

# Chapter 11

## The Ankle and Foot Joints

### Manual of Structural Kinesiology

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10-1

## The Ankle and Foot Joint

- 26 bones
- 19 large muscles
- Many small (intrinsic) muscles
- More than 100 ligaments
- Support & propulsion
  - Foot trouble - common ailment
  - Poor foot mechanics leads to foot discomfort
  - No substitute for adequate muscular development, strength, & proper foot mechanics

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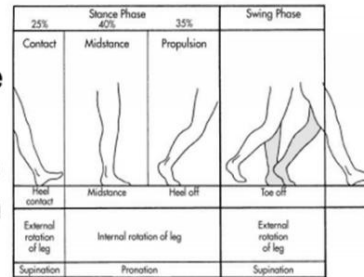
10-2

## The Ankle and Foot Joint

### • Walking & running

#### – Stance phase

- Heel-strike occurs when landing on heel, foot should be in supination
- Midstance immediately follows with foot moving into pronation
- Toe-off follows midstance, foot returns to supination prior to and during push off

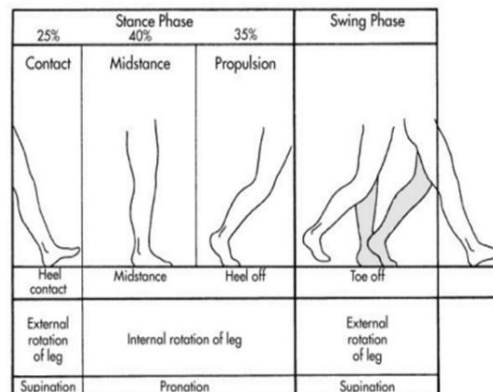


## The Ankle and Foot Joint

### • Walking & running

#### – Swing phase

- occurs when foot leaves ground & leg moves forward to another point of contact



## The Ankle and Foot Joint

- Problems arise
  - foot is too rigid & does not pronate adequately
  - foot remains in pronation past midstance
- Walking
  - one foot is always in contact with ground
- Running
  - point when neither foot is in contact with ground

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## Bones

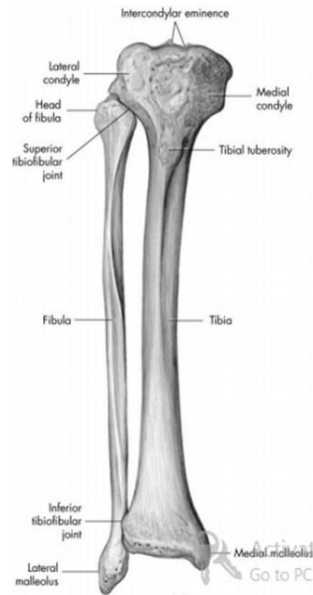
- 26 bones in each foot that form arch
- Body weight is transferred from tibia to talus & calcaneus (tarsal bones)
- 5 other rear & midfoot tarsal bones
  - Navicular - between talus & 3 cuneiform bones
  - Cuboid - between calcaneus and 4<sup>th</sup> & 5<sup>th</sup> metatarsals
  - 5 metatarsals - anterior to tarsals
  - 5 phalanges
    - 3 phalanges in each except 1<sup>st</sup> toe (2 phalanges)
    - 2 sesamoids beneath 1<sup>st</sup> metatarsophangeal joint

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## Bones

- Distal malleoli of tibia & fibula
  - Enlarged & protrude horizontally & inferiorly
  - Serve as pulley for posterior tendons to increase mechanical advantage of muscles in performing inversion & eversion actions



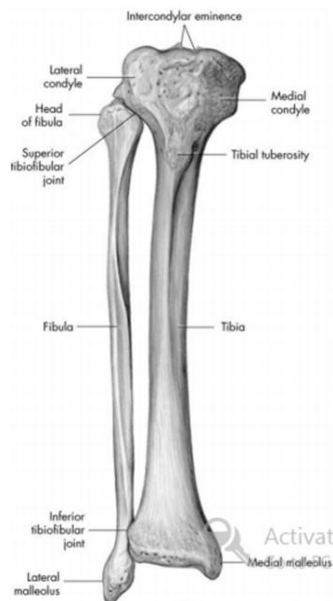
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10-7

## Bones

- Pulley for posterior tendons
  - Peroneus brevis & peroneus longus - immediately behind lateral malleolus
  - Peroneus brevis & peroneus longus - immediately behind lateral malleolus
  - “Tom, Dick & Harry” muscles immediately posterior to medial malleolus
    - Tibialis posterior
    - Flexor digitorum longus
    - Flexor hallucis longus



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## Bones

- **Base of 5th metatarsal**
  - enlarged & prominent to serve as insertion for peroneus brevis & tertius

