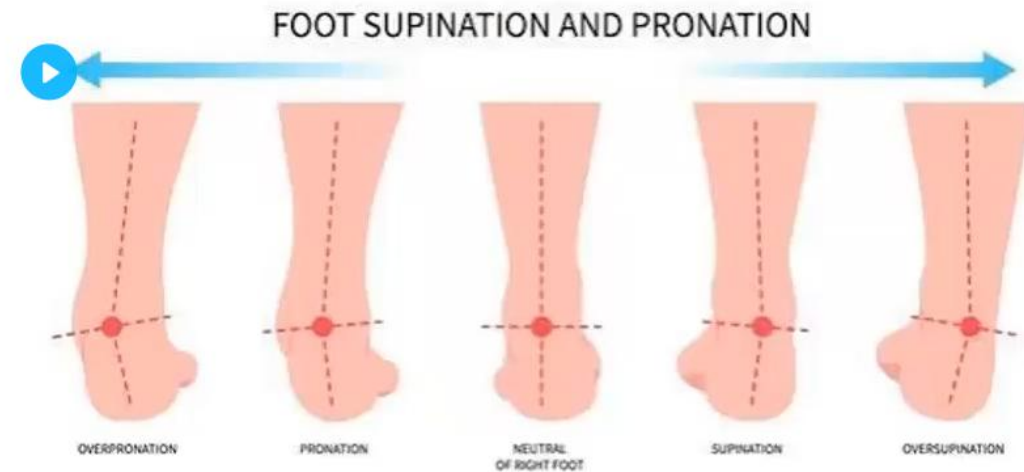


Pes Planus

Dr. Manju Setia RMT BAMS

- Pes planus is a decreased medial longitudinal arch and a pronated hindfoot.
- The terms **pes planus**, **pronated foot** and **flat foot** are often used interchangeably



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Different Regions of the Foot

- The Foot is Divided into Three Parts

1. Forefoot

The **forefoot** is the **front portion of the foot**.

Bones of the Forefoot

It consists of:

- **5 Metatarsals**
- **14 Phalanges (toe bones)**

Total = **19 bones**

Location

Starts at the **heads of the metatarsals** and extends to the tips of the toes.



Functions

- Pushes the body forward during walking.
- Helps maintain balance.
- Bears body weight during toe-off.
- Assists in propulsion during running and jumping.

Clinical Importance

- Pain in the forefoot may be caused by:
- Metatarsalgia
- Stress fractures
- Morton's neuroma
- Bunions (Hallux valgus)



Midfoot

2. The **midfoot** is the **middle part of the foot**.

Bones of the Midfoot :There are **5 bones**:

- Navicular
- Cuboid
- Medial cuneiform
- Intermediate cuneiform
- Lateral cuneiform

Functions :The midfoot:

- Forms the arches of the foot.
- Acts as a shock absorber.
- Transfers forces from the heel to the forefoot.

Clinical Importance : Conditions include:

- Pes planus
- Midfoot sprain
- Arthritis



3. Hindfoot

The **hindfoot** is the **back portion of the foot**.

- **Bones of the Hindfoot**
- Only **2 bones**:
- Calcaneus (heel bone)
- Talus

Functions

- Supports body weight.
- Transfers force from the leg to the foot.
- Forms the ankle and subtalar joints.

Clinical Importance :Common problems:

- Heel pain
- Achilles tendinitis
- Calcaneal fracture
- Subtalar arthritis



How Pronation Affects These Regions

During **pronation**:

- **Hindfoot:** Calcaneus everts (heel tilts outward).
- **Midfoot:** Arch flattens as the midfoot becomes more flexible.
- **Forefoot:** Abducts (moves outward away from the body's midline).

During Supination

The opposite happens:

- **Hindfoot:** Inverts (heel tilts inward).
- **Midfoot:** Arch rises and becomes rigid.
- **Forefoot:** Adducts (moves toward the body's midline).



Two Types of Pes Planus

1. Functional (Flexible) Pes Planus

Cause:

- Weak muscles
- Loose ligaments
- Poor muscle control

Characteristics:

- Arch appears when sitting.
- Arch disappears while standing.
- Correctable.

Clinical Example

- A patient stands and the arch flattens.
When sitting, the arch returns.
- → Functional Flat Foot.



2. Structural (Rigid) Pes Planus

Cause:

- Bone deformity
- Congenital abnormality
- Arthritis
- Joint fusion

Characteristics:

- Arch remains flat all the time.
- Present in sitting and standing.
- Cannot be corrected manually.



Three Foot Arches

1. Medial Longitudinal Arch (Most Important)

- Highest and most flexible arch.
- **Bones forming the arch**
- Calcaneus
- Talus
- Navicular
- Three Cuneiforms
- First three Metatarsals
- **Ligaments supporting it**
- Long Plantar Ligament
- Short Plantar Ligament
- Plantar Calcaneonavicular (Spring) Ligament
- Plantar Aponeurosis (Plantar Fascia)

