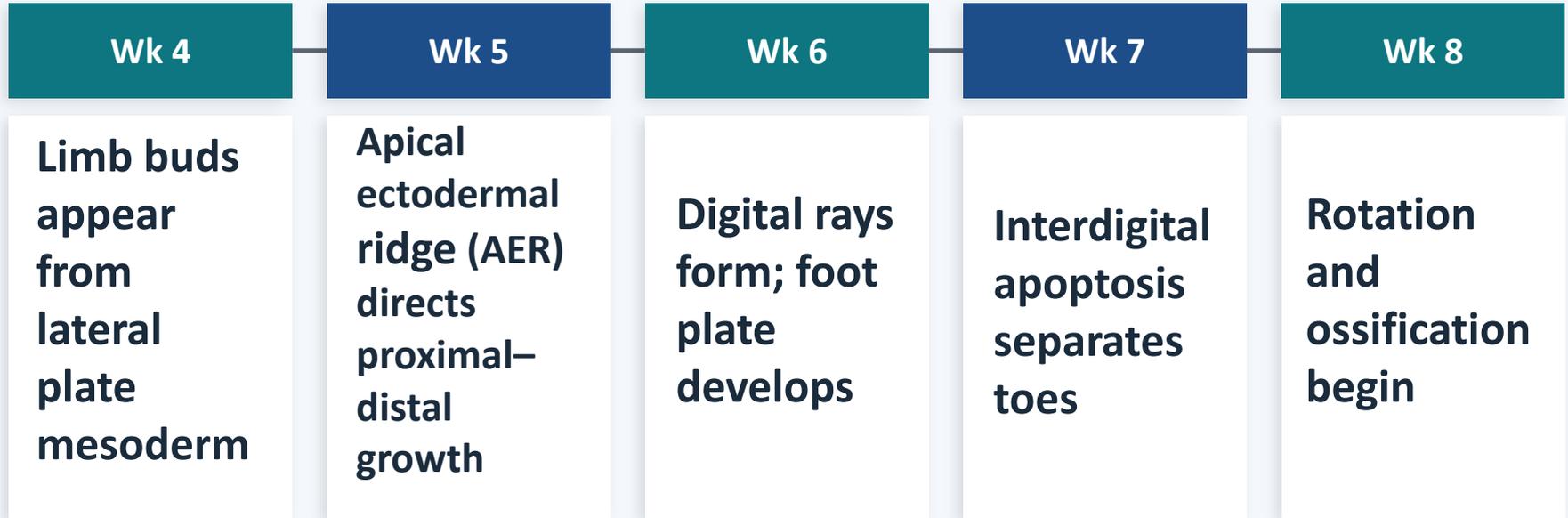
Lateral Longitudinal Arch

Components: Calcaneus → Cuboid → MT
4–5

Transverse Arch

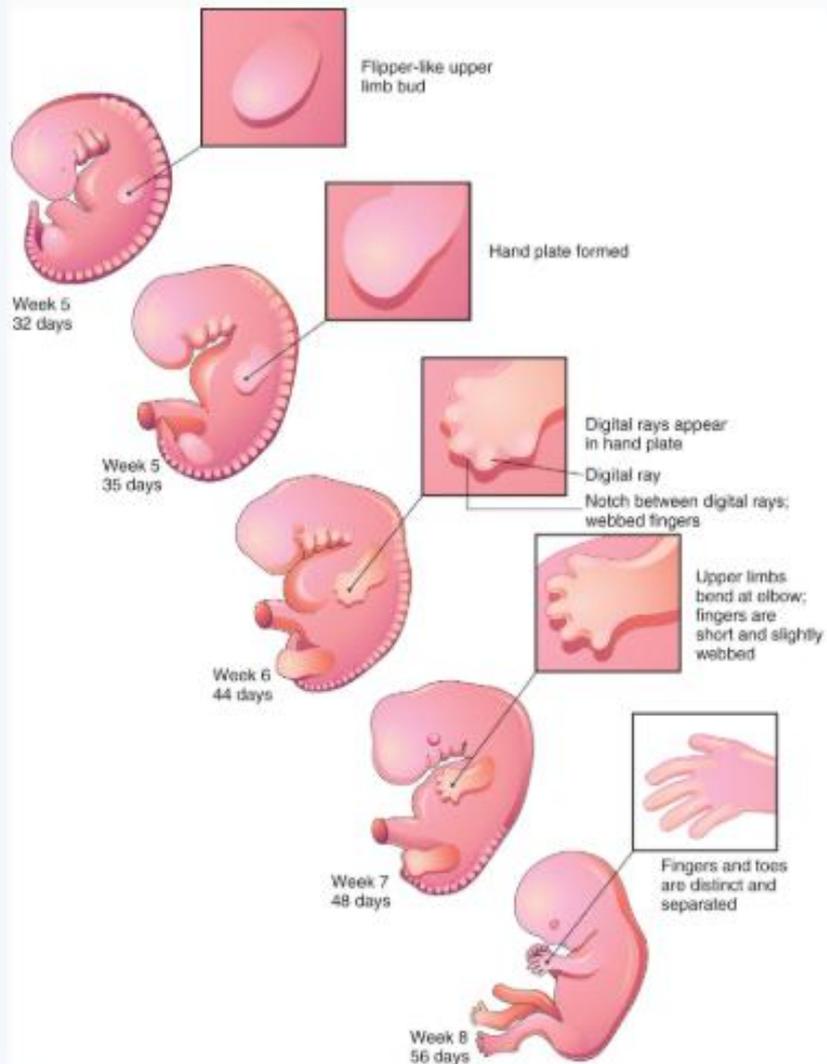
Components: Bases of metatarsals + all 3
cuneiforms + cuboid

Embryological Basis



Disruption at any stage can lead to structural or positional anomalies

Embryological Basis



Wk 8

Embryological Development of the Foot

Disruption of normal developmental sequence → specific anatomical deformity

Wk 4

Limb bud emergence

Anomaly: Absent →
Amelia/Ectromelia

Wk 7

Interdigital apoptosis

Anomaly: Failed apoptosis →
Syndactyly

Wk 5

Foot plate forms

Anomaly: Disrupted ZPA →
Polydactyly

Wk 8

Medial rotation

Anomaly: Arrested rotation →
Clubfoot CTEV

Wk 6

Digital rays appear

Anomaly: Fused rays → **Syndactyly**

Wk 9–12

Ossification begins

Anomaly: Coalition → **Tarsal bars**

Classification of Congenital Foot Anomalies

Positional / Postural

- Calcaneovalgus foot
- Metatarsus adductus
- Positional clubfoot

Structural Deformities

- Congenital vertical talus
- Skewfoot

Ray Anomalies

- Polydactyly
- Syndactyly
- Macrodactyly
- Brachydactyly

Arch Disorders

- Congenital flatfoot
- Cavus foot
- Rocker-bottom foot

Clubfoot (CTEV)—Congenital Talipes Equinovarus

Definition

A complex three-dimensional foot deformity present at birth, characterized by four cardinal components:

- C** **Cavus** — high arch
- A** **Adductus** — forefoot turns inward
- V** **Varus** — hindfoot inversion
- E** **Equinus** — plantarflexed heel

Key Statistics

1 in 1,000

Live births affected

2:1

Male : Female ratio

50%

Cases are bilateral

Idiopathic

Most common type (~80%)

Clubfoot (CTEV)—Congenital Talipes Equinovarus



Pirani Scoring System for Clubfoot

The Pirani score (0–6) guides treatment decisions and monitors response to Ponseti casting.