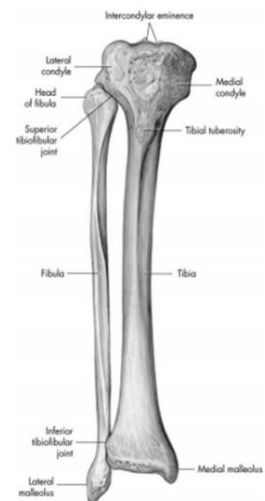


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## Joints

- **Tibiofibular joint**
  - Syndesmotic amphiarthrodial joint
  - Joined at both proximal & distal tibiofibular joints
  - Ligaments and a strong, dense interosseus membrane between tibia & fibula shafts provide support
  - Minimal movement possible
  - Distal joint becomes sprained occasionally in heavy contact sport



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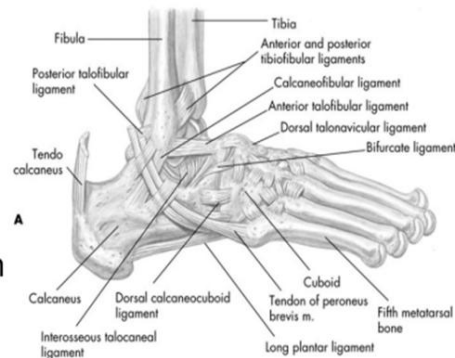
10-10

## Joints

- Tibiofibular joint

- Syndesmosis joint sprain

- “High ankle sprain” primarily involves anterior inferior tibiofibular ligament
    - More severe injuries can involve posterior tibiofibular ligament, interosseus ligament, & interosseus membrane



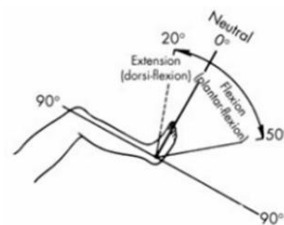
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10-11

## Joints

- Ankle joint (talocrural joint)

- Hinge or ginglymus-type joint
  - Talus, distal tibia, & distal fibula
  - 50 degrees of plantar flexion
  - 15 to 20 degrees of dorsiflexion
  - Greater range of dorsiflexion with knee flexed (reduces gastrocnemius tension)
  - Fibula rotates 3 to 5 degrees externally with ankle dorsiflexion & 3 to 5 degrees internally during plantarflexion
  - Syndesmosis joint widens by 1 to 2 millimeters during full dorsiflexion



Ankle joint

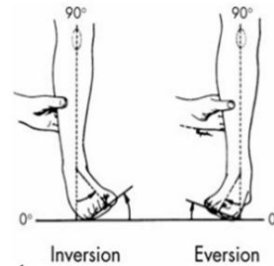
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10-12

## Joints

- Subtalar & transverse tarsal joints

- Inversion & eversion occurs here
- Classified as gliding or arthrodial
- Combined movement of
  - 20 to 30 degrees of inversion
  - 5 to 15 degrees of eversion



- Intertarsal & tarsometatarsal joints

- Arthrodial
- Minimal movement

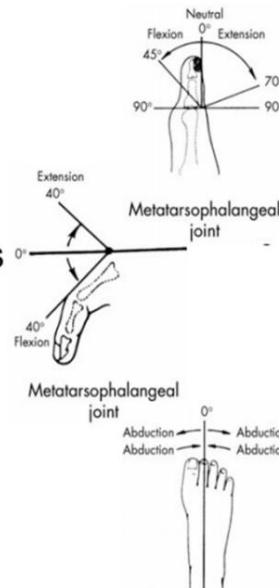
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10-13

## Joints

- Metatarsophalangeal joints

- Phalanges join metatarsals
- Classified as condyloid-type joints
- Great toe metatarsophalangeal (MP) joint flexes 45 degrees & extends 70 degrees
- MP joints of the four lesser toes
  - 40 degrees of flexion
  - 40 degrees of extension
  - also abduct & adduct minimally