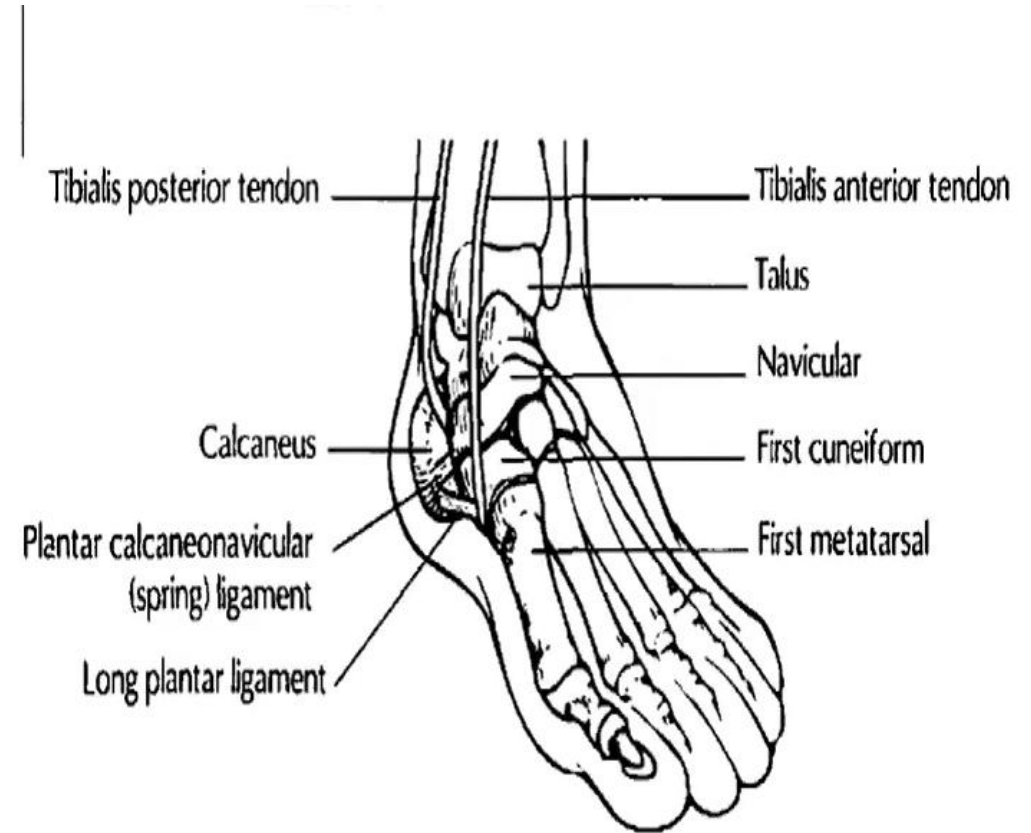


Figure 39.1
The medial longitudinal arch.

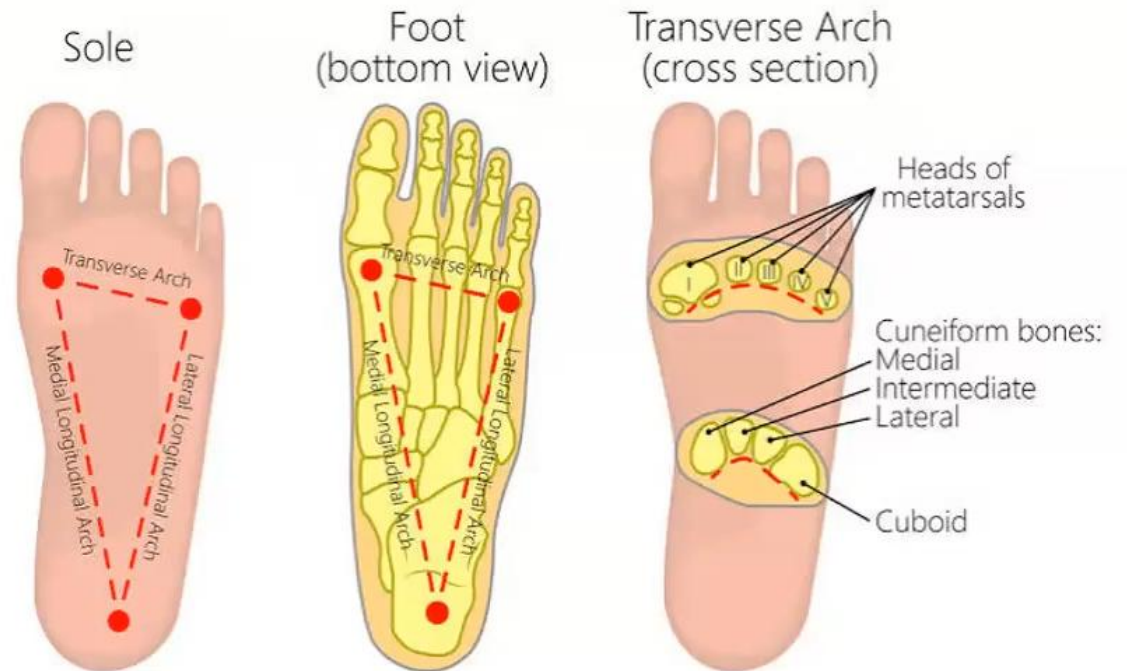


Muscles supporting it dynamically

- Primary muscles:
- Tibialis Posterior
- Tibialis Anterior
- Peroneus Longus
- Additional support:
- Flexor Hallucis Longus
- Flexor Digitorum Longus
- Intrinsic Foot Muscles

3. Anterior Transverse Arch

- Located across the metatarsal heads.
- Supported mainly by:
 - Lumbricals
 - Interossei
- These muscles keep the metatarsal heads properly aligned.



Development of Foot Arches

Newborn babies have:

- No arches
- This is completely normal.
- The medial longitudinal arch begins developing around:
- **2 years of age**
- Therefore: Flat feet in infants are normal.



Twisted Plate Theory

- Imagine the foot as a **twisted plate**.
- When the foot is:

Supinated

- Twist increases
- Arch becomes higher
- Foot becomes rigid

Pronated

- Twist decreases
- Arch flattens
- Foot becomes flexible
- This explains why pronation lowers the arch.

