Biomecânica do Tornozelo e Pé

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LaBiMPH USP
Laboratório de Biomecânica do Movimento e Postura Humana

MEDICINA

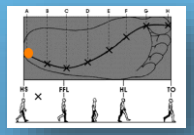
VISÃO GERAL

Arcos Plantares:

estrutura, função, suporte estático, alterações

Rolamento funcional do pé:

suporte dinâmico

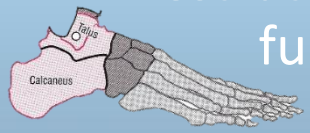


Anatomia e Biomecânica Complexo tornozelo e pé:

componentes, generalidades

Divisão sistemática pé:

estruturas articulares e funcionalidade



Contexto clínico :

Hálux valgo e deformidades de dedos; pé diabético; calçados e órteses

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Sacco, ICN

Referência Complementar

SACCO, I.C.N.; TANAKA C. Cinesiologia e Biomecânica dos Complexos Articulares. Guanabara Koogan, RJ, 2008.

Biomecânica do complexo articular do tornozelo & pé

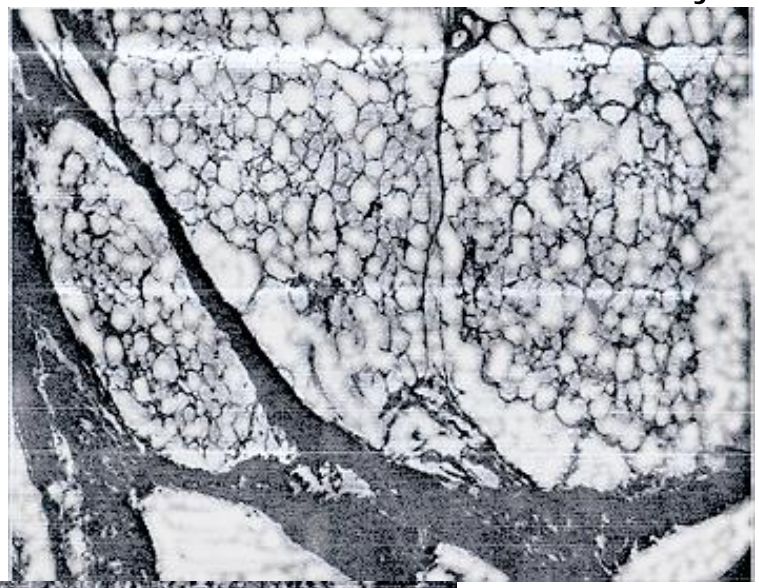
FUNÇÕES

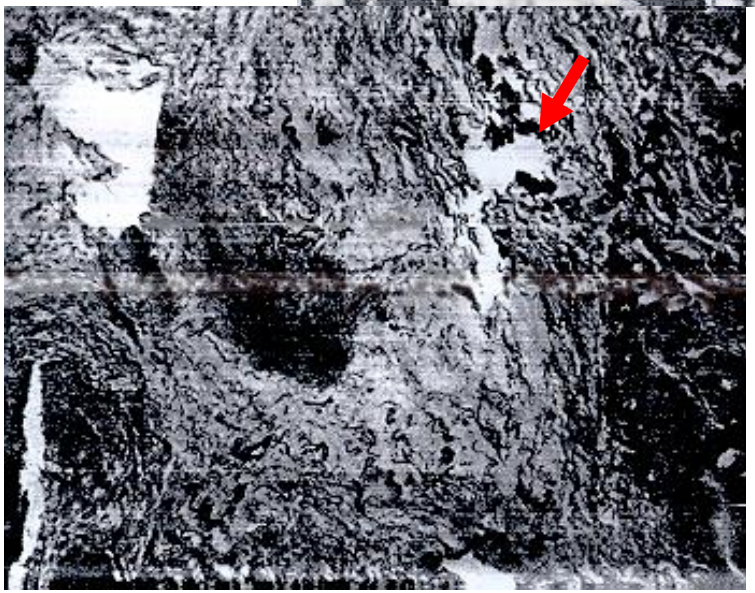
- Suporte do peso
- Controle e estabilização do MMII
- Ajuste à superfície de contato
- Manipulação de objetos e operação de máquinas
- Propulsão - locomoção
- Amortecimento de choques: músculos instrínsecos + coxins adiposos (calcanhar, 2ª a 4ª CMT)

Coxim Adiposo

Septos

Criança

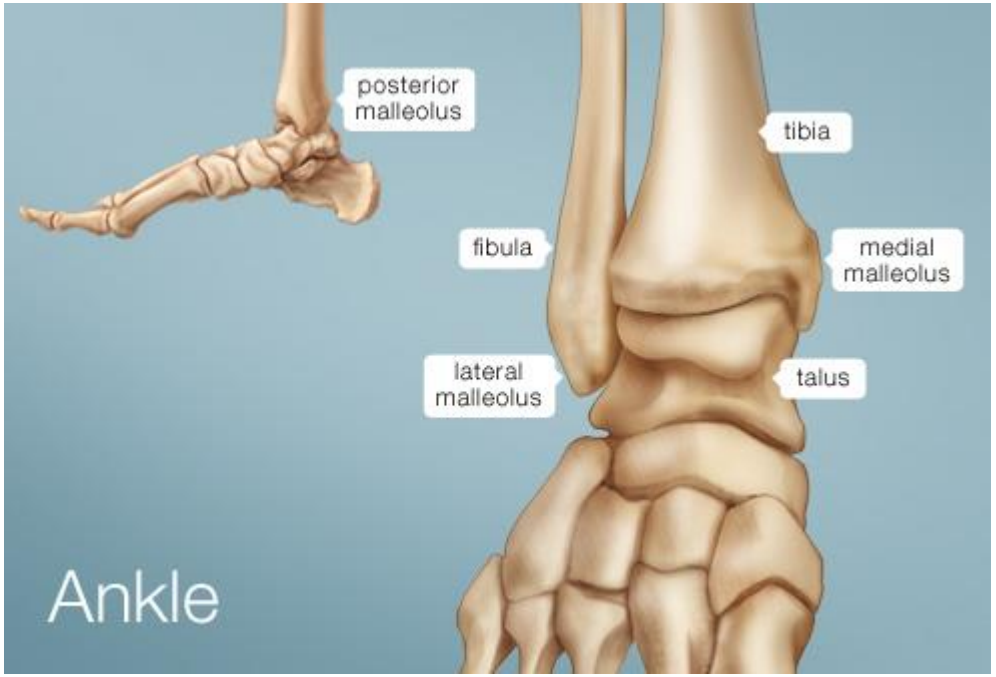




60 anos

TORNOZELO

Formado por tíbia, fíbula e tálus



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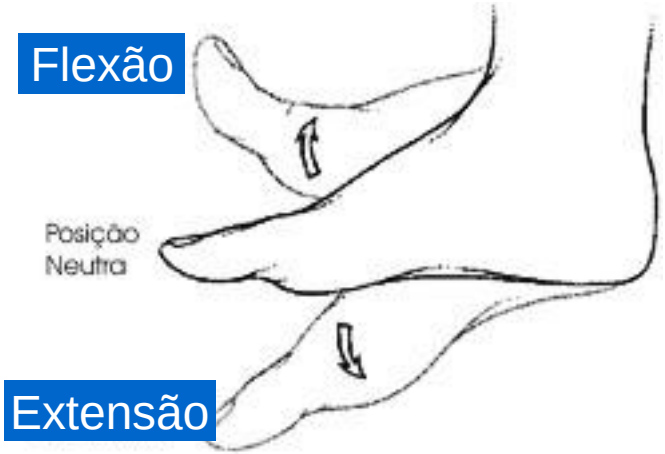
TORNOZELO