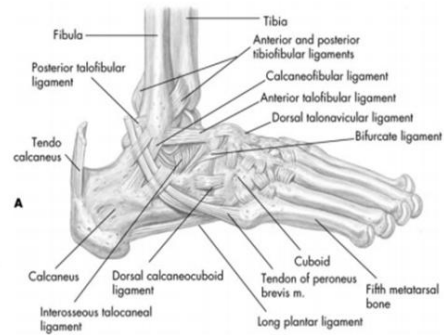


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## Joints

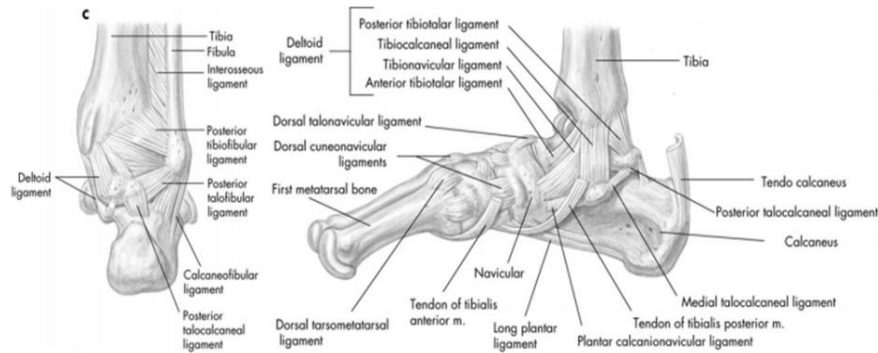
- Ankle sprains very common injury
  - Sprains involve stretching or tearing of one or more ligaments
  - Most common ankle sprain results from excessive inversion that causes damage to lateral ligamentous structures, primarily anterior talofibular ligament & calcaneofibular ligament



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- Ankle sprains very common injury
  - Excessive eversion forces injures deltoid ligament (medially) - less common



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## Joints

- Ligaments in foot & ankle maintain arches
- Two longitudinal arches
  - Medial longitudinal arch - extends from calcaneus bone to talus, navicular, 3 cuneiforms, and proximal ends of 3 medial metatarsals
  - Lateral longitudinal arch - extends from calcaneus to cuboid and proximal ends of 4<sup>th</sup> & 5<sup>th</sup> metatarsals
  - Long arches may be high, medium, or low

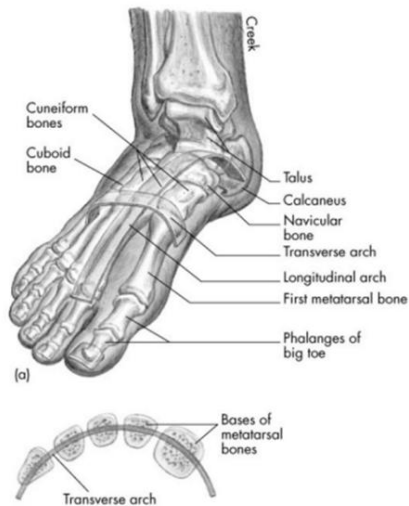


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## Joints

- Transverse arch
  - extends across foot from 1<sup>st</sup> metatarsal to the 5<sup>th</sup> metatarsal



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## Movements

- Dorsiflexion (flexion)
  - movement of top of ankle & foot toward anterior tibia
- Plantar flexion (extension)
  - movement of ankle & foot away from tibia



Dorsiflexion



Plantar flexion

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10-19

## Movements

- Eversion
  - turning ankle & foot outward; abduction, away from midline; weight is on medial edge of foot
- Inversion
  - turning ankle & foot inward; adduction, toward midline; weight is on lateral edge of foot



Transverse tarsal and subtalar eversion



Transverse tarsal and subtalar inversion

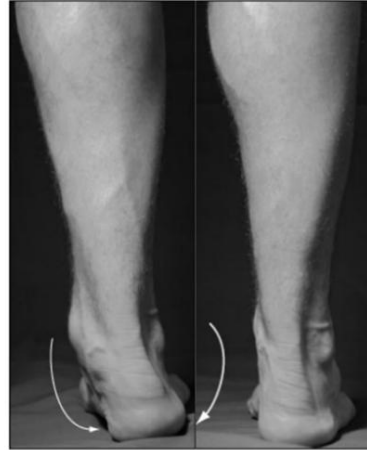
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10-20

## Movements

- **Pronation**
  - combination of ankle dorsiflexion, subtalar eversion, & forefoot abduction (toe-out)
- **Supination**
  - combination of ankle plantar flexion, subtalar inversion, & forefoot adduction (toe-in)



**Pronation**

**Supination**

*malof*

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10-21

## Muscles

- **Group according to location & function**
  - Anterior ankle & foot - dorsal flexors
  - Posteriorly - plantar flexors
    - triceps surae
      - gastrocnemius & soleus
  - Laterally - evertors
  - Medially - invertors

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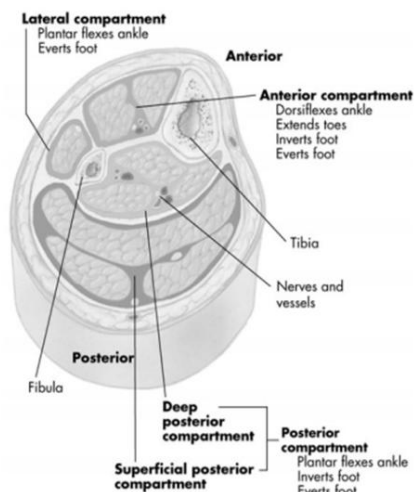
- Lower leg - divided into 4 compartments
  - Dense fascia - tightly surrounds & binds each
    - Facilitates venous return & prevents excessive swelling of muscles during exercise
  - Anterior compartment
    - Dorsiflexor group - tibialis anterior, peroneus tertius, extensor digitorum longus, & extensor hallucis longus
  - Lateral compartment
    - Peroneus longus & peroneus brevis (two most powerful evertors)