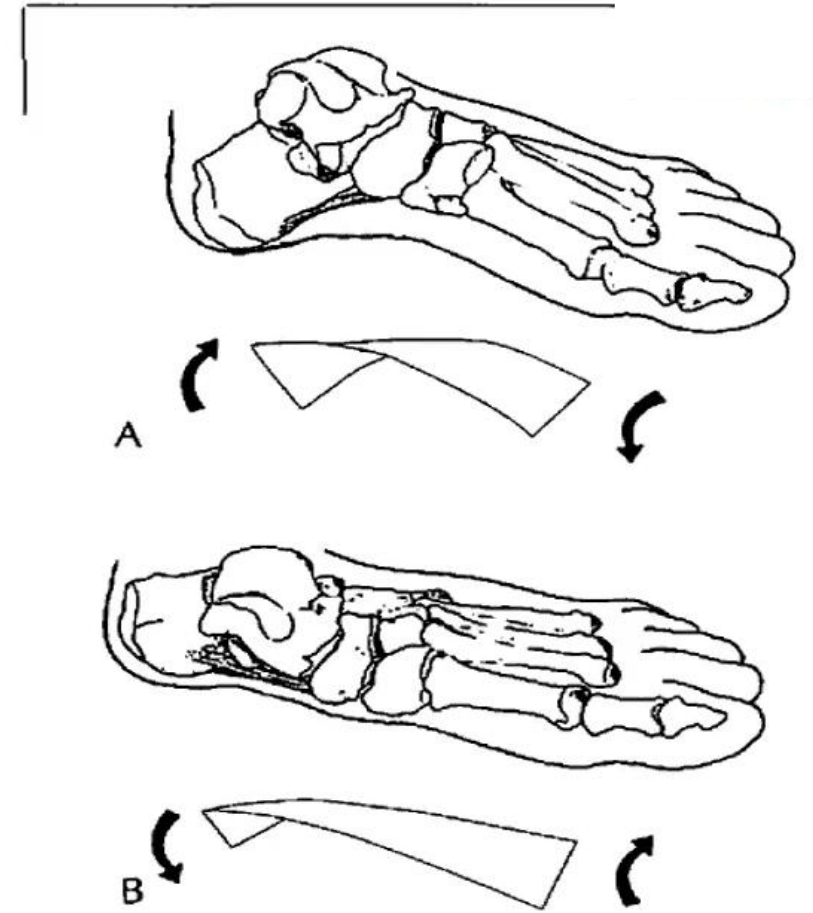


Figure 39.2

The medial longitudinal arch: A) twisting into supination; B) untwisting into pronation.

Pronation During Walking

- Normal gait requires a **small amount of pronation** after heel strike.
- Benefits:
- Shock absorption
- Adapts to uneven surfaces
- Allows tibial internal rotation
- This is **normal pronation**.



Supination During Toe-Off

- During push-off:
- The **plantar aponeurosis tightens.**
- This is called the **Windlass Mechanism.**
- Result:
- Medial arch rises.
- Foot becomes rigid.
- Better propulsion.



Talus

What Happens in Pes Planus?

Normal Alignment:

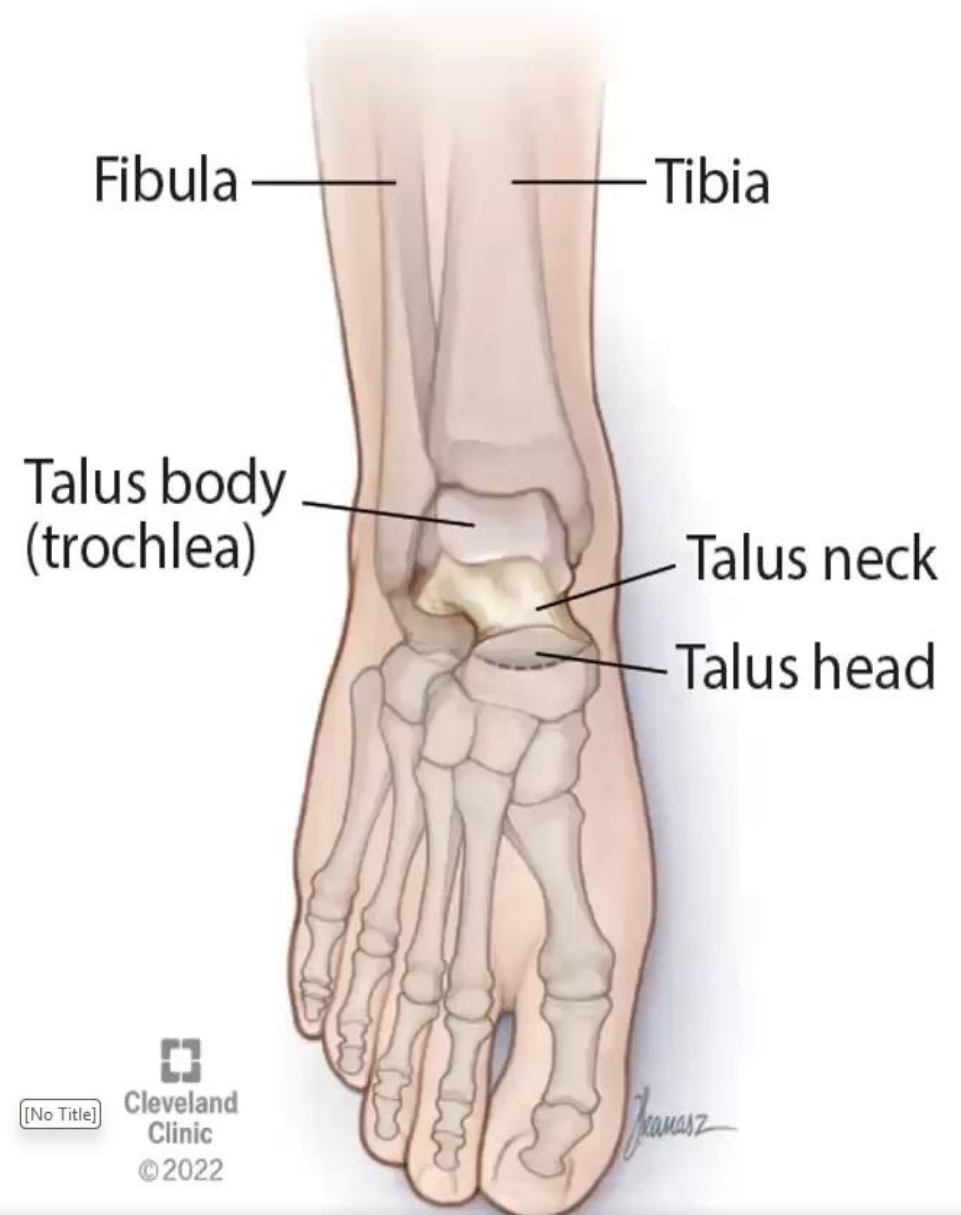
- Talus sits properly on the Navicular.

