

# Arches of Foot

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## ? Arches of Foot — Introduction

- The **arched foot** is a distinctive human feature that allows **bipedal locomotion** and efficient **weight transmission**.
- Although present from birth, arches are masked in infants due to **fat in the soles**.
- They act as **shock absorbers** and **springs** during walking and running

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## Classification of Arches

### 1. Longitudinal Arches

- **Medial longitudinal arch**
- **Lateral longitudinal arch**

### 2. Transverse Arches

- **Anterior transverse arch**
- **Posterior transverse arch**

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## ? Medial Longitudinal Arch

- **Higher, mobile, and resilient;** acts as a **shock absorber**.
- Shaped like a **big arc of a small circle** — with more bones and joints.

### Bones Forming the Arch

- **Calcaneus, talus, navicular, three cuneiforms, and first–third metatarsals.**

### Ends

- **Anterior end:** Heads of 1st–3rd metatarsals.
- **Posterior end:** Medial tubercle of calcaneum.
- **Keystone: Talus** (its head supports the summit of the arch)

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### Pillars

- **Anterior pillar:** Talus ? Navicular ? 3 cuneiforms ? 1st–3rd metatarsals.
- **Posterior pillar:** Medial half of calcaneum.

### Main Joint

- **Talocalcaneonavicular joint.**

### Supporting Structures

- **Ligamentous support:**

- *Spring (plantar calcaneonavicular) ligament* — supports head of talus.
- *Plantar aponeurosis* — acts as tie-beam.

- **Muscular support:**

- *Tibialis posterior, flexor hallucis longus, and flexor digitorum longus* (posterior sling).
- *Tibialis anterior and peroneus longus* act as stirrup-like supports pulling the arch upward.
- *Abductor hallucis and flexor digitorum brevis* act as dynamic tie-beams

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## ? Lateral Longitudinal Arch

- **Lower, shorter, less mobile**, and more **rigid** — transmits body weight to the ground.
- Considered a **small arc of a big circle**.

### Bones

- **Calcaneus, cuboid, and 4th–5th metatarsals.**

### Ends

- **Anterior:** Heads of 4th and 5th metatarsals.
- **Posterior:** Lateral tubercle of calcaneum.
- **Keystone: Cuboid**

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## Pillars

- **Anterior pillar:** Cuboid and 4th–5th metatarsals.
- **Posterior pillar:** Lateral half of calcaneum.

## Main Joint

- **Calcaneocuboid joint.**

## Supporting Structures

- **Ligaments:** Long and short plantar ligaments; plantar aponeurosis acts as tie-beam.
- **Muscles:**
  - *Flexor digitorum brevis*, *abductor digiti minimi*, and *flexor digiti minimi brevis* (tie-beams).
  - *Peroneus longus*, *brevis*, and *tertius* maintain arch height

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## ? Anterior Transverse Arch

- Lies in **coronal plane** at the heads of metatarsals.
- **Complete arch**, which flattens slightly during weight-bearing.

### Bones

- **Heads of all five metatarsals.**
- **Supported by:**
  - *Intermetatarsal ligaments* and *deep transverse metatarsal ligament*.
  - *Transverse head of adductor hallucis* binds metatarsal heads together.
  - *Peroneus longus* tendon acts as sling from lateral to medial side

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## ? Posterior Transverse Arch

- Lies across **bases of metatarsals and distal tarsals** (cuneiforms, cuboid).
- **Incomplete (half-dome)** — completed by opposite foot when together.