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10-23

## Muscles

- Superficial posterior compartment
  - Gastrocnemius, soleus, & plantaris - plantar flexors
- Deep posterior compartment
  - Flexor digitorum longus, flexor hallucis longus, popliteus, & tibialis posterior
  - All are plantar flexors & invertors except popliteus



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10-24

## Muscles

- **Acute & chronic injuries are common**
  - “Shin splints” - common term describing painful leg condition often associated with running activities
    - Not a specific diagnosis
    - Attributed to a number of different specific musculotendinous injuries
    - Most often involves tibialis posterior, medial soleus, or anterior tibialis, but may also involve extensor digitorum longus
    - May be partially prevented by stretching plantar flexors & strengthening dorsiflexors

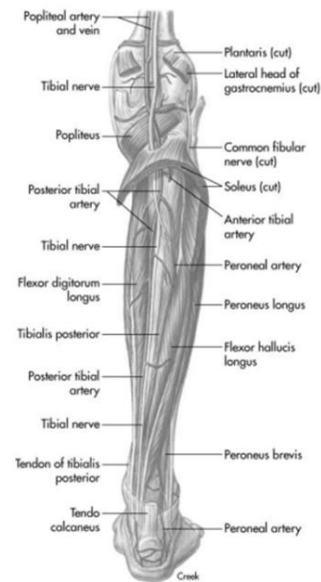
## Muscles

- **Painful cramps - acute muscle spasm in gastrocnemius & soleus**
  - Occur somewhat commonly
  - May be relieved through active & passive dorsiflexion
- **Complete rupture of Achilles tendon**
  - very disabling injury
- **Several ankle & foot muscles produce more than one movement**

## Muscles

### Ankle & foot joint muscles by function

- Plantar flexors
  - Gastrocnemius
  - Flexor digitorum longus
  - Flexor hallucis longus
  - Peroneus (fibularis) longus
  - Peroneus (fibularis) brevis
  - Plantaris
  - Soleus
  - Tibialis posterior



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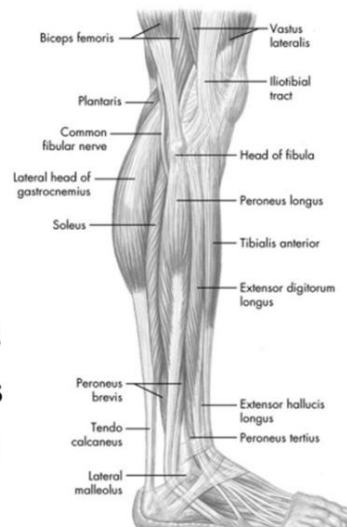
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10-27

## Muscles

### Ankle & foot joint muscles by function

- Evertors
  - Peroneus (fibularis) longus
  - Peroneus (fibularis) brevis
  - Peroneus (fibularis) tertius
  - Extensor digitorum longus



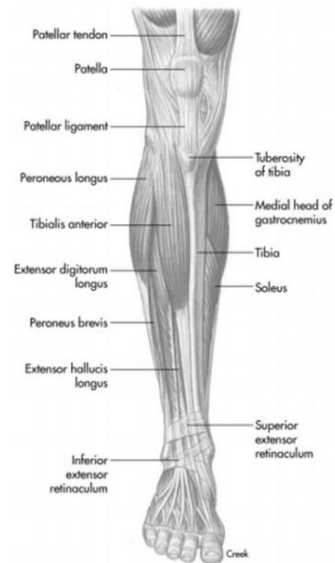
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10-28

## Muscles

### Ankle & foot joint muscles by function

- Dorsiflexors
  - Tibialis anterior
  - Peroneus (fibularis) tertius
  - Extensor digitorum longus (extensor of lesser toes)
  - Extensor hallucis longus (extensor of great toe)



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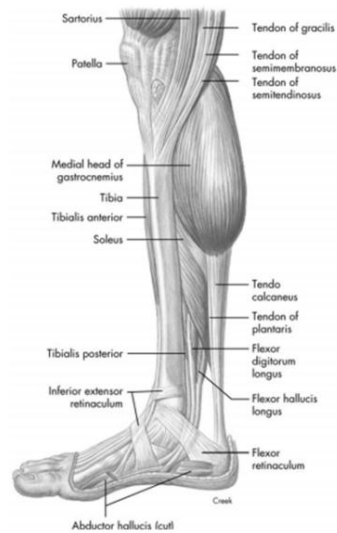
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10-29

## Muscles

### Ankle & foot joint muscles by function

- Invertors
  - Tibialis anterior
  - Tibialis posterior
  - Flexor digitorum longus (flexor of lesser toes)
  - Flexor hallucis longus (flexor of great toe)



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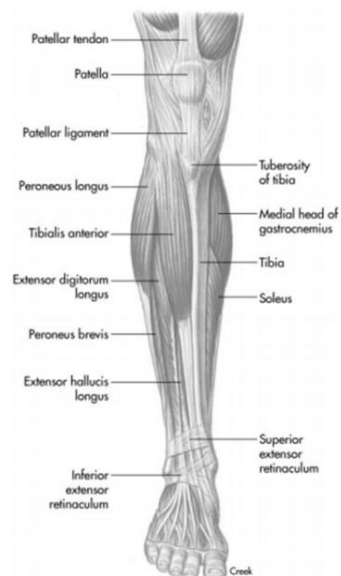
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10-30

## Muscles

### Ankle & foot joint muscles by compartment

- Anterior compartment
  - Tibialis anterior
  - Extensor hallucis longus
  - Extensor digitorum longus
  - Peroneus (fibularis) tertius



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## Nerves

- Sciatic nerve
  - tibial division
    - gastrocnemius (medial head), soleus, tibialis posterior, flexor digitorum longus, & flexor hallucis longus
    - medial & lateral plantar nerves - intrinsic foot muscles
      - medial plantar nerve
        - » abductor hallucis, flexor hallucis brevis, first lumbricale, & flexor digitorum brevis



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10-32



## Nerves

- **Sciatic nerve**
  - tibial division
    - medial & lateral plantar nerves
      - intrinsic foot muscles
        - lateral plantar nerve
          - » adductor hallucis, quadratus plantae, lumbricales (2, 4, & 4), dorsal interossei, plantar interossei, abductor digiti minimi, & flexor digiti minimi

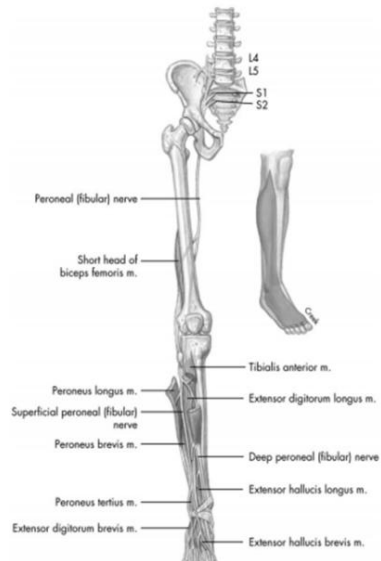


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10-33

## Nerves

- **Sciatic nerve**
  - common peroneal (fibular) division
    - Superficial peroneal nerve
      - peroneus longus & peroneus brevis
    - Deep peroneal nerve
      - tibialis anterior, extensor digitorum longus, extensor hallucis longus, peroneus tertius, & extensor digitorum brevis



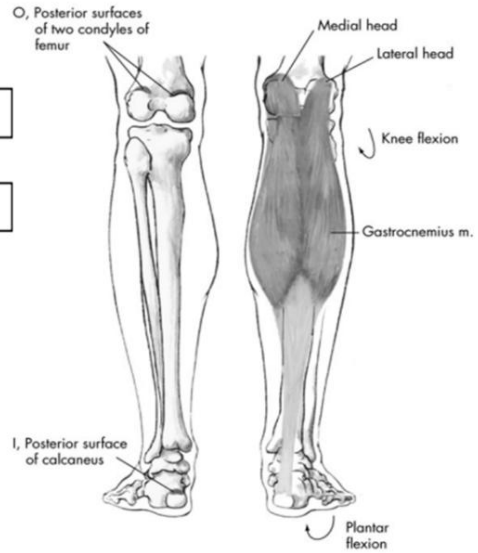
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10-34

## Gastrocnemius Muscle

Plantar flexion of ankle

Flexion of knee



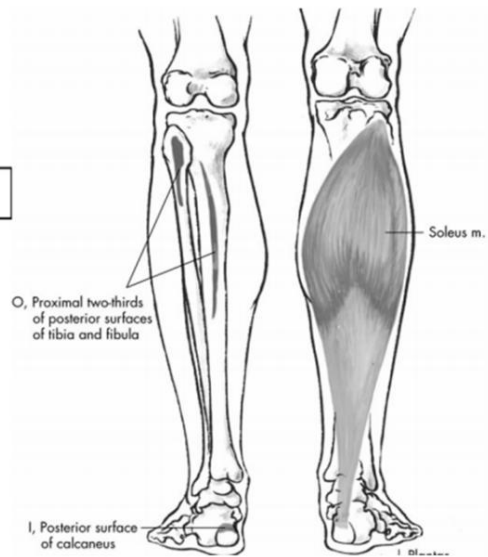
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## Soleus Muscle

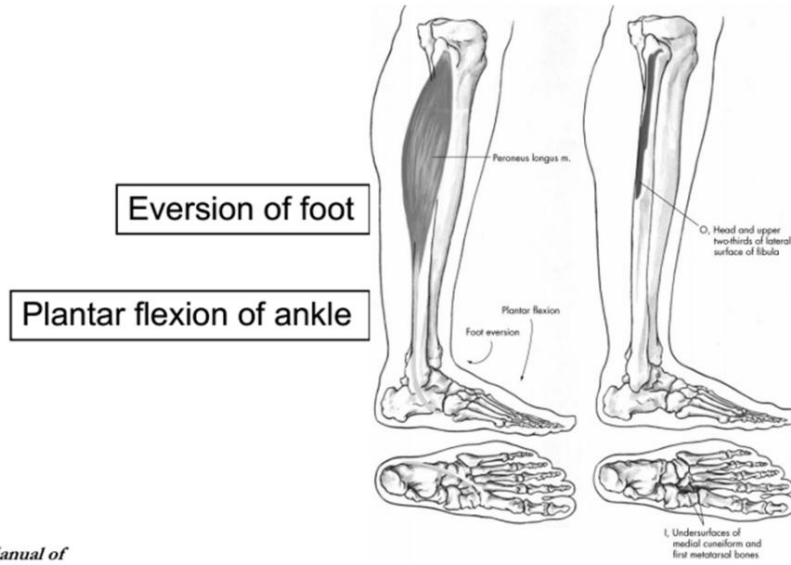
Plantar flexion of ankle



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## Peroneus Longus (fibularis) Muscle

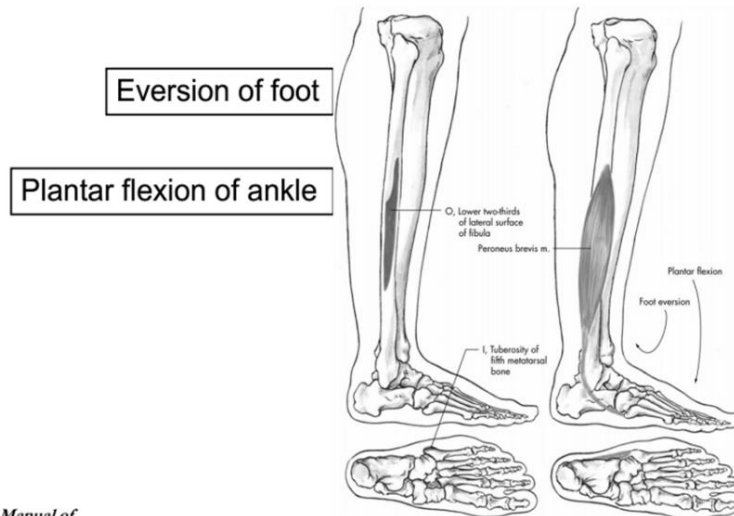


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10-37

## عضلة بيرونيوس القصيرة (الشظية).



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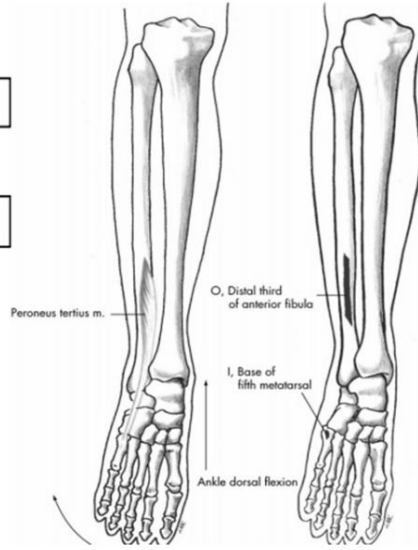
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10-38

## عضلة بيرونيوس تيرتيوس (الشظية).

Eversion of foot

Dorsal flexion of ankle



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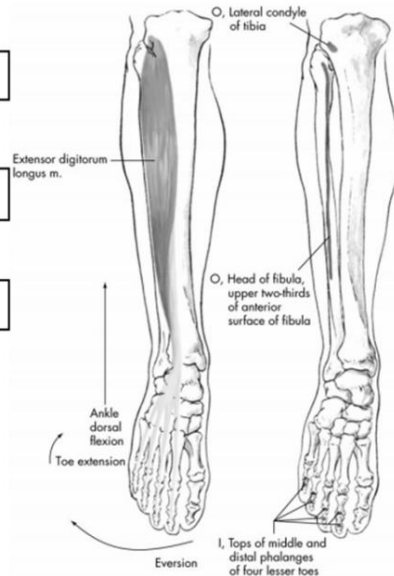
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## العضلة الطويلة لأصابع الباسطة

Extension of four lesser toes

Dorsal flexion of ankle

Eversion of foot



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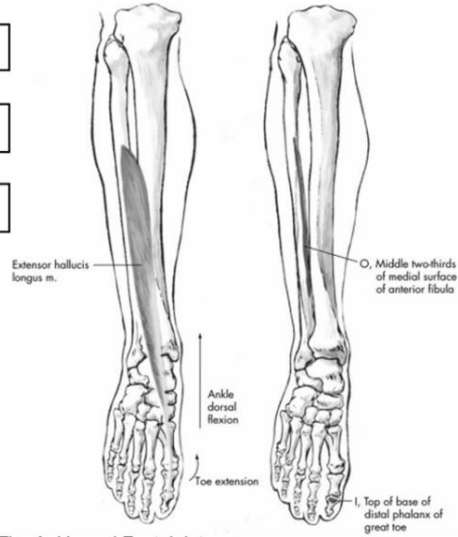
10-40

## العضلة الباسطة للهلوسة الطويلة

Dorsiflexion of ankle

Extension of great toe

Weak inversion of foot



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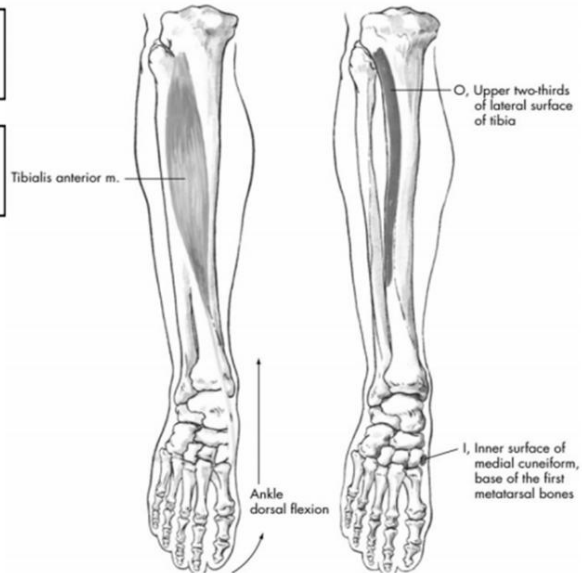
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10-41

## العضلة الظنبوية الأمامية

Dorsal flexion of ankle

Inversion of foot



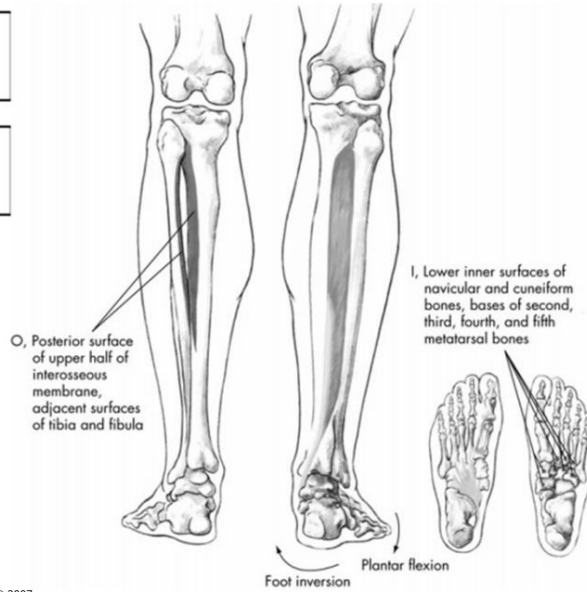
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10-42

## العضلة الظنبوية الخلفية

Plantar flexion of ankle

Inversion of foot



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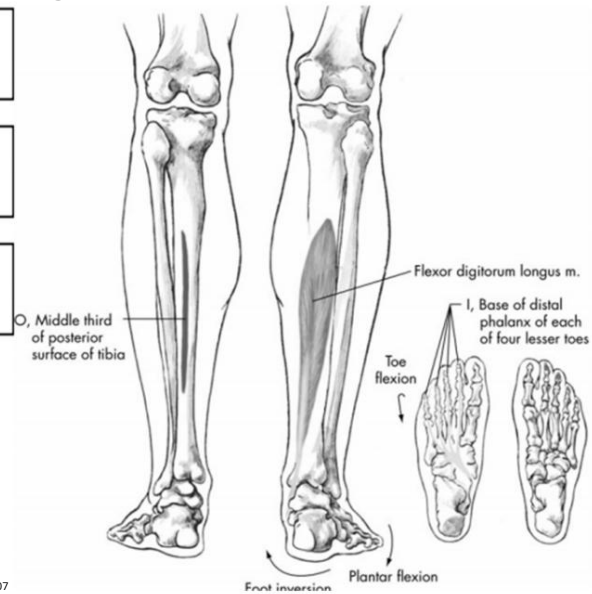
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## العضلة المثنية الطويلة للأصابع

Flexion of four lesser toes

Plantar flexion of ankle

Inversion of foot



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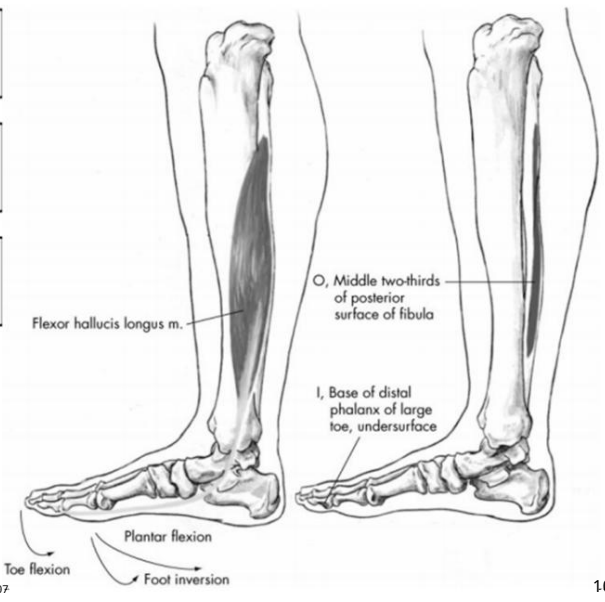
10-44

## العضلة المثنية الطويلة للهلوسة

Flexion of great toe

Inversion of foot

Plantar flexion of ankle

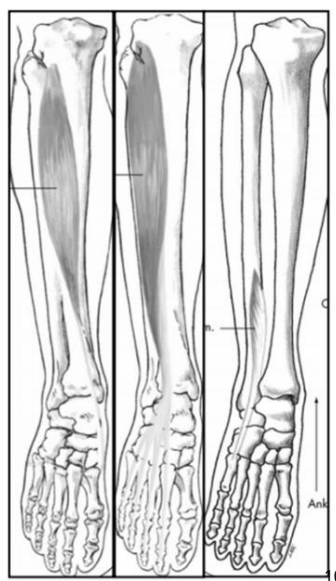


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10-45

## عطف ظهري الكاحل

- Agonists
  - Tibialis anterior
  - Extensor digitorum longus
  - Peroneus tertius
    - Extensor hallucis longus



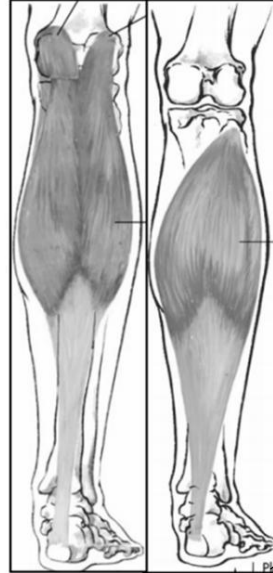
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10-46

## انثناء الكاحل الأمامي

- Agonists

- Gastrocnemius
- Soleus
  - Flexor digitorum longus
  - Flexor hallucis longus
  - Peroneus (fibularis) longus
  - Peroneus (fibularis) brevis
  - Plantaris
  - Tibialis posterior



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## انعكاس تحت الكاحل

- Agonists

- Tibialis anterior
- Tibialis posterior
  - Flexor digitorum longus
  - Flexor hallucis longus



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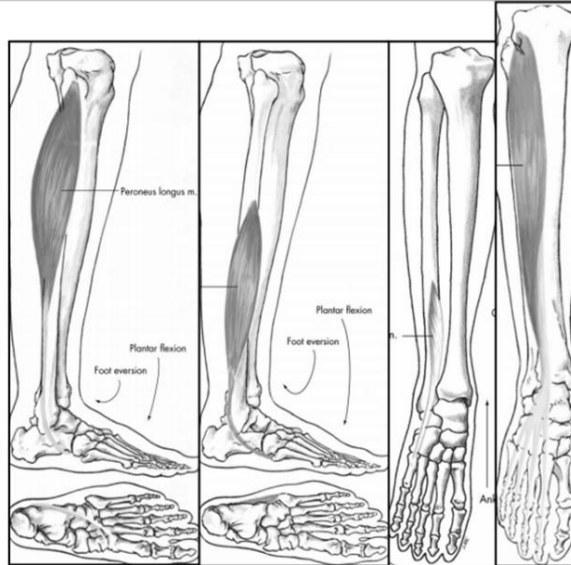
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## انقلاب تحت التالار

### Agonists

- Peroneus (fibularis) longus
- Peroneus (fibularis) brevis
- Peroneus tertius
- Extensor digitorum longus



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