Sign	Grade 0 (Normal)	Grade 0.5 (Mild)	Grade 1 (Severe)
Curved lateral border	Straight	Mildly curved	Severely curved
Medial crease	Absent	Shallow	Deep
Lateral head of talus	Not palpable	Partially covered	Fully covered
Posterior crease	Absent	Shallow	Deep
Rigid equinus	Absent	Mild	Severe
Empty heel	Normal	Partly empty	Completely empty

Score 0–2: Mild | Score 2–4: Moderate | Score 4–6: Severe (Hindfoot score + Midfoot score = Total)

Congenital Vertical Talus (CVT)

Definition: Irreducible dorsal dislocation of the navicular on the talus, creating a 'rocker-bottom' deformity

Incidence: ~1 in 10,000 live births; bilateral in 50%

Associations: Myelomeningocele, arthrogryposis, trisomies 13, 15, 18

Presentation: Rigid flatfoot; convex plantar surface; tight heel cord

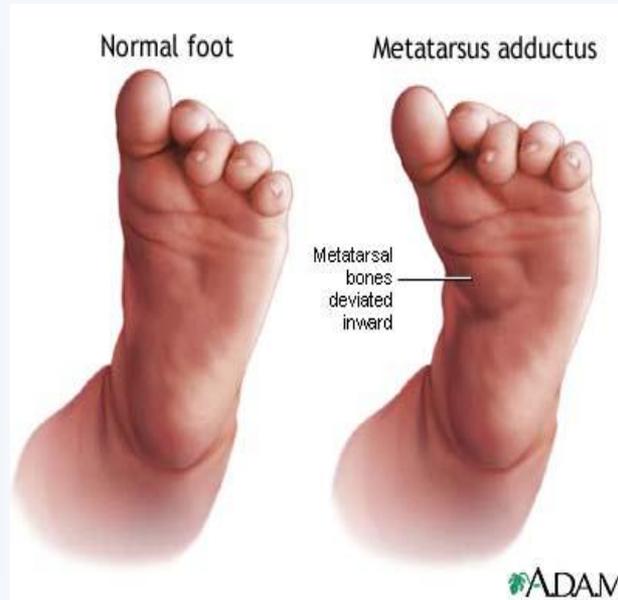


Metatarsus Adductus

Most common congenital foot deformity — forefoot adduction with neutral hindfoot

Etiology & Incidence

- Intrauterine positioning
- 1–2 per 1,000 births
Bilateral in 50%
- More common in firstborn



Natural History

- 90% resolve spontaneously by age 3–4 without treatment

Calcaneovalgus Foot & Positional Deformities

Calcaneovalgus Foot

- Dorsiflexed, everted foot — dorsum touches anterior shin
- Most common positional deformity of newborn
- Caused by intrauterine packaging (oligohydramnios, primiparity)
- Resolves spontaneously in weeks with gentle stretching
- Must exclude posteromedial tibial bowing on X-ray
- Excellent prognosis — no surgery needed



Calcaneovalgus Foot & Positional Deformities



Congenital Curly Toes

- Flexion and medial rotation of lesser toes
- 4th and 5th toes most commonly affected
- Often bilateral and familial
- Rarely symptomatic in childhood
- Conservative: toe stretching, tape splinting
- Surgery (flexor tenotomy) if persistent beyond age 3–5

Polydactyly — Extra Digits

Presence of supernumerary toes; one of the most common congenital limb anomalies:

Preaxial (Tibial)

- Duplication of hallux
- less common
- may be part of syndromes

Central

- 2nd–4th toe duplication
- rarest type
- associated with syndactyly

Postaxial (Fibular)

- Duplication of 5th toe
- most common type
- 8 times more in African Americans

Polydactyly — Extra Digits

Polydactyly (extra fingers or toes)

Postaxial
Extra pinkie digit



Preaxial
Extra thumb or big toe



Central
Extra middle digit



Syndactyly of the Foot

Definition

Failure of interdigital apoptosis;
fusion of adjacent toes

Incidence

1 in 2,000–3,000 births; M:F = 2:1

Genetics

Autosomal dominant with
variable penetrance

Common toes

2nd–3rd toe most commonly
affected

Syndromic

Apert syndrome, Poland
sequence, Down syndrome



Congenital Flatfoot (Pes Planus)