Formado por tíbia, fíbula e tálus

Tipo Gínglimo – 1 grau liberdade

Flexão: 20 a 30º

Extensão: 30 a 50º



57 articulações

25 músculos

108 ligamentos

26 ossos
Pé
Ações preventivas
Intervenções precoces
108 ligamentos

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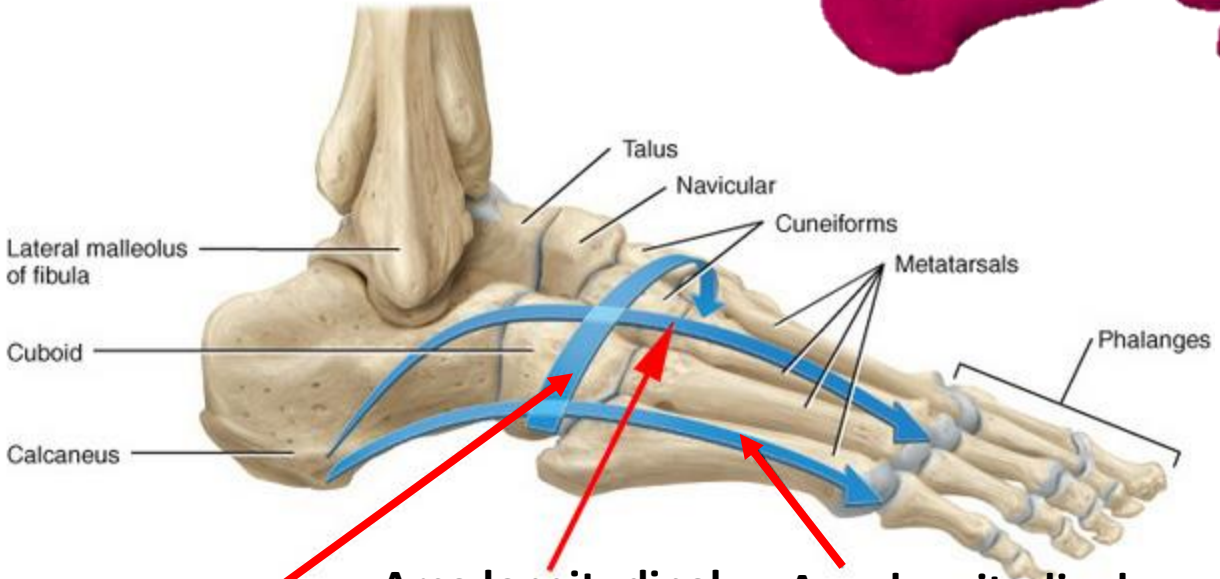
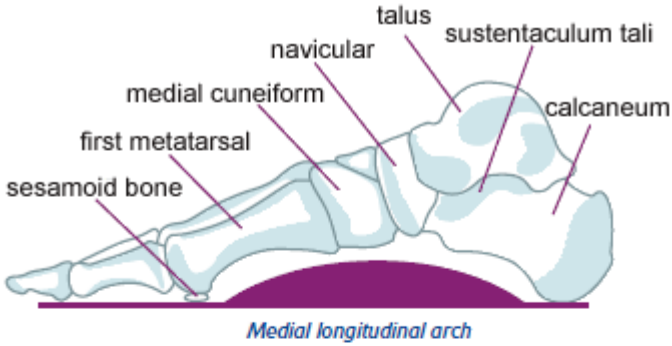
Arcos Plantares



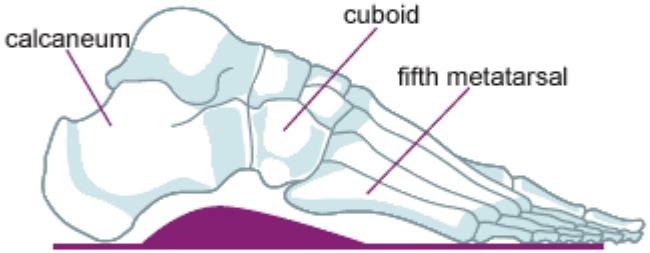
Arco longitudinal (parte lateral)

Arco longitudinal (parte medial)

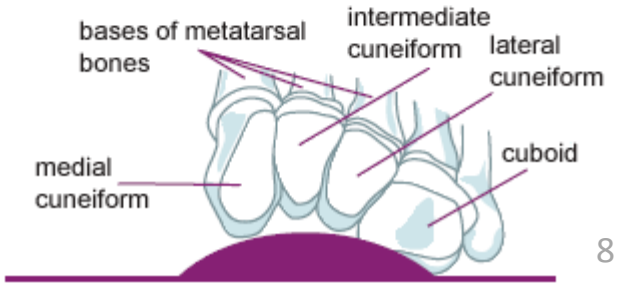
Arco transverso
Art: intercuneiforme e cuneocubóide



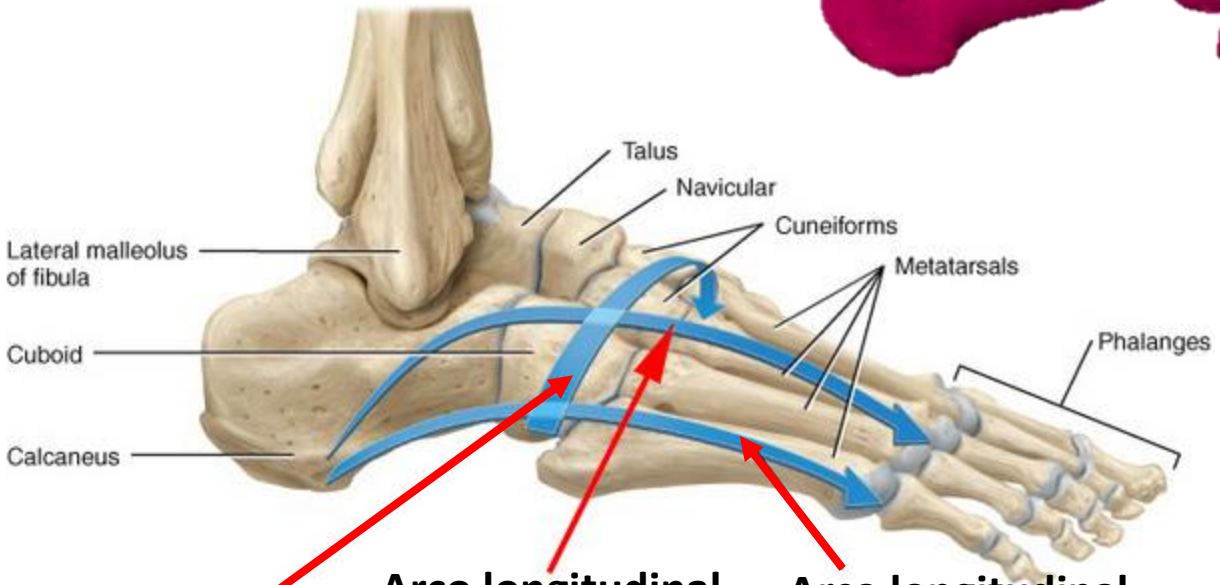
Medial longitudinal arch



Lateral longitudinal arch



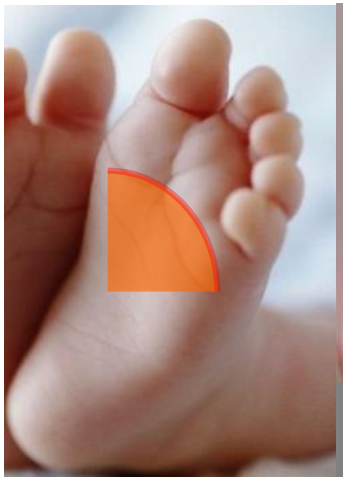
Arcos Plantares



Arco longitudinal
(parte lateral)

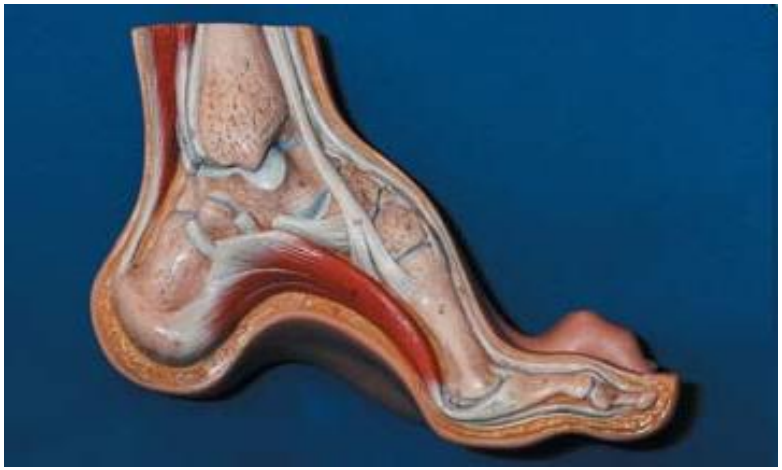
Arco longitudinal
(parte medial)

Arco transverso
Art: intercuneiforme e cuneocubóide



Transverso (ças sem carga retropé e medio-pé)