### Bones

- **Navicular, three cuneiforms, cuboid, bases of metatarsals**

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## Support

- *Intertarsal and tarsometatarsal ligaments, dorsal interossei, flexor hallucis brevis, and peroneus longus* tendon sling maintain the curvature

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## ?? Factors Maintaining All Arches

1. **Shape of bones** — wedge-shaped cuneiforms and metatarsal bases provide bony configuration.
2. **Intersegmental ties** — ligaments joining adjacent bones (spring, long, and short plantar ligaments).
3. **Tie-beams** — plantar aponeurosis and intrinsic muscles hold ends together.
4. **Slings** — tendons like *tibialis posterior, peroneus longus, tibialis anterior* pull the arch upward

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## ? Functions of the Arches

1. Distribute **body weight** over heel and toes.

2. Act as **springs and shock absorbers** during locomotion.
3. **Protect** soft tissues of the sole from pressure.
4. Provide **resiliency** (medial arch) and **rigidity** (lateral arch)

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## ? Clinical Anatomy

- **Flat Foot (Pes Planus):** Collapse of longitudinal arches ? clumsy gait, pain, neuralgia due to pressure on plantar nerves and vessels.
- **Pes Cavus:** Exaggerated arches; seen in spastic or neurological conditions.
- **Clubfoot (Talipes Equinovarus):** Congenital deformity with inversion and plantar flexion of foot

## ? Factors Responsible for Maintenance of Arches

The arches of the foot are maintained by **bony, ligamentous, and muscular mechanisms** which act together for stability and elasticity.

### 1. Shape of the Bones (Bony Factor)

- **Transverse arch:** Maintained by wedge-shaped tarsal and metatarsal bones — the **apex of wedge points downward**.

- Bony factor is less important for longitudinal arches but contributes to the foot's concavity.
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## 2. Intersegmental Ties (Ligamentous Factor)

Ligaments connecting segments of the arch prevent separation:

- **Spring ligament (plantar calcaneonavicular):** Maintains the **medial longitudinal arch**.
  - **Long and short plantar ligaments:** Maintain the **lateral longitudinal arch**.
  - **Interosseous ligaments and intermetatarsal ligaments:** Support **transverse arches**.
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## 3. Tie Beams (Bowstrings)

Structures that connect the two ends of the arch and resist flattening:

- **Plantar aponeurosis:** Prevents flattening of longitudinal arches.
  - **Muscles of the first layer of sole** (abductor hallucis, flexor digitorum brevis) act as tie-beams.
  - **Adductor hallucis (transverse head):** Acts as tie-beam for transverse arch.
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## 4. Slings (Suspensory Factors)

Muscular tendons that pull the arch upwards:

- **Medial longitudinal arch:**
  - *Tibialis posterior, flexor hallucis longus, and flexor digitorum longus.*



- **Lateral longitudinal arch:**

- *Peroneus longus* and *peroneus brevis*.

- **Both arches:**

- *Tibialis anterior* and *peroneus longus* act like a **stirrup**, pulling the midfoot upward.

- **Transverse arches:**

- Maintained by *peroneus longus* (running across the sole) and *tibialis posterior*.

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## ? Functions of the Arches

1. **Weight Distribution:**

- Transfers body weight to heel and heads of metatarsals (mainly 1st and 5th).
- Lateral border bears lesser weight due to its arch shape.

2. **Spring Action:**

- Medial longitudinal arch acts like a spring aiding in walking and running.

3. **Shock Absorption:**

- Cushions the impact of stepping and jumping.

4. **Protection:**

- Concavity of the sole protects soft tissues, vessels, and nerves.

5. **Functional Differences:**

- **Medial arch:** Resilient and elastic.
- **Lateral arch:** Rigid and stable.

? **Summary**

- The **foot arches** include two longitudinal (medial and lateral) and two transverse (anterior and posterior).
- The **medial longitudinal arch** is the most prominent and clinically significant — affected in *pes planus* (flat foot) and *pes cavus* (high arch).
- **Ligamentous and muscular supports** are essential for maintaining the arches during weight-bearing and locomotion.