In Flat Foot:

- The **head of the talus** moves:
- Medially
- Inferiorly

As a result:

- Arch collapses.
- Ligaments overstretch.
- Plantar fascia stretches.
- Joint capsules become loose.



Effect on Ligaments

- The following structures become overstretched:
- Spring ligament : also called the **plantar calcaneonavicular ligament**) is a strong ligament located on the **medial (inner) side of the foot**.
- **Attachments**
 - **Proximal attachment:** sustentaculum tali of the calcaneus
 - **Distal attachment:** Plantar surface of the head of the talus and the navicular
- Long plantar ligament
- Short plantar ligament
- Plantar fascia
- Joint capsules
- Eventually these tissues lose their ability to support the arch.

Muscle Compensation

- Since ligaments become weak, muscles must work continuously.
- Normally these muscles are quiet during standing.
- In Pes Planus they become overactive:
- Tibialis Posterior
- Tibialis Anterior
- Peroneus Longus
- Long Toe Flexors
- Intrinsic Foot Muscles



Result:

- Muscle fatigue



- Pain



- Trigger points



- Further arch collapse



Muscle Types

- **Phasic Muscles**
- Characteristics:
- Designed for movement
- Fatigue easily
- Become weak
- Examples:
- Tibialis Anterior
- Peroneal Muscles



Postural Muscles

- Characteristics:
- Designed for endurance
- Become tight instead of weak
- Examples:
- Gastrocnemius
- Soleus
- These muscles commonly shorten in flat-foot patients.



Peroneal Muscles

- **Peroneus Longus**

- Insertion:
- Base of First Metatarsal
- Medial Cuneiform
- Function:
- Everts foot indirectly
- Supports medial arch
- Pushes first metatarsal into the ground

- **Peroneus Brevis**

- Insertion:
- Base of Fifth Metatarsal
- Function:
- Directly everts foot

- **Peroneus Tertius**

- Insertion:

- Fifth Metatarsal

Function:

- Dorsiflexion

- Eversion

Why Peroneals Become Tight

- Because the foot remains pronated:

- Peroneals stay shortened.

- Trigger points develop.

- They keep pulling the foot outward.

- Flat foot worsens.

- This creates a vicious cycle.

Gastrocnemius & Soleus

- These postural muscles often become adaptively shortened.
- Tight calves:
- Limit ankle dorsiflexion.
- Increase pronation during walking.
- Place more stress on the medial arch.



- **What Happens if Functional Pes Planus Is Not Treated?**

- Without proper arch support:
- Ligaments continue stretching.
- Muscles fatigue more quickly.
- The arch progressively collapses.
- Pain and biomechanical problems increase.

A study of people completing a **100 km hike** found that those with existing pes planus experienced a further drop in their arches after the walk, while participants with normal arches showed no significant change. This demonstrates how prolonged loading can worsen an unsupported functional flat foot.