Flexible Flatfoot

Arch disappears on standing, returns on tiptoe

💡 *Most common; physiologic until age 6–8*

Tarsal Coalition

Bony/cartilaginous/fibrous bar between tarsal bones

💡 *Calcaneonavicular most common (53%)*

Accessory Navicular

Extra ossification center medial to navicular

💡 *Present in 10–12% of population; often asymptomatic*



Healthy Foot



Flat Foot

Cavus Foot — Pes Cavus

High arched foot with clawing of toes and varus hindfoot — neurological cause first!

Etiology

- Charcot-Marie-Tooth (most common)
- Friedreich's ataxia
- Spinal cord tumors
- Polio / Spina bifida
- Idiopathic (mild, symmetric)

Clinical



Macroductyly & Other Digital Anomalies

Macroductyly

Overgrowth of all structures of a digit.



Macroductyly & Other Digital Anomalies

Clinodactyly

- Angular deviation of a toe in the coronal plane.
- Often associated with other syndromes (Down, Klinefelter). Commonly affects 5th toe.



Macroductyly & Other Digital Anomalies



Brachydactyly

- Short metatarsals or phalanges due to premature physeal closure.
- Often autosomal dominant.
Brachymetatarsia: 4th metatarsal most common.

Macroductyly & Other Digital Anomalies



Ainhum

- Constricting band around 5th toe leading to auto-amputation.
- More common in Sub-Saharan Africa.

Syndromic Associations —

Down Syndrome (T21)

Foot: Sandal gap deformity, flatfoot, clinodactyly

Also: Hypotonia, intellectual disability, atlantoaxial instability

Arthrogryposis

Foot: Severe bilateral clubfoot (rigid), CVT, vertical talus

Also: Multiple joint contractures; normal intelligence

Charcot-Marie-Tooth

Foot: Progressive cavovarus foot, claw toes, foot drop

Also: Peripheral neuropathy, distal muscle wasting

Spina Bifida

Foot: Clubfoot, calcaneovalgus, rocker-bottom depending on level

Also: Level determines foot position; L4-5 = calcaneus, L3-4 = equinovarus

Apert Syndrome

Foot: Broad/fused toes, syndactyly

Also: Craniosynostosis, midfacial hypoplasia

Constriction Band Syndrome

Foot: Constriction rings, pseudosyndactyly, amputations, clubfoot

Also: Amniotic band disruption sequence; variable severity

Complications & Long-Term Outcomes

⚠️ Complications

Relapse:	Most common (clubfoot ~30%); especially if bracing non-compliant
Stiffness:	Post-surgical; avoid unnecessary joint violation
Nerve injury:	Sural, superficial peroneal nerves at risk
Wound healing:	Poor blood supply; avoid circumferential incisions
Overcorrection:	Flatfoot/calcaneovalgus post clubfoot treatment

✓ Long-Term Outcomes

Clubfoot :	● Excellent — 90% achieve plantigrade foot
CVT:	● Good with early intervention; delayed = worse function
Metatarsus adductus:	● Excellent — 90% self-resolve
Tarsal coalition:	● Good with timely resection
Cavus foot:	● Variable — depends on underlying neurological cause
Macroductyly:	● Guarded — requires multiple surgeries

Take-Home Messages

1

Embryological disruption at weeks 4–8 underlies most congenital foot anomalies — know the timeline.

2

Pirani scoring guides Ponseti casting — the gold standard for clubfoot with 90–95% success.

3

Always think NEUROLOGICAL in asymmetric or progressive deformities — don't miss a spinal cause.

4

Metatarsus adductus is common and largely self-resolving — avoid over-treatment.

5

Syndromic associations are common — a thorough systemic exam is part of every foot assessment.

6

Goal of all treatment: a plantigrade, painless, functional, shoeable foot.

Thank You | Questions Welcome

Thank you!

SO MUCH