?? **Comparison: Medial vs Lateral Longitudinal Arch**

FEATURE	MEDIAL LONGITUDINAL ARCH	LATERAL LONGITUDINAL ARCH
Height & Mobility	Higher, more mobile, resilient	Lower, rigid, transmits weight
Function	Acts as shock absorber	Provides stability for weight transmission

FEATURE	MEDIAL LONGITUDINAL ARCH	LATERAL LONGITUDINAL ARCH
<b>Bones</b>	Calcaneus, talus, navicular, three cuneiforms, 1st–3rd metatarsals	Calcaneus, cuboid, 4th–5th metatarsals
<b>Keystone</b>	<b>Head of talus</b>	<b>Cuboid</b>
<b>Anterior End</b>	Heads of 1st–3rd metatarsals	Heads of 4th–5th metatarsals
<b>Posterior End</b>	Medial tubercle of calcaneum	Lateral tubercle of calcaneum
<b>Main Joint</b>	Talocalcaneonavicular joint	Calcaneocuboid joint
<b>Ligamentous Support</b>	Spring ligament	Long and short plantar ligaments
<b>Tie-Beams</b>	Plantar aponeurosis (medial part), abductor hallucis, flexor digitorum brevis (medial part)	Plantar aponeurosis (lateral part), abductor digiti minimi, flexor digitorum brevis (lateral part)
<b>Muscular Slings</b>	Tibialis posterior, FHL, FDL	Peroneus longus and brevis
<b>Suspension (Stirrup)</b>	Tibialis anterior + Peroneus longus	Tibialis anterior + Peroneus longus
<b>Character</b>	Elastic and spring-like	Stable and weight-bearing

## Clinical Anatomy — Arches of the Foot

## 1. Flat Foot (Pes Planus)

- **Definition:** Collapse or loss of the medial longitudinal arch ? sole becomes flat and touches the ground.
  - **Types:**
    - **Congenital:** Due to tarsal bone malformation.
    - **Acquired:** Common; results from **weakening of ligaments and intrinsic foot muscles** (especially plantar aponeurosis).
  - **Causes:**
    - Excessive standing, obesity, rickets, pregnancy, poorly fitting shoes, or paralysis of tibialis posterior.
  - **Features:**
    - Medial border of foot touches the ground.
    - Foot appears broader and everted.
    - Pain and fatigue after walking or standing.
  - **Complications:**
    - Strain on ligaments, callosities on sole, valgus deformity of heel.
  - **Treatment:**
    - Arch supports, proper footwear, physiotherapy, surgical correction in severe cases.
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## 2. Pes Cavus (High-Arched Foot)

- **Definition:** Exaggerated height of the medial longitudinal arch.
  - **Causes:**
    - Neurological disorders (spastic paralysis, poliomyelitis, Charcot–Marie–Tooth disease).
  - **Features:**
    - Toes are flexed, heel and metatarsal heads bear excessive weight.
    - Painful callosities under metatarsal heads.
  - **Clinical importance:**
    - Loss of normal shock absorption ? frequent ankle sprains.
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## 3. Clubfoot (Talipes Equinovarus)

- **Definition:** Congenital deformity where the foot is **plantarflexed (equinus)**, **inverted (varus)**, and **adducted**.
- **Cause:**
  - Abnormal intrauterine position or defective muscle balance between invertors and evertors.
- **Features:**
  - Sole faces medially; child walks on the lateral border of foot.

- **Treatment:**

- Early manipulation, plaster correction, or surgical release.
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#### 4. Claw Foot

- **Definition:** Hyperextension at metatarsophalangeal joints with flexion at interphalangeal joints.

- **Cause:**

- Weakness or paralysis of small muscles of foot (as in leprosy, diabetic neuropathy).

- **Clinical Feature:**

- Toes resemble claws; difficulty in walking.

- **Treatment:**

- Orthopedic correction and physiotherapy.
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#### 5. Hallux Valgus

- **Definition:** Lateral deviation of the great toe at the metatarsophalangeal joint.

- **Cause:**

- Tight footwear, genetic predisposition, flat foot.

- **Clinical Importance:**

- Medial deviation of first metatarsal, formation of **bunion (bursa)** over the joint ? painful swelling.

- **Treatment:**

- Corrective footwear or surgical correction.
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## 6. Plantar Fasciitis and Calcaneal Spur

- **Plantar Fasciitis:** Inflammation of plantar aponeurosis ? severe heel pain, especially on first step in morning.