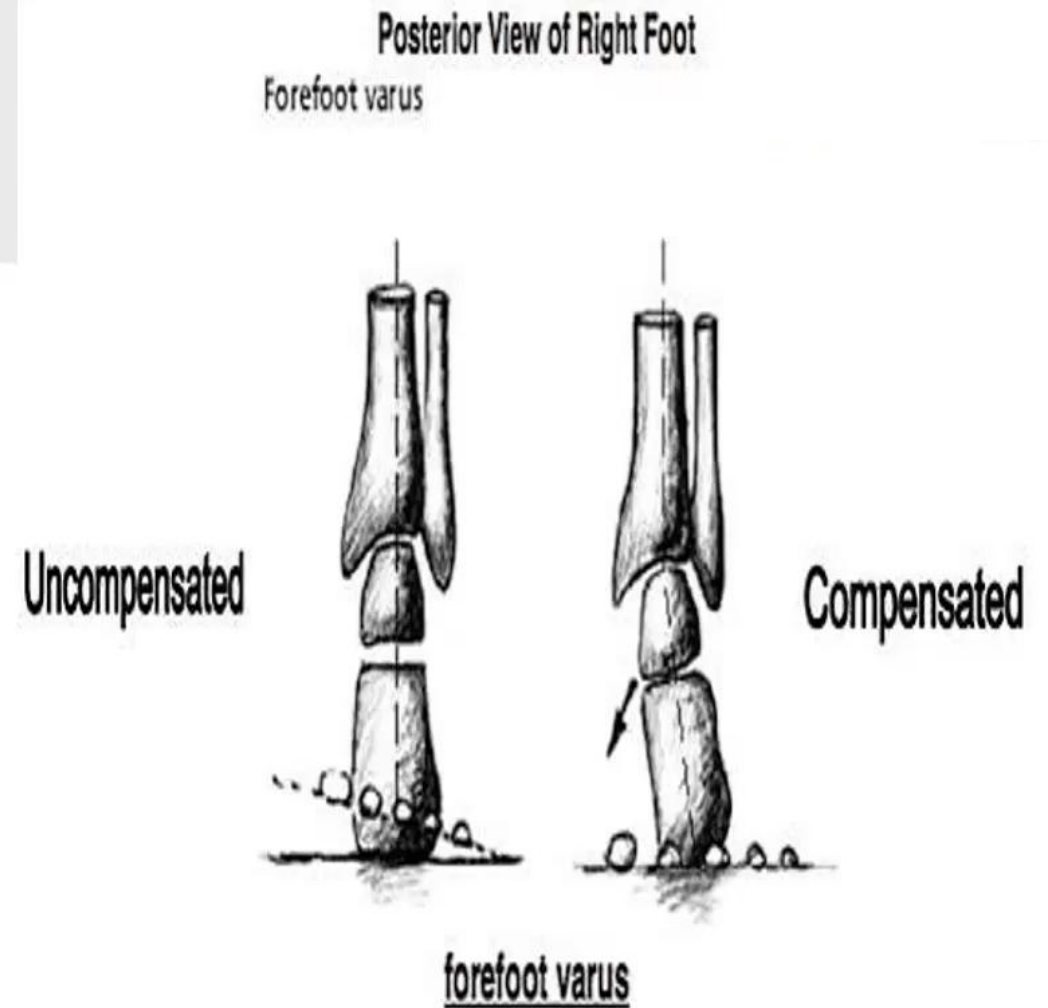


Other foot problems the therapist may see:

1. Forefoot Varus

Definition:

- **Forefoot varus** is a structural deformity where the **forefoot is inverted (turned inward) compared with the hindfoot** at the **midtarsal joint**.
- **Simple explanation:**
- The **back of the foot (hindfoot)** is relatively normal.
- The **front of the foot (forefoot)** is tilted inward.
- When the person stands, the body tries to compensate by **rolling the foot inward (pronation)** to bring the forefoot flat to the ground.

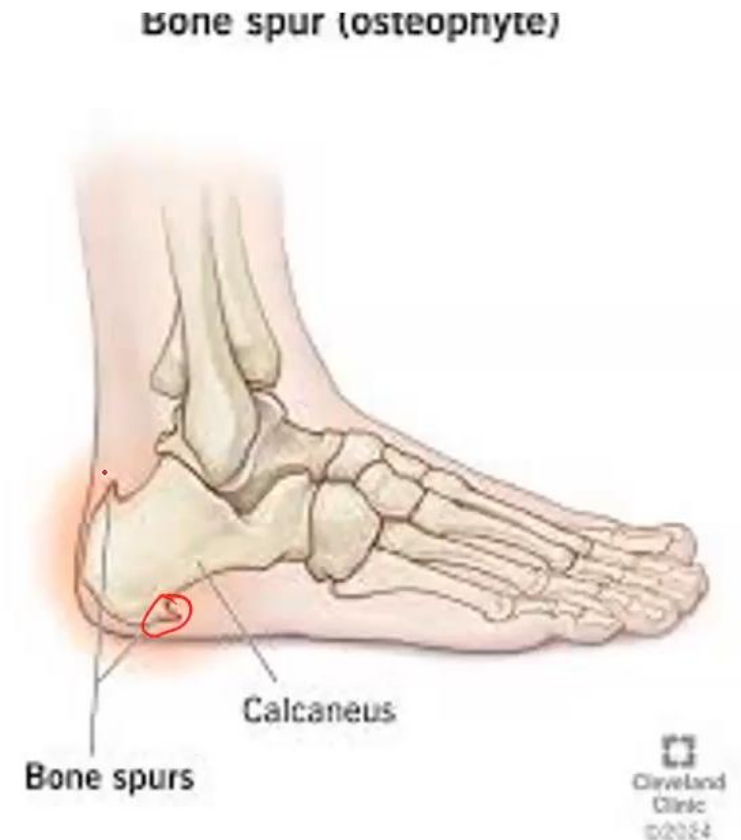


Appearance:

- Although the problem is an inward tilt of the forefoot, clinically it may **like pes planus (flat foot)** because the foot collapses into pronation during weight bearing.
- **Problems associated:**
- **1. Tibialis Posterior Tendinitis**
- Excessive pronation places extra stress on the **tibialis posterior tendon**.
- Over time, the tendon becomes irritated and painful.
- Tibialis posterior normally supports the medial arch.
- **2. Morton's Neuroma**
- Excessive pressure between metatarsal heads can irritate the digital nerve.
- Usually occurs between the **3rd and 4th metatarsals**.
- Symptoms:
 - Burning pain
 - Tingling
 - Feeling of a pebble under the foot

2. Heel Spurs

- **Definition:**
 - A **heel spur** is a bony growth that develops due to **chronic pulling stress on the attachment of the plantar aponeurosis (plantar fascia)**.
- **Mechanism:**
 - The medial longitudinal arch begins to flatten.
 - The plantar fascia becomes overstretched.
 - Continuous pulling occurs at its attachment on the calcaneus.
 - The body responds by forming extra bone → **heel spur**.



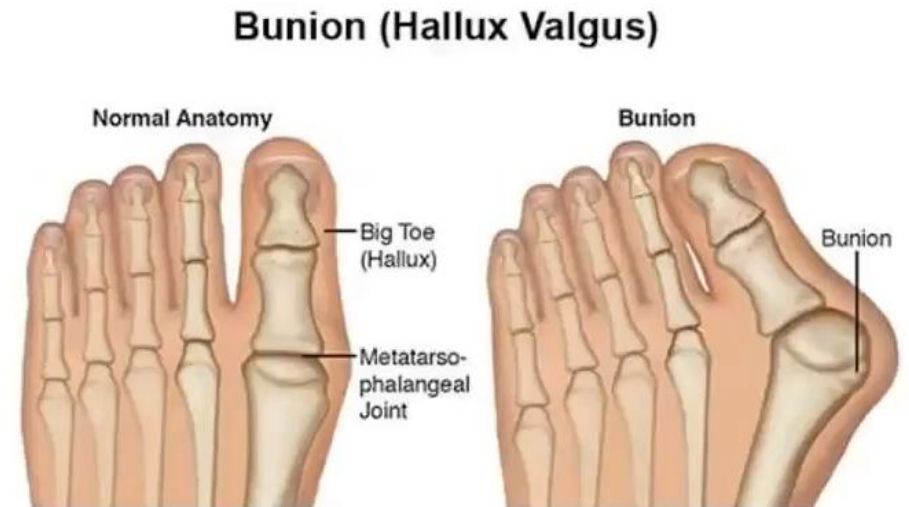
Common location:

- Bottom of the heel
- Attachment of plantar fascia to the calcaneus
- **Symptoms:**
- Sharp heel pain
- Worse with first steps in the morning
- Pain after prolonged standing
- **RMT Considerations:**
- Treat contributing factors:
- Tight gastrocnemius
- Tight soleus
- Plantar fascia tension
- Poor foot mechanics



3. Hallux Valgus (Bunion)

- **Definition:**
- **Hallux valgus** is a deformity where:
 - The **big toe (hallux) moves laterally toward the other toes** (valgus).
 - The **first metatarsal bone moves medially** (toward the inside of the foot).
- **Simple explanation:**
- The big toe drifts outward, while the first metatarsal pushes inward, creating a bump.



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Causes:

- Footwear with a narrow toe box
- High heels
- Genetic factors
- Pes planus (flat feet)
- **Relationship with Pes Planus:**
- Flat feet increase stress on the first metatarsophalangeal joint and may contribute to hallux valgus.



Changes that occur:

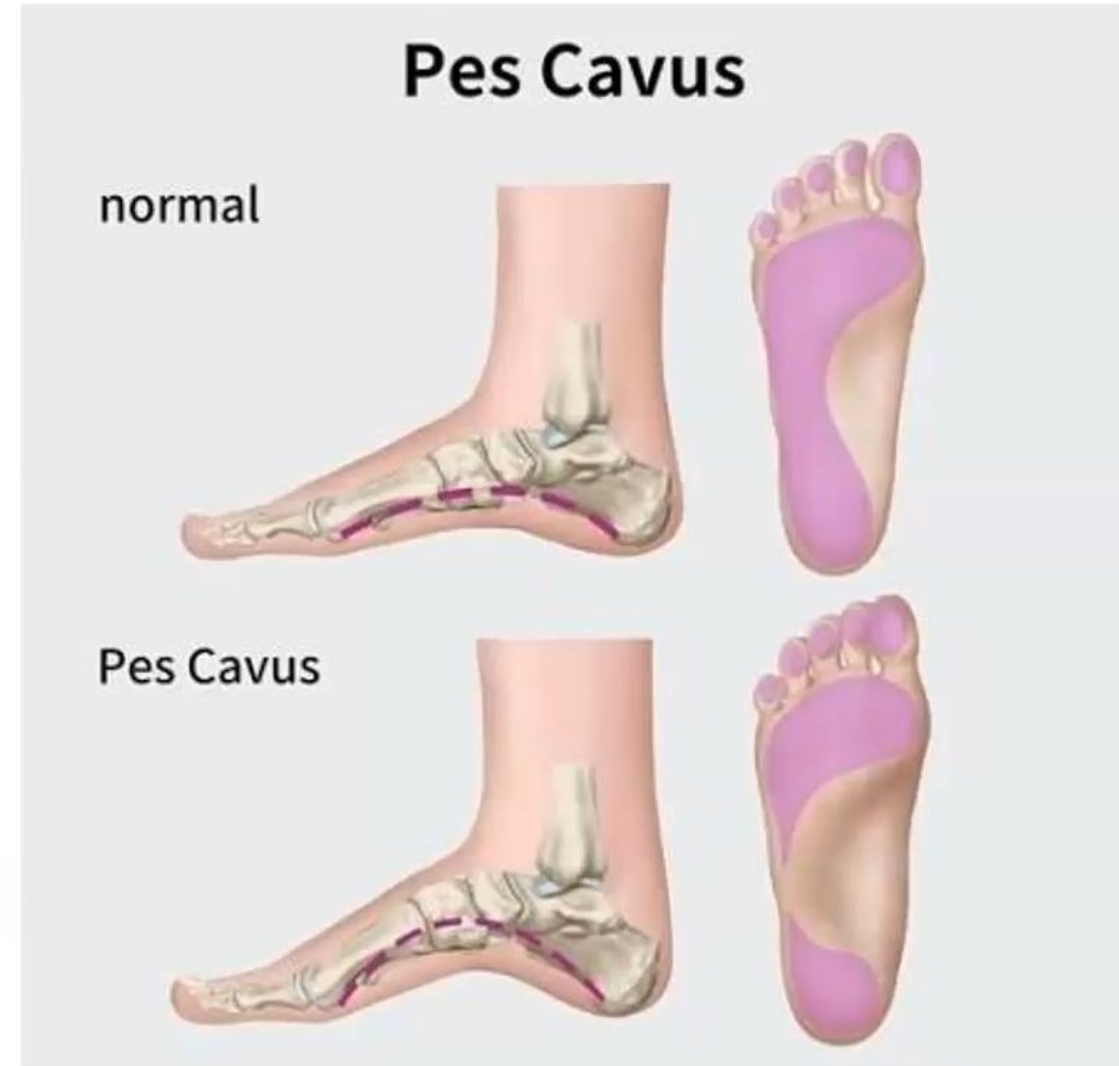
- **1. Joint Capsule Changes**
- The first MTP joint capsule becomes **loose and unstable (hypermobile)**.
- **2. Bunion Formation:**
- A bunion develops due to:
- Thickened joint capsule
- Inflamed bursa
- Callus formation
- **Symptoms:**
- Pain around big toe joint
- Swelling
- Difficulty wearing shoes

Clinical Considerations:

- Avoid aggressive pressure directly over:
- Bunion
- Inflamed bursa
- Focus on:
- Foot muscles
- Calf muscles
- Plantar fascia

4. Pes Cavus (High Arch Foot)

- **Definition:**
- **Pes cavus** is the opposite of pes planus.
- Pes planus = flat arch
- Pes cavus = excessively high arch
- **Cause:**
- Occurs due to excessive **supination** of the foot.
- **Foot position:**
- Increased inversion of calcaneus
- High medial longitudinal arch
- Less shock absorption



Muscle Changes in Pes Cavus

Shortened muscles:

- **1. Tibialis Anterior**

- Function:
- Dorsiflexion
- Inversion

- **2. Tibialis Posterior**

- Function:
- Plantarflexion
- Inversion
- Supports medial arch

- **3. Toe Flexors**

- Function:
- Curl toes
- Help maintain arch
- Because these muscles are shortened, the foot becomes rigid and supinated.