Tipos arco longitudinal

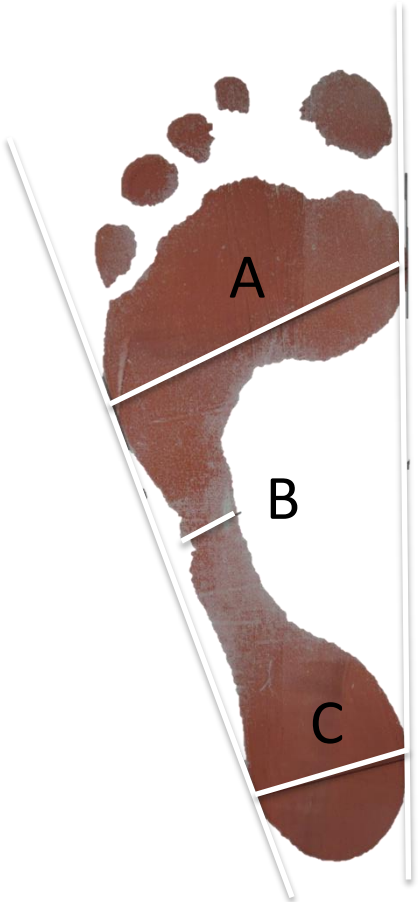


Avaliação Arco longitudinal:
impressão plantar

Pedígrafo

DISTRIBUIÇÃO DE CARGA DO PÉ

Cálculo índice Arco Plantar

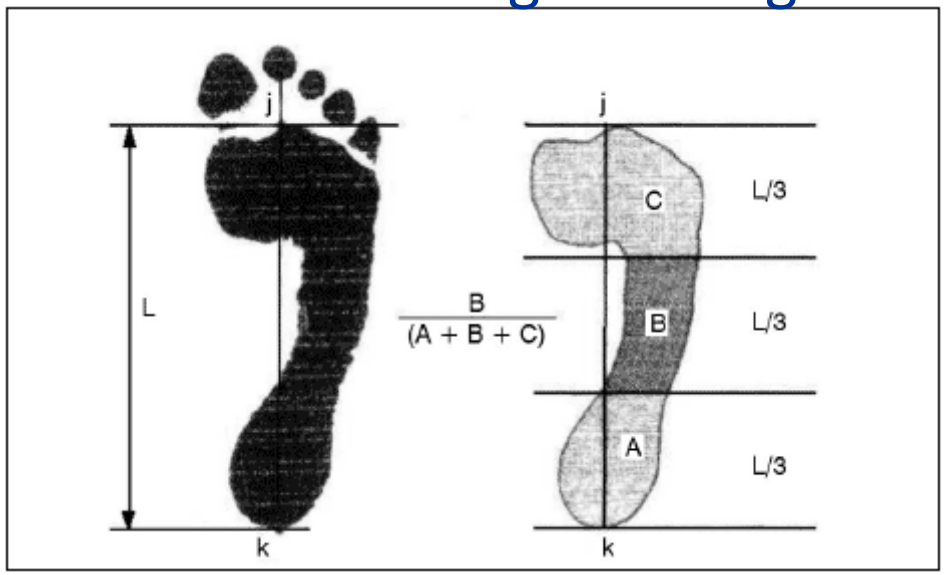


A – Largura Antepé
B – Largura Médio-pé
C – Largura calcanhar

B/A – Chippaux-Smirak Index

B/C – Staheli Index

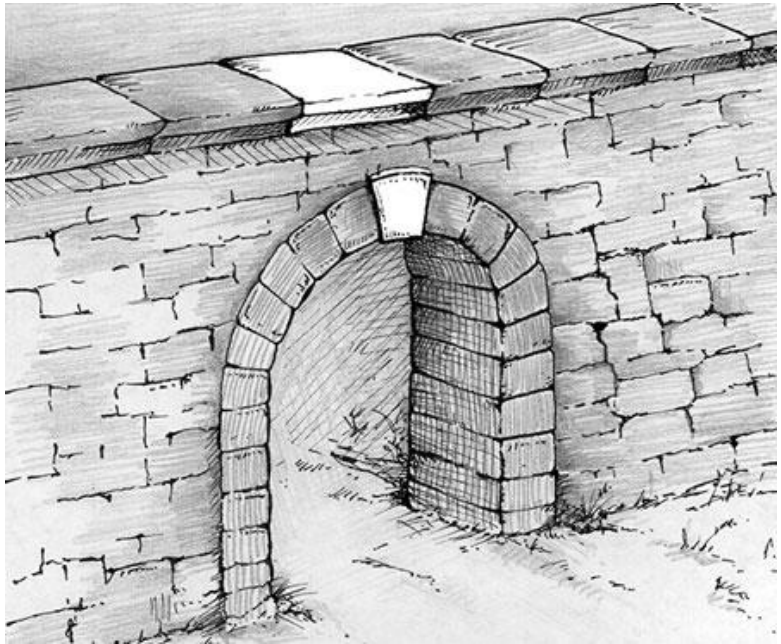
Índice de Cavanagh & Rodgers



Arcos Plantares

Definição Arco: "estrutura curva que suporta o peso de um material acima de um espaço vazio."

Assim, um **ARCO** é uma estrutura que é capaz de suportar um peso acima de um espaço sem suporte, a partir do apoio de suas extremidades.



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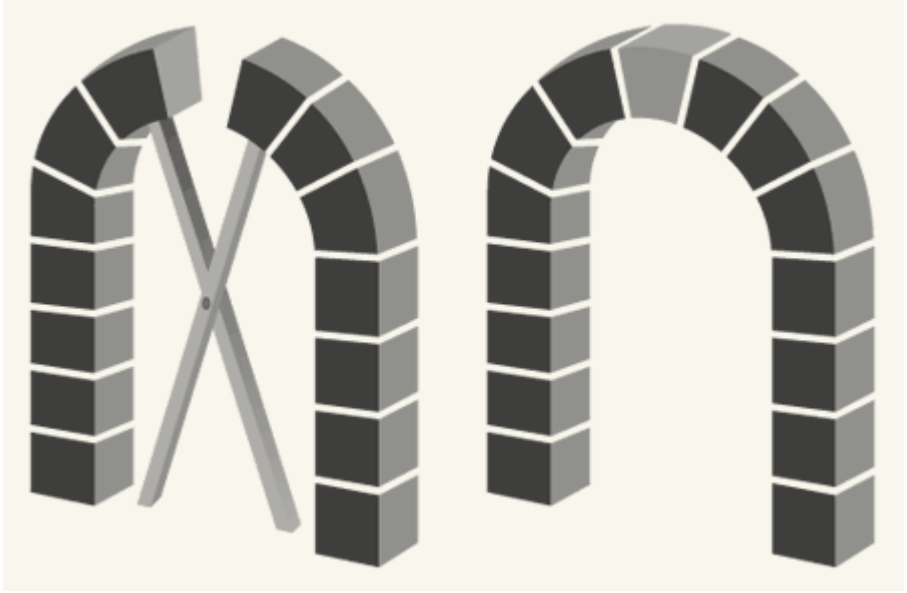
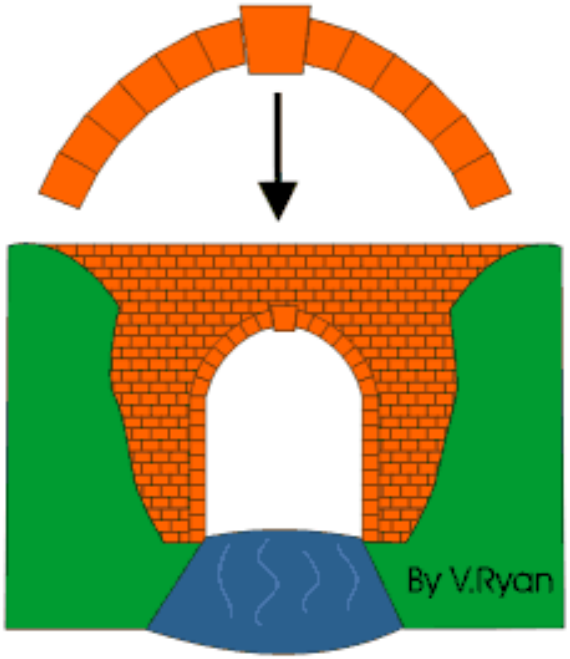
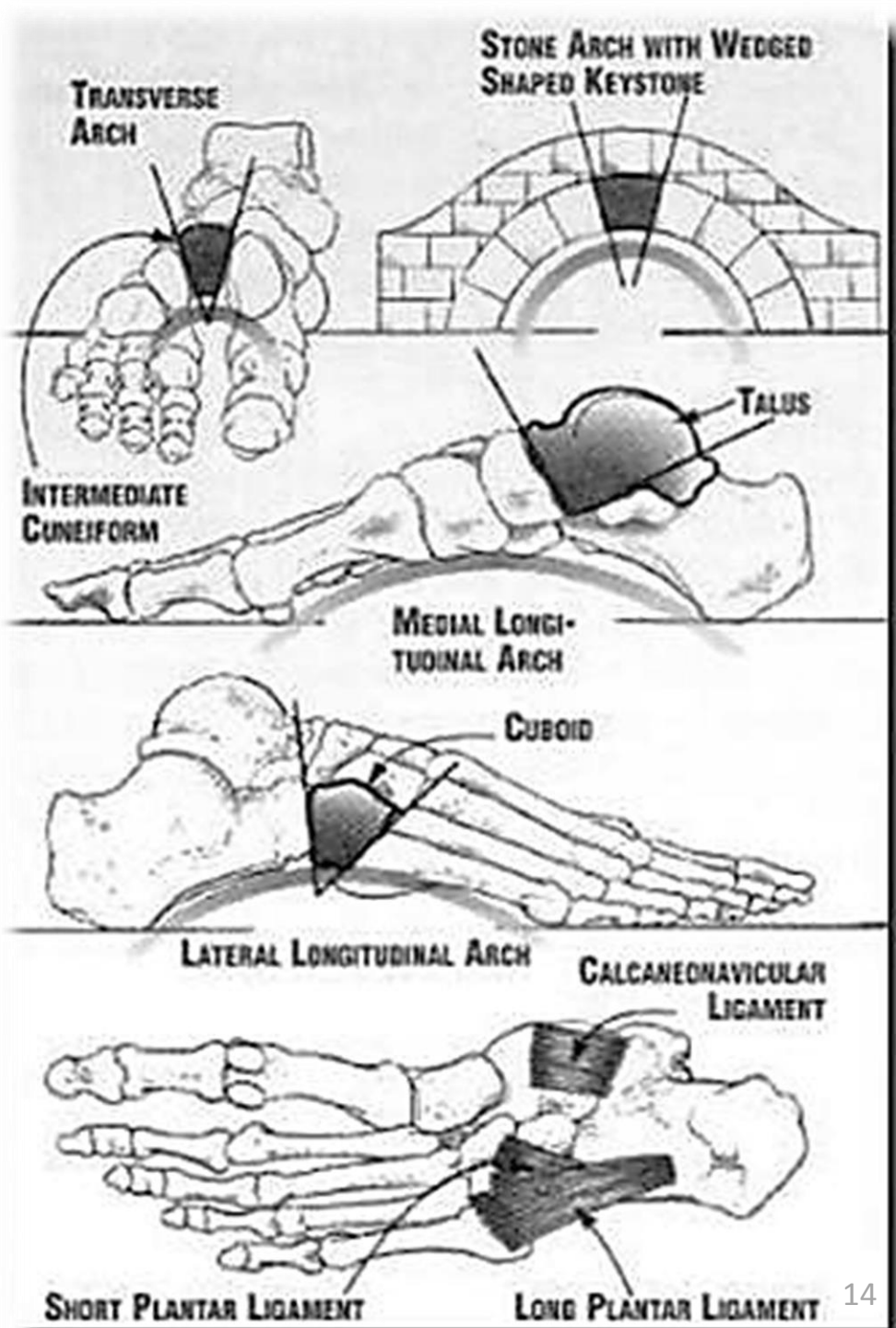