- **Calcaneal Spur:**

- Bony outgrowth at calcaneal tuberosity where aponeurosis attaches.
- Often accompanies chronic plantar fasciitis.

- **Treatment:**

- Rest, heel padding, physiotherapy, corticosteroid injection.
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## 7. Flatfoot in Children (Physiological)

- Due to fatty cushion masking the arch; **usually corrects by age 6–7 years** as intrinsic muscles strengthen.
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## 8. Fallen Arches in Adults

- Seen in **teachers, soldiers, or waiters** due to prolonged standing.

- Chronic pain over the sole; managed with arch supports and exercises.

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## ? Facts to Remember — Arches of the Foot

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1. The **foot acts as a spring and shock absorber**, distributing weight during locomotion.
2. There are **two longitudinal arches** (medial and lateral) and **two transverse arches** (anterior and posterior).
3. The **medial longitudinal arch** is the **highest, most mobile, and most important**.
4. The **lateral longitudinal arch** is **lower and rigid**, transmitting weight to the ground.
5. **Talus** acts as the **keystone** of the medial arch; **cuboid** acts as the keystone of the lateral arch.
6. **Spring ligament** supports the head of talus and maintains medial arch.
7. **Long and short plantar ligaments** maintain lateral arch.
8. **Plantar aponeurosis** acts as a tie-beam for both longitudinal arches.
9. **Tibialis anterior and peroneus longus** form a **stirrup sling** supporting both arches.
10. The **transverse arches** are maintained by wedge-shaped bones, ligaments, interosseous muscles, and peroneus longus tendon.
11. **Flat foot** results from collapse of the medial arch due to ligament and muscle weakness.
12. **Pes cavus** is the exaggerated form of the medial arch, commonly neurological in origin.



13. The **arches protect plantar vessels, nerves, and muscles** from direct pressure.
14. **Resiliency of the medial arch** and **rigidity of the lateral arch** provide both spring and stability.
15. During walking, **arches flatten slightly during stance** and **recoil during toe-off**, ensuring smooth locomotion.
16. The **transverse arch** is completed by both feet when standing together.
17. **Children's flat foot** is often physiological and self-correcting.
18. **Adults' flat foot** may lead to pain, valgus deformity, and fatigue.
19. **Arch supports** and **strengthening exercises** are key to management of foot deformities.
20. Proper **footwear and posture** are essential for maintaining normal arch structure.

### **Clinicoanatomical Problem — Arches of the Foot**

A **young adult** was **disqualified from army recruitment** because of **flat feet**.

#### **Questions:**

1. What are flat feet?
2. Name the factors maintaining the medial longitudinal arch of the foot.

#### **Answer:**

- When the **medial border of the foot** fails to show its normal **upward concavity**, the condition is termed a **flat foot (pes planus)**.

- If such a person places a **wet foot on the ground**, the entire sole makes an imprint — unlike the arched footprint of a normal foot.
- A **flat foot** person cannot run efficiently because of reduced elasticity and shock absorption in the sole. Hence, such individuals are often **unfit for military service**, where running performance is essential

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### Factors maintaining the medial longitudinal arch:

#### 1. Shape of bones:

- Specially the **talus** and **calcaneus**, which form the bony configuration of the arch.

#### 2. Ligamentous supports:

- **Spring (plantar calcaneonavicular) ligament**
- **Deltoid ligament**
- **Plantar aponeurosis** acting as a tie-beam

#### 3. Short muscles:

- **Abductor hallucis**
- **Flexor hallucis brevis**
- **Dorsal interossei**

#### 4. Long tendons:

- **Flexor hallucis longus (FHL)**
- **Tibialis posterior**
- **Tibialis anterior**
- **Peroneus longus**

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### **Clinical Relevance:**

- In **flat foot**, loss of arch support causes **pain**, **muscle fatigue**, and **valgus deformity** of the heel.
- **Arch supports, physiotherapy, and corrective footwear** can relieve symptoms.