5. Hind foot Varus

Definition:

- **Hindfoot varus** is inversion of the calcaneus.
- **Simple explanation:**
 - The heel tilts inward.
- **Associated with:**
 - Supination
 - Pes cavus
- **Opposite:**
 - Hindfoot valgus = heel tilts outward (seen in pronation/pes planus)

- **6. Forefoot Valgus**

- **Definition:**

- Forefoot valgus occurs when the **forefoot everts (turns outward) compared with the hindfoot** at the midtarsal joint.

- **Appearance:**

- It may clinically resemble **pes cavus** because the person compensates with supination.

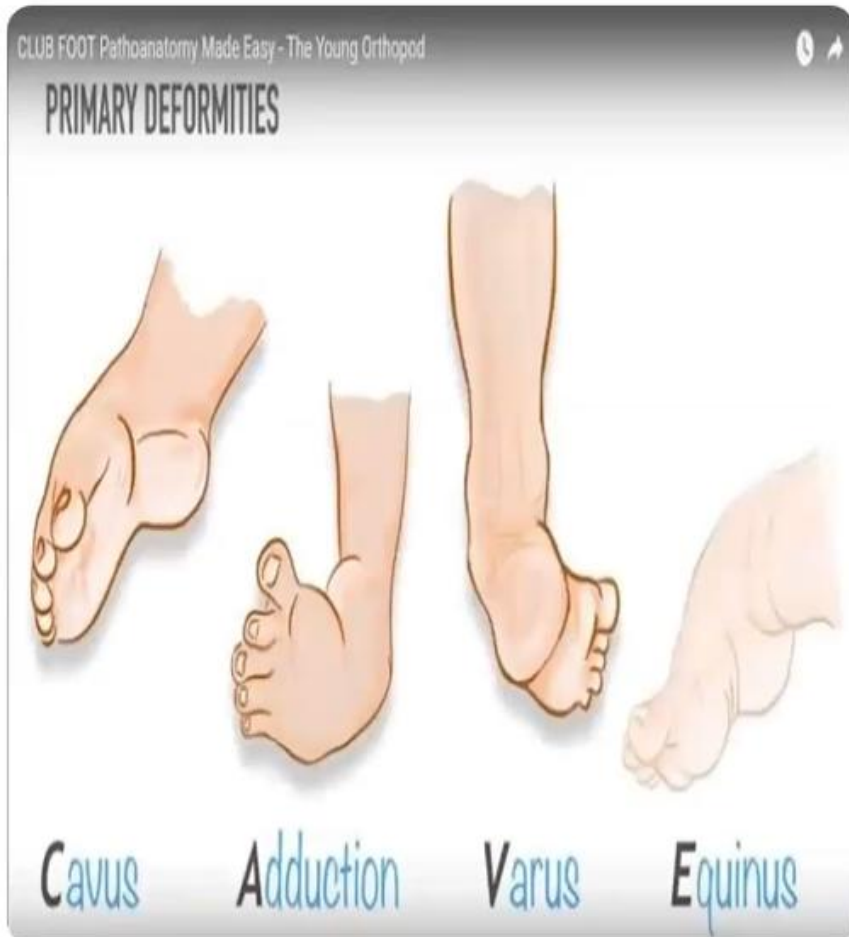
- **Simple analogy:**

- Think of the foot like a book:
 - Forefoot varus → front of book tilts inward
 - Forefoot valgus → front of book tilts outward

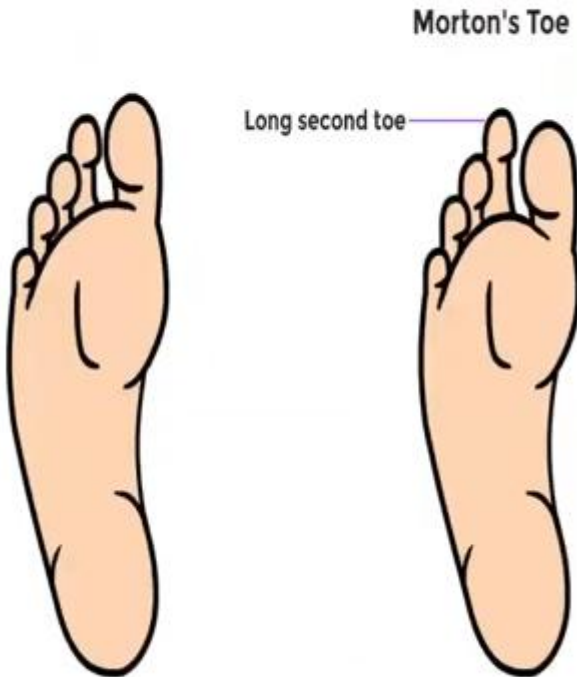
A FOREFOOT
VALGUS
DEFORMITY







- **Metatarsalgia** is a general term for foot pain experienced under the metatarsal heads. It may occur with either pes planus or pes cavus.
- **Congenital talipes equinovarus (CTEV)**, also called **clubfoot**, is a congenital deformity in which one or both feet are abnormally positioned at birth due to abnormal development of bones, muscles, tendons, and ligaments.
- **The four components of clubfoot (CAVE mnemonic)**
- **C – Cavus:** High medial arch due to plantar flexion of the first metatarsal.
- **A – Adductus:** Forefoot is deviated medially.
- **V – Varus:** Heel (hindfoot) is inverted.
- **E – Equinus:** Ankle is plantar-flexed, with the heel pointing downward.