KEYSTONE


By V.Ryan


Stone Arch with Wedged Shaped Keystone
Transverse Arch
Talus
Intermediate Cuneiform
Medial Longi-tudinal Arch
Cuboid
Lateral Longitudinal Arch
Calcaneonavicular Ligament
Short Plantar Ligament
Long Plantar Ligament

Pedra principal

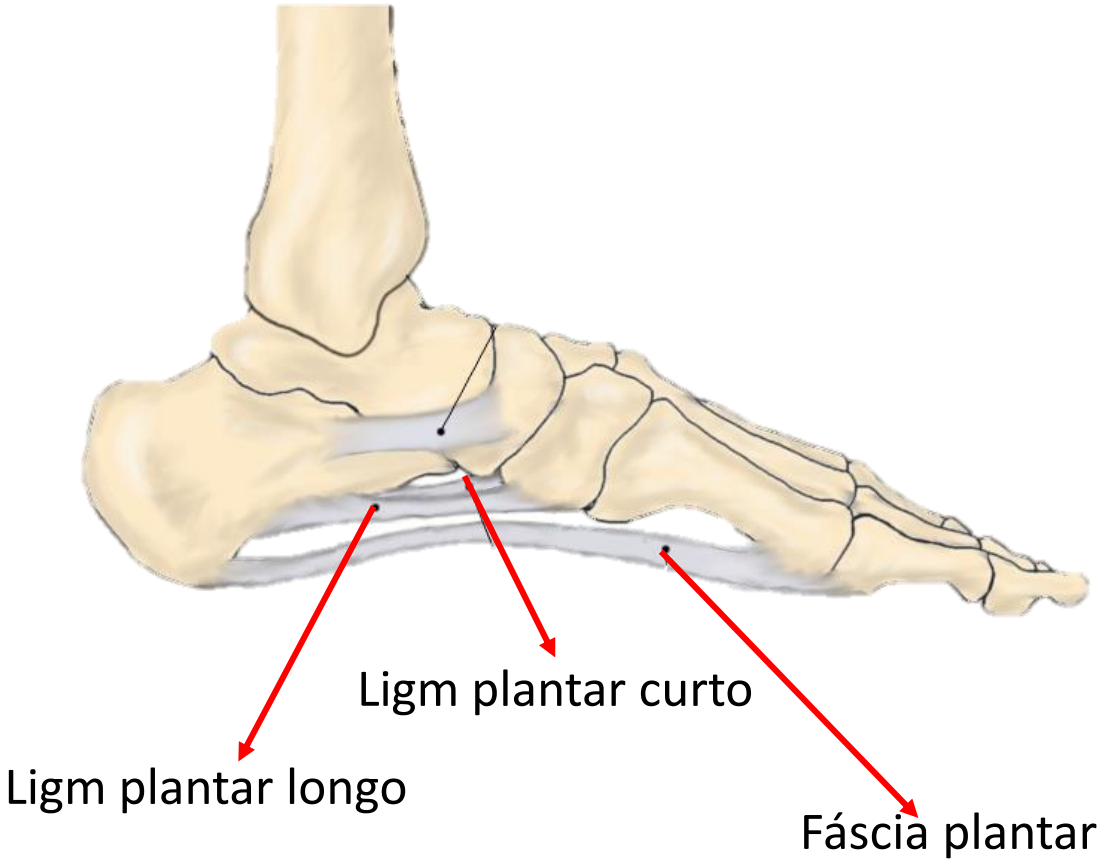
“Grampos”

Viga mestra

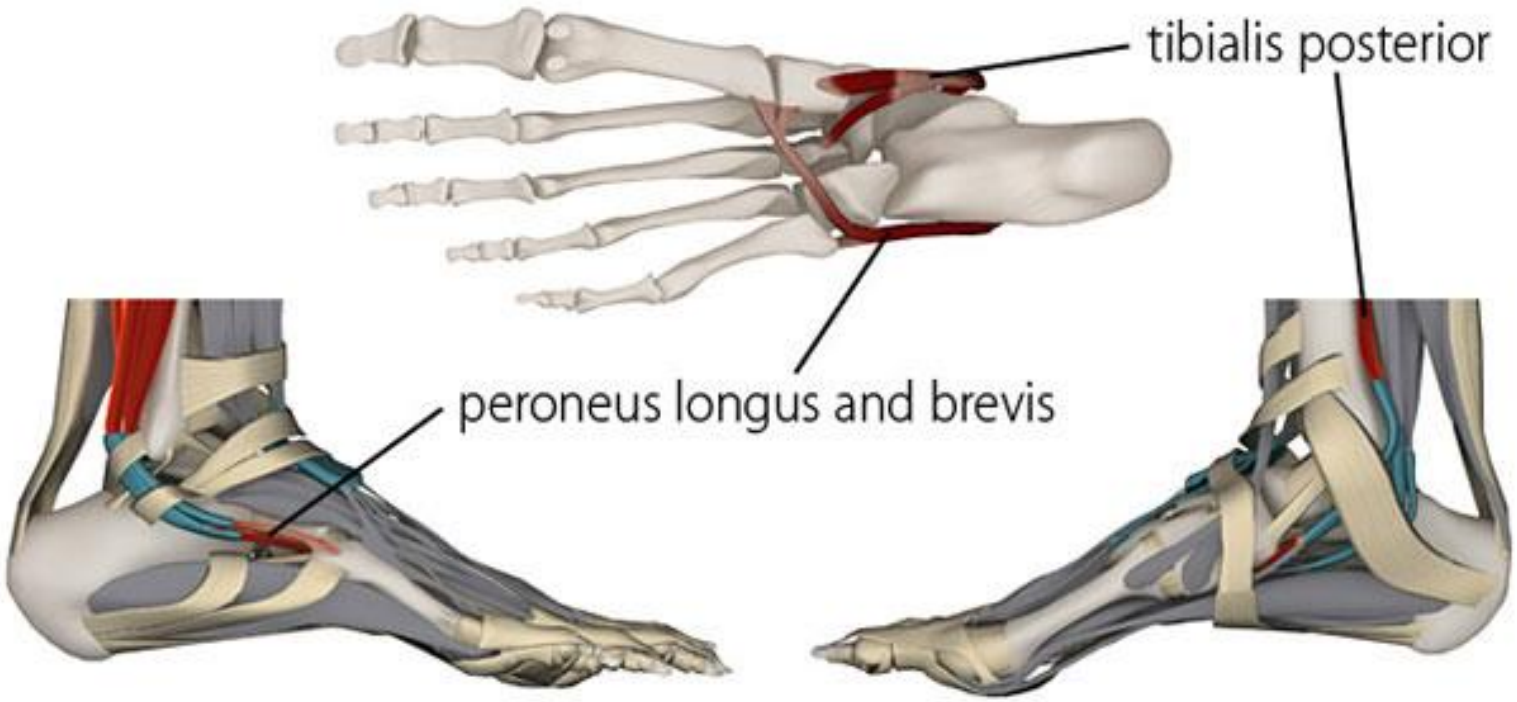
Suspensões

Estabilizadores passivos

Fáscia plantar

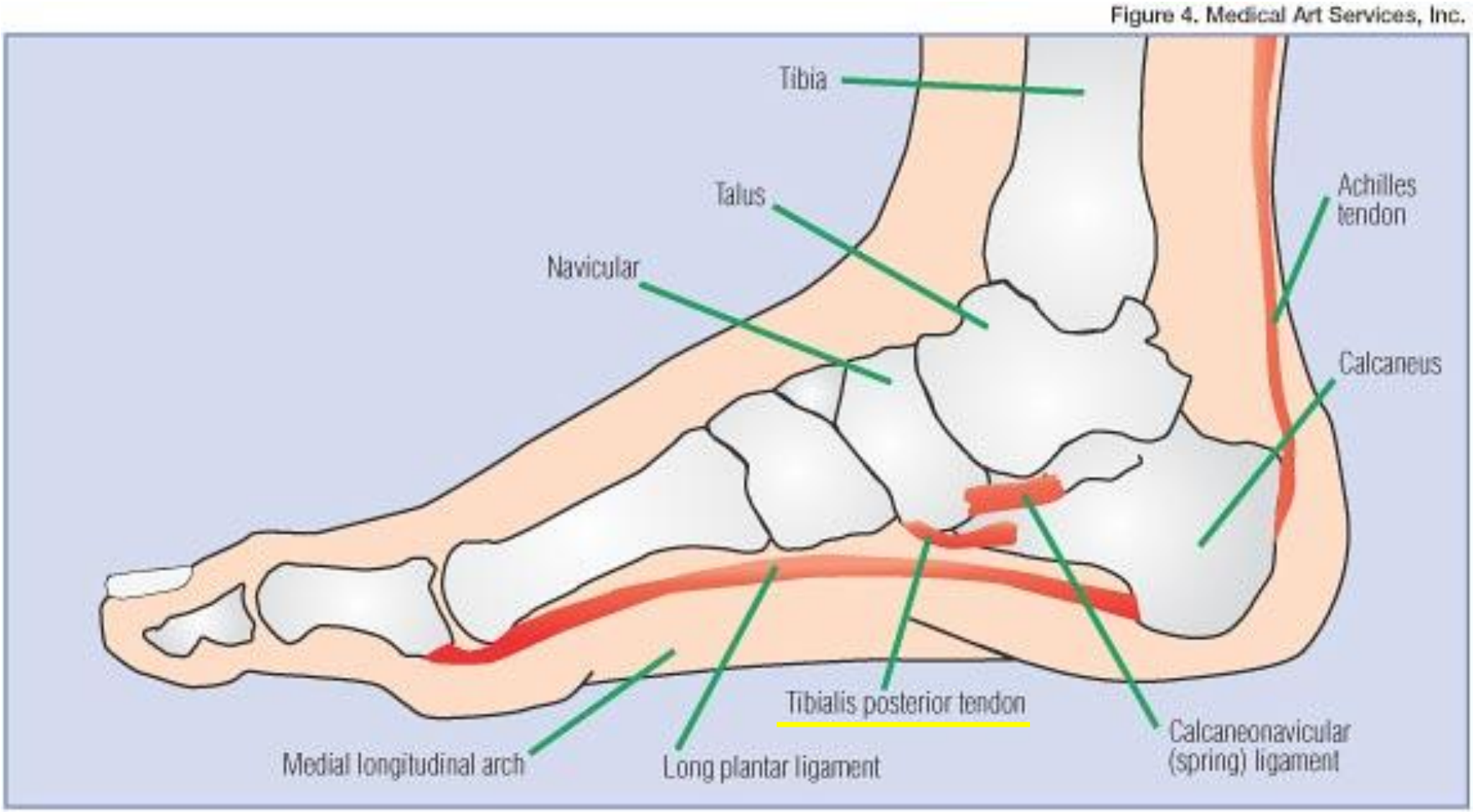


Estabilizadores ativos



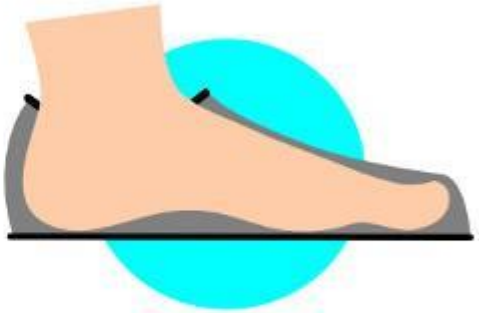
Tibial posterior, fibular longo, flexor longo hálux, intrínsecos do pé

ARCO LONGITUDINAL MEDIAL



Tibial posterior, fibular longo e flexor longo hálux + aponeurose

Suporte para arcos plantares



Calçado convencional Calçado mínimo

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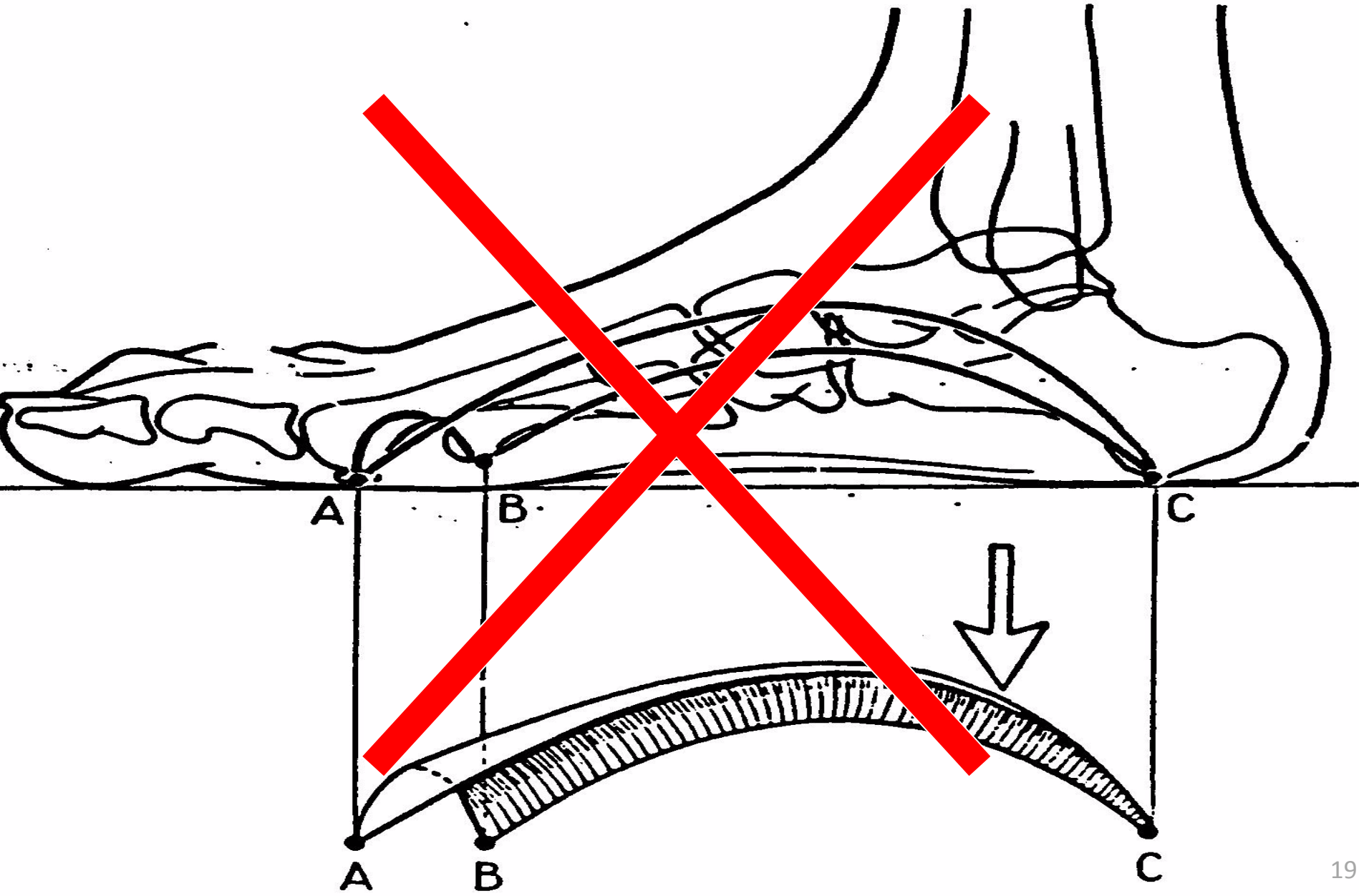
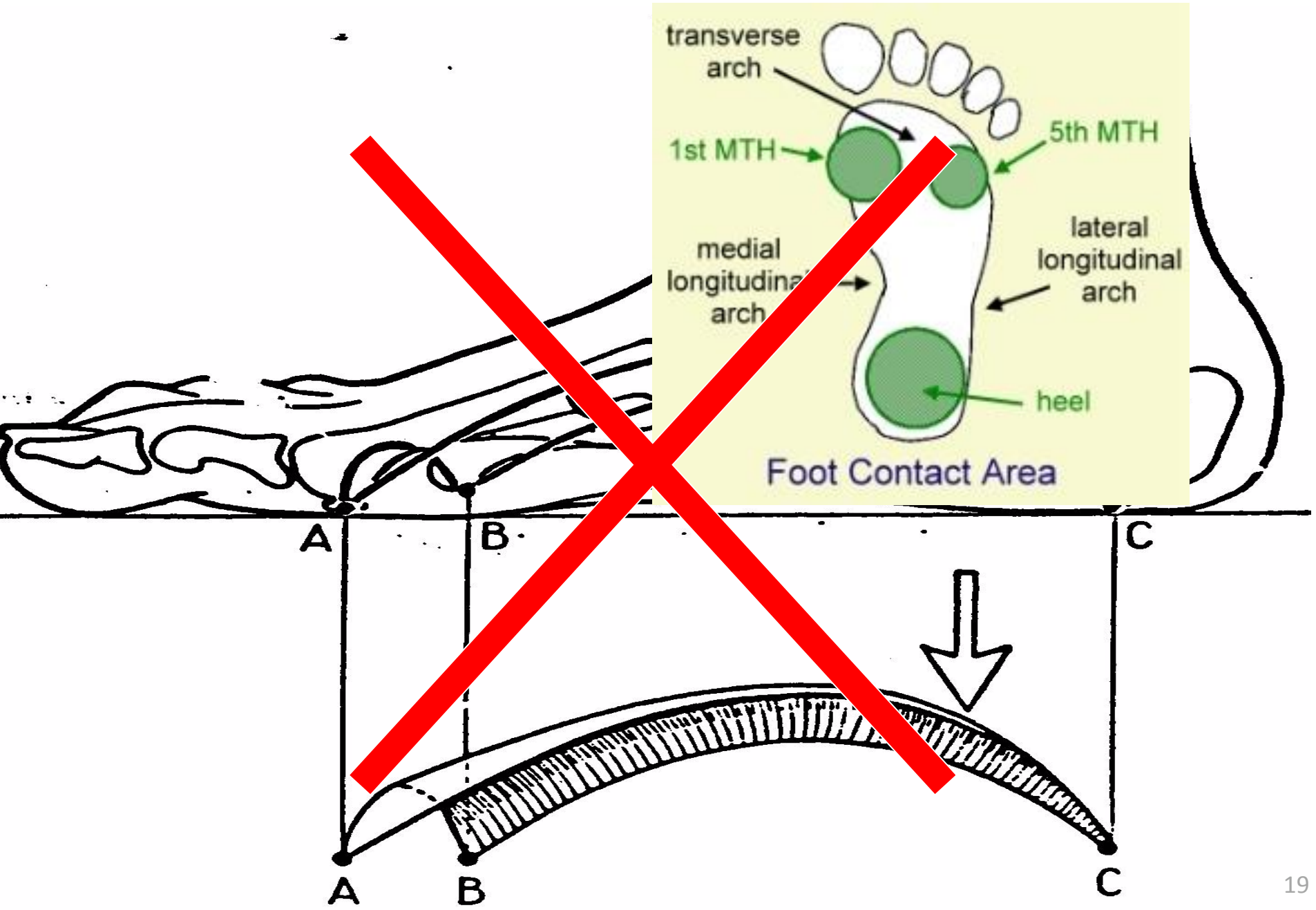
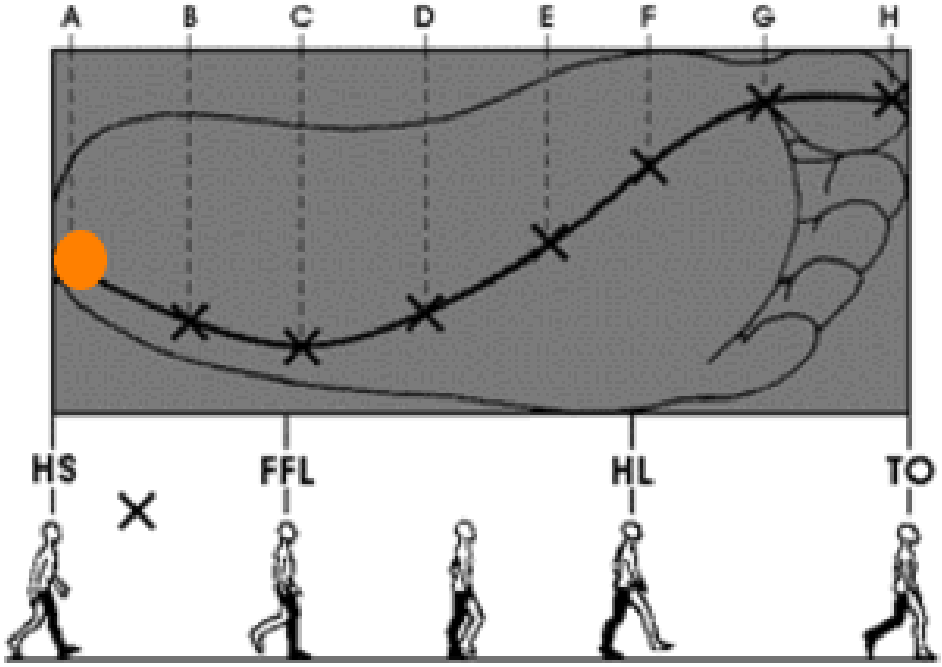

A
B
C
A
B
C


transverse arch
1st MTH
5th MTH
medial longitudinal arch
lateral longitudinal arch
heel
Foot Contact Area
A
B
C
A
B
C

Rolamento Fisiológico do Pé



Giacomozzi & Martelli, 2006

Divisão Sistemática do Pé

RETROPÉ :

calcâneo, tálus (subtalar)

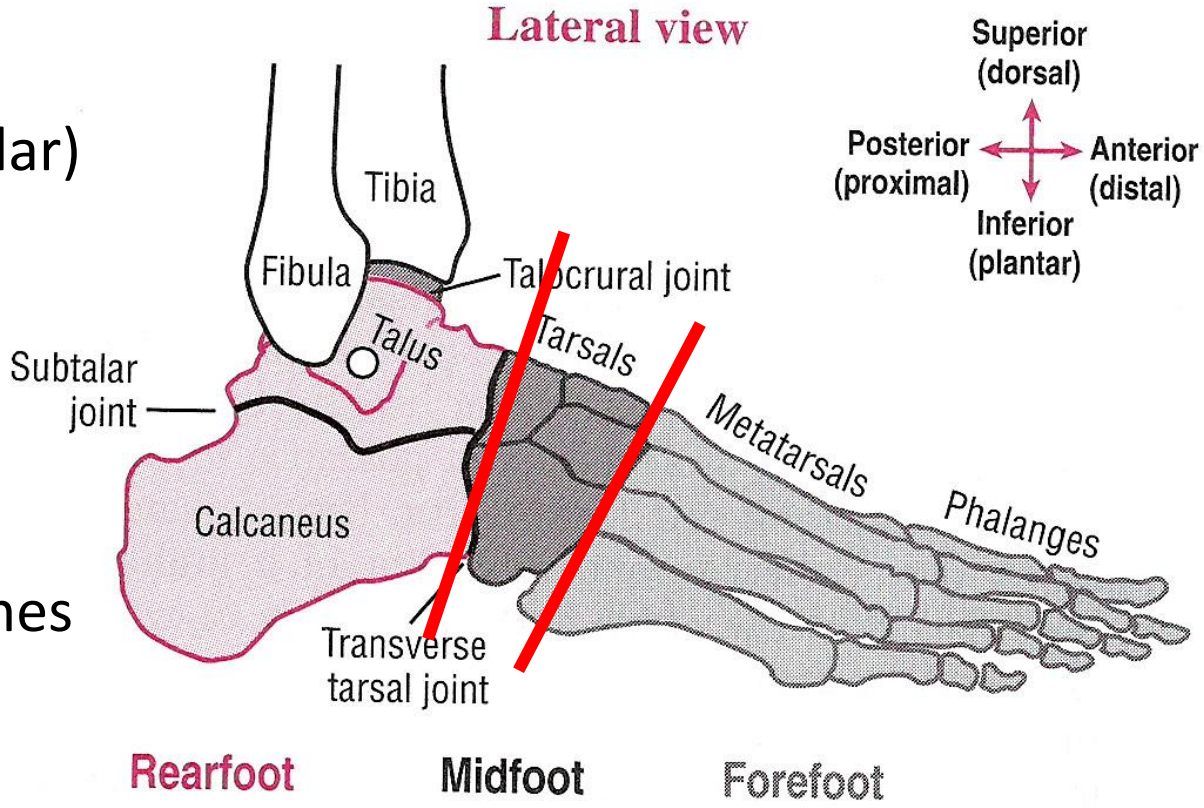
coxim fibrogorduroso

MEDIOPÉ: navicular,

cubóide e 3 cuneiformes

ANTEPÉ: metatarsos, falanges

coxim fibrogorduroso

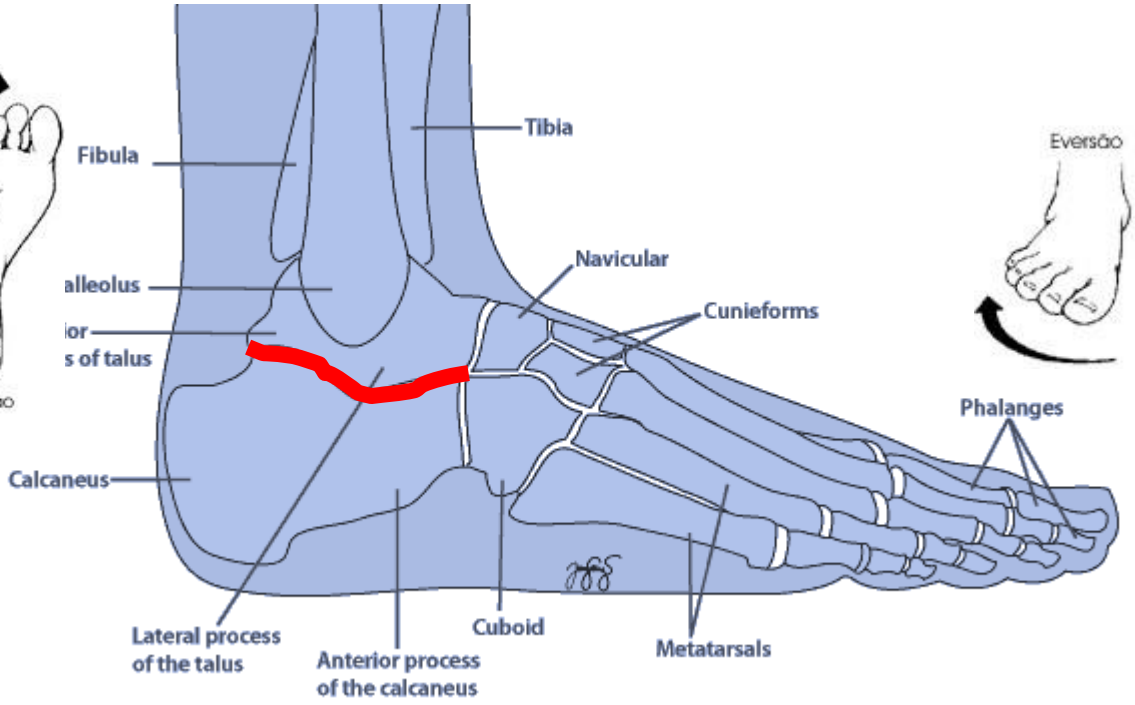


RETROPÉ

Articulação Subtalar

- Formada pelo calcâneo e tálus
- 1 grau de liberdade: Pronação/supinação

(inversão/eversão + adu/abdução)



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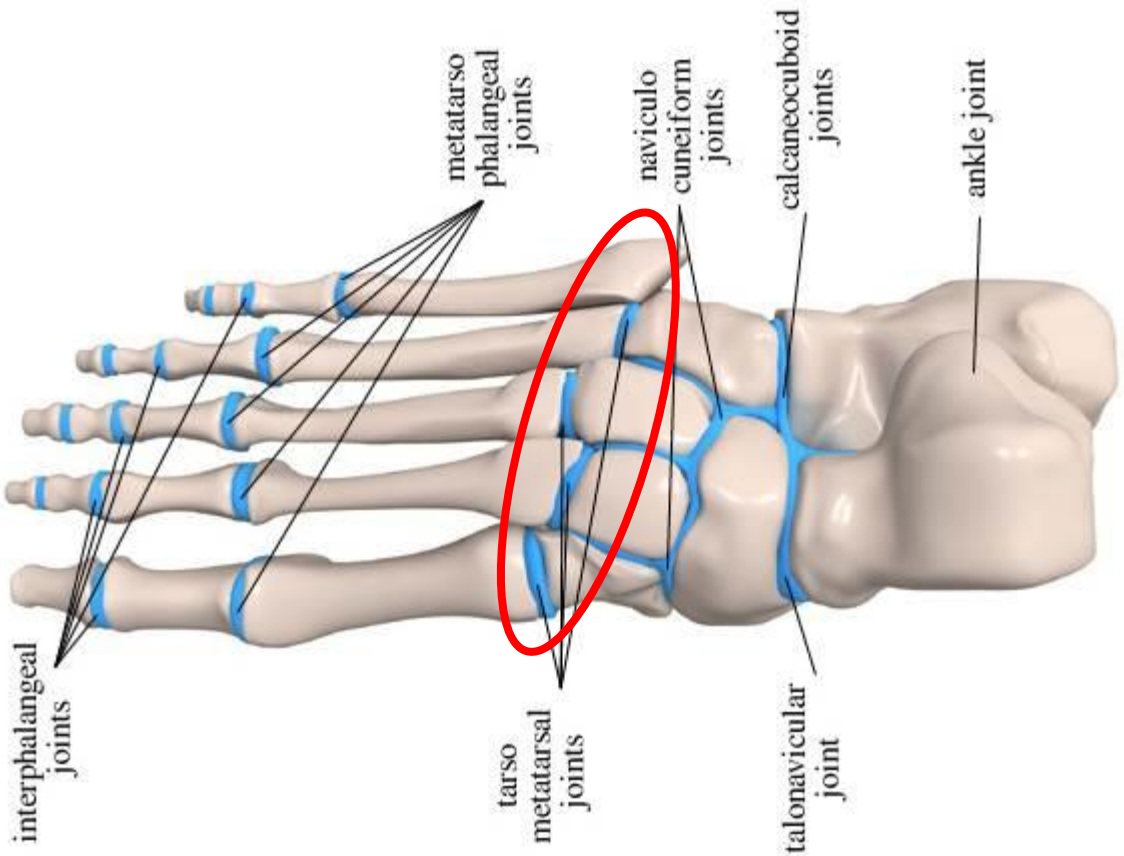
MÉDIO–PÉ

- Diversas articulações sinoviais planas que permitem deslizamento.
- Auxiliam os movimentos do tornozelo e subtalar: pequena ADM (pron/sup)
- Ajustam a planta do pé ao terreno e às solicitações da tarefa

MÉDIO–PÉ

ARTICULAÇÕES TARSOMETATARSIANAS



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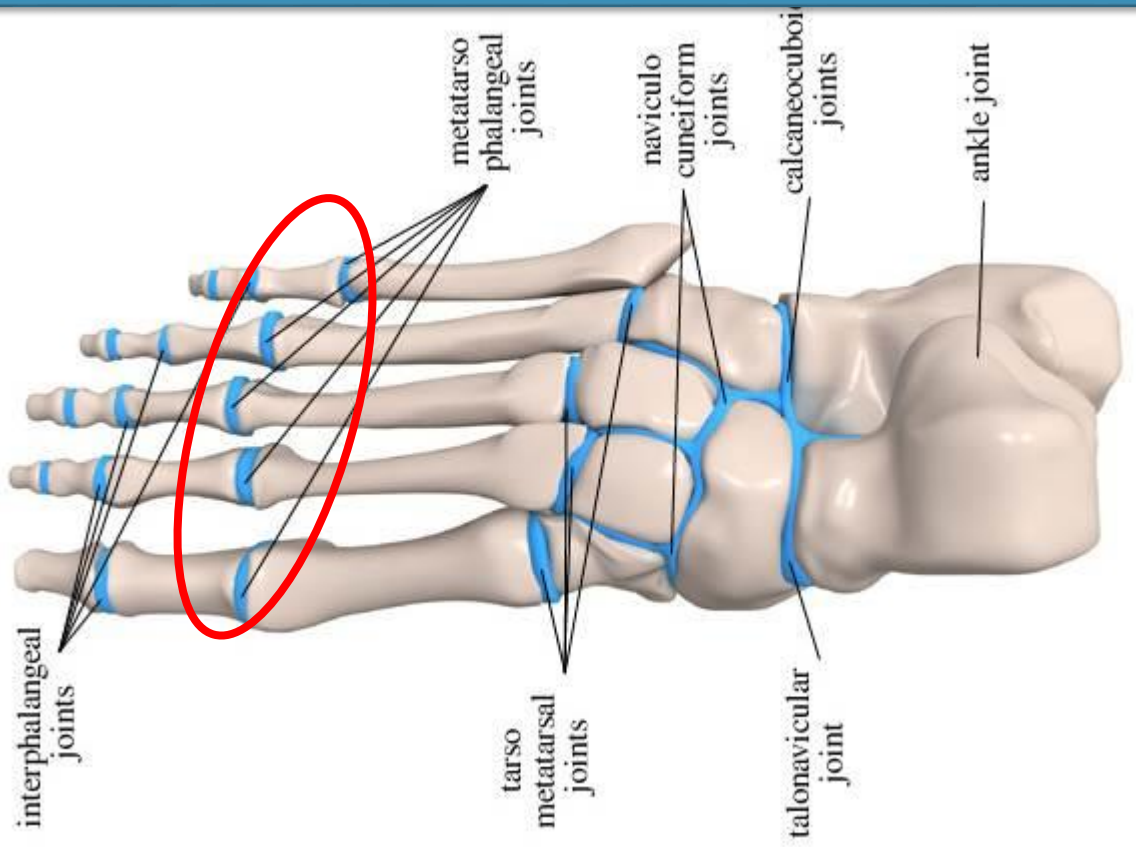
ANTEPÉ

ARTICULAÇÕES METATARSOFALANGIANAS



Extensão e Flexão (sentido movimento inverso do T)

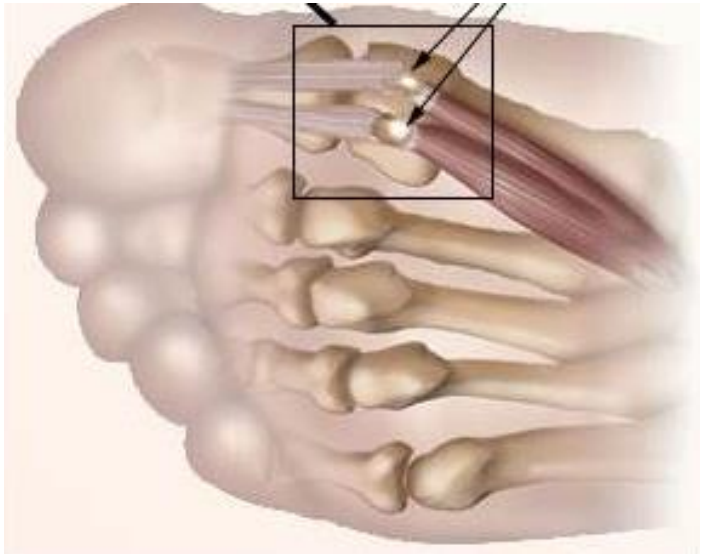
Associado a inversão/eversão (rotação meta) + abdução/adução

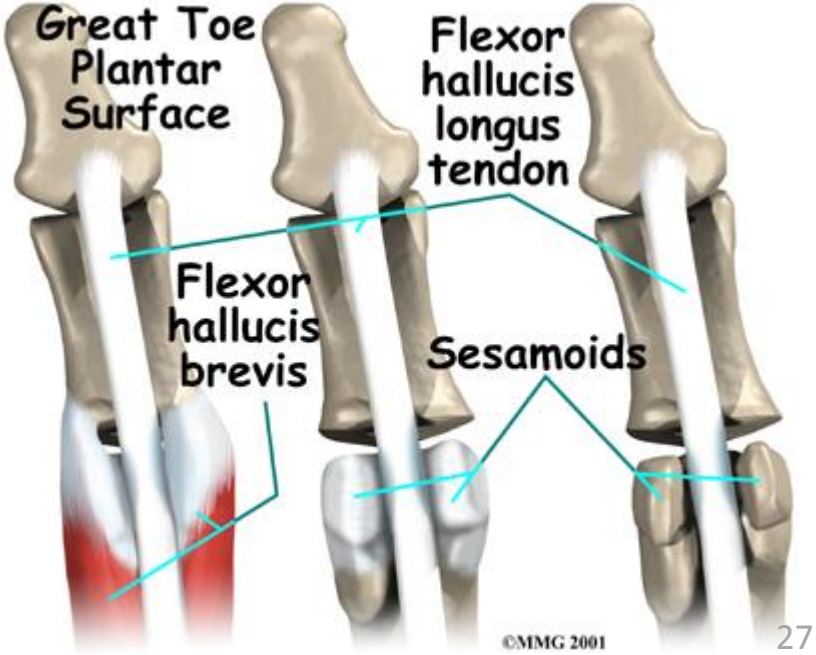
ANTEPÉ

Articulações Metatarsofalangianas

Ossos sesamóides → polias para flexor curto do hálux

- protegem o tendão do flexor longo do hálux
- auxiliam na descarga de peso



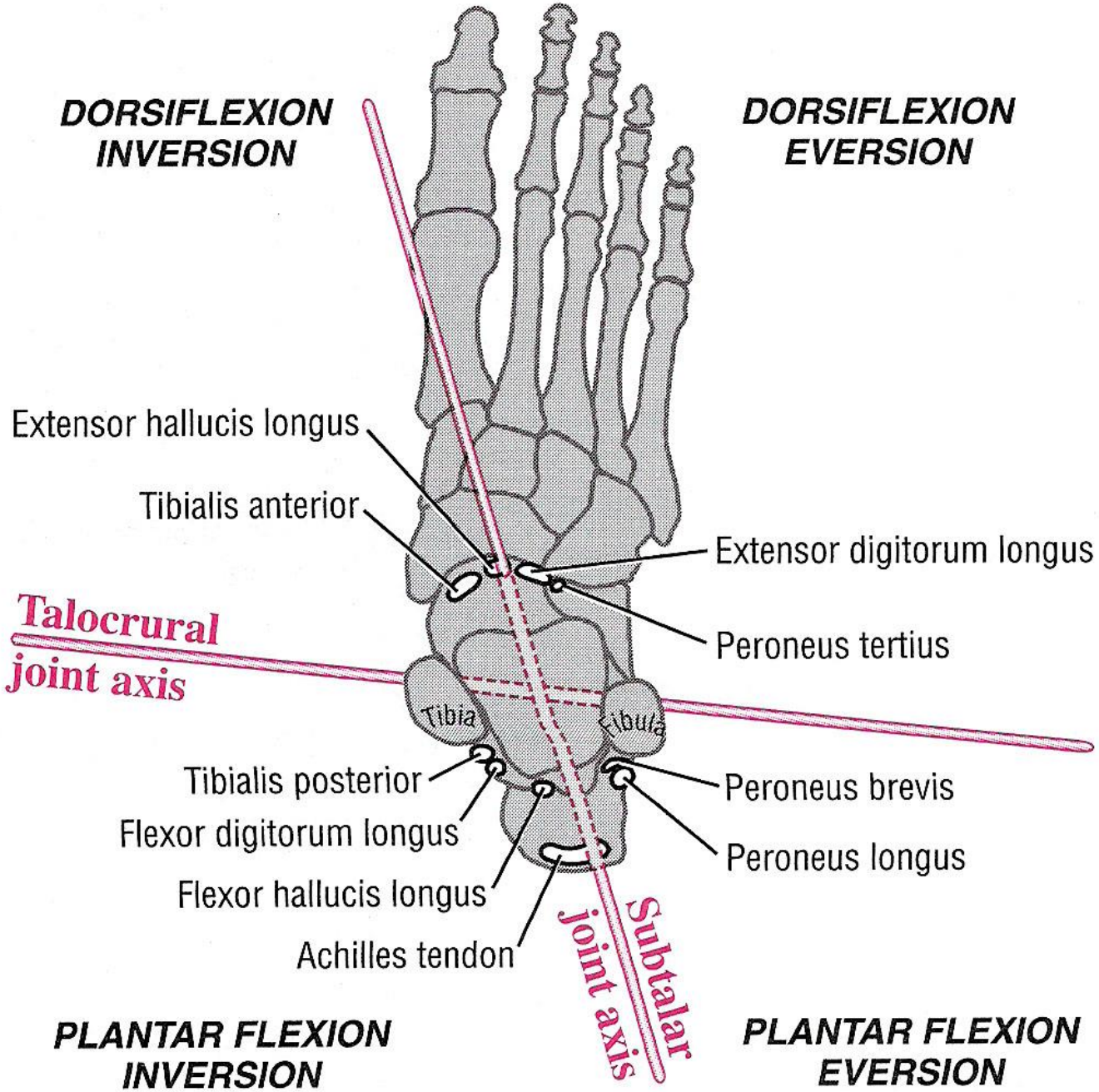


ANTEPÉ

Articulações Interfalangianas

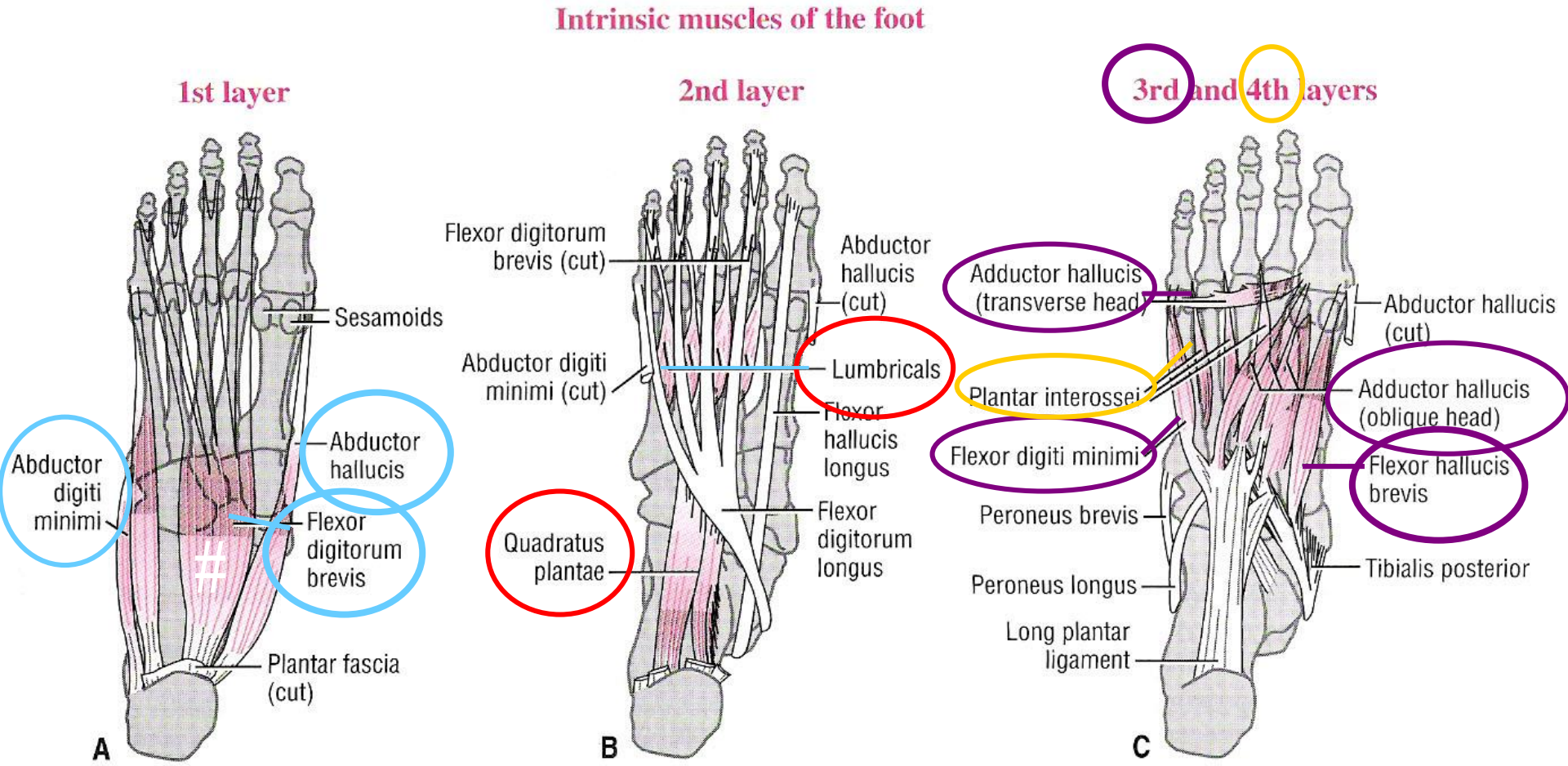
Sinoviais com 1 grau de liberdade :