- **Morton's Foot Structure**
- **Second metatarsal is longer than the first metatarsal.**
- First metatarsal becomes **too mobile (hypermobile)**.
- During **toe-off phase of gait**, more body weight goes through the **2nd metatarsal head**.
- Causes:
 - Pain and tenderness under the 2nd metatarsal head.
 - **Callus formation** due to increased pressure.
- Can increase stress on **tibialis posterior muscle**.
- Often associated with **pes planus (flat foot)**.

Morton's Neuroma

- A **thickening/swelling of the interdigital nerve** in the foot.
- Usually occurs between the **3rd and 4th metatarsals**.
- Caused by:
 - Compression of the nerve between metatarsal bones.
 - Excessive movement (hypermobility) of metatarsals.
- Symptoms:
 - Burning pain, tingling, or numbness in the toes.
 - Pain increases with **walking or weight bearing**.
 - Tight shoes can make symptoms worse.

Typical Location of a Morton's Neuroma



Causes of Pes Planus

- **1. Joint & Ligament Laxity**
 - Loose joint capsules and ligaments allow excessive foot movement.
 - Can be inherited or caused by conditions like rheumatoid arthritis.
- **2. Poor Foot Biomechanics**
 - Abnormal movement of the **subtalar** and **midtarsal joints** can collapse the arch.
- **3. Tight Muscles & Tendons**
 - Tight **gastrocnemius, soleus, and Achilles tendon** limit ankle dorsiflexion.
 - Foot compensates by pronating, causing arch flattening.
- **4. Muscle Weakness**
 - Weak **tibialis posterior** (main arch-supporting muscle) reduces dynamic arch support.
- **5. Bone Abnormalities**
 - Abnormal foot bones or joint fusion can affect arch formation.
 - Long second metatarsal and hallux valgus may contribute.



Causes of Pes Planus (Flat Foot)

- **Lower Limb Alignment Problems**
- **Femoral anteversion** and **internal tibial torsion** increase internal rotation → foot pronation.
- **7. Poor Posture & Habits**
- Standing with feet wide apart increases hindfoot pronation.
- **8. Nerve Injury**
- Common peroneal or posterior tibial nerve damage can weaken foot muscles.
- **9. Trauma & Aging**
- Fractures, ligament injuries, or tibialis posterior tendon rupture can cause acquired flat foot.
- **10. Footwear & Pregnancy**
- Poor arch-support footwear may worsen pes planus.
- Pregnancy-related ligament laxity can contribute to flat feet.



Pes Planus (Flat Foot) – Symptoms & Muscle Changes

- **Medial arch becomes hypermobile** → foot collapses inward (**pronation**).
- Can be **functional or structural** and may affect **one or both feet**.
- **Pain may or may not occur**; when present, it is usually due to **muscle and ligament fatigue**.
- Common pain areas:
 - Bottom of the foot (plantar surface)
 - Tibialis anterior and posterior muscles
 - Sometimes knee, hip, or low back due to compensation.
- **Short & tight muscles (overactive):**
 - Peroneus longus, brevis, tertius
 - Gastrocnemius and soleus
 - Possible trigger points and tendon adhesions.
- **Lengthened & weak muscles:**
 - Tibialis posterior and anterior
 - Long toe flexors
 - Intrinsic foot muscles.
- May be associated with:
 - Plantar fasciitis
 - Shin splints
 - Iliotibial band tightness.
- Poor footwear, excessive standing, running, or occupational stress can worsen symptoms.



Pes Planus Assessment – Objective Findings

- **Observation & Postural Assessment**
- **Moderate Pes Planus**
- Hindfoot valgus: **6–10°**
- Foot is **pronated** and medial arch is flattened.
- Achilles tendon shows **valgus alignment**.
- Possible **internal tibial torsion** and knee valgus.
- Hip may show **internal rotation**.
- **Foot Changes**
- Talus head may bulge medially.
- Redness/callus may appear where shoes rub.
- First metatarsal may become valgus → **bunion formation**.
- Forefoot may be abducted.
- Morton's foot may show callus under 1st and 2nd metatarsal heads.
- **Gait Assessment**
- Normal gait: pronation occurs during **15–20% of stance phase**.
- Pes planus: pronation continues throughout the **entire stance phase**.



- **Palpation Findings**
- Tenderness may occur at:
 - Spring ligament
 - Navicular bone
 - Plantar fascia
 - Metatarsal heads
 - 1st MTP joint
- Possible heat, thickened skin, and callus formation.
- Muscle tightness:
 - **Short & tight:** Gastrocnemius, soleus, peroneals
 - **Overstretched:** Tibialis anterior/posterior, toe flexors
- **ROM & Testing**
- Increased calcaneal eversion ($>10^\circ$).
- Foot joints may be hypermobile.
- Severe cases may have limited ankle dorsiflexion.
- Hip internal rotation may be increased due to femoral anteversion.

Clinical Significance

Pes planus affects the entire lower limb alignment and may contribute to pain in the foot, knee, hip, and lower back.

- **Contraindications**

- Do not mobilize the hypermobile joints on the medial longitudinal arch.
- Do not passively stretch tibialis anterior and posterior, since this will allow increased pronation of the foot.
- Avoid using heat on the plantar surface of the foot in the presence of an inflammatory process such as plantar fasciitis.
- Friction techniques are contraindicated if the client is using anti-inflammatory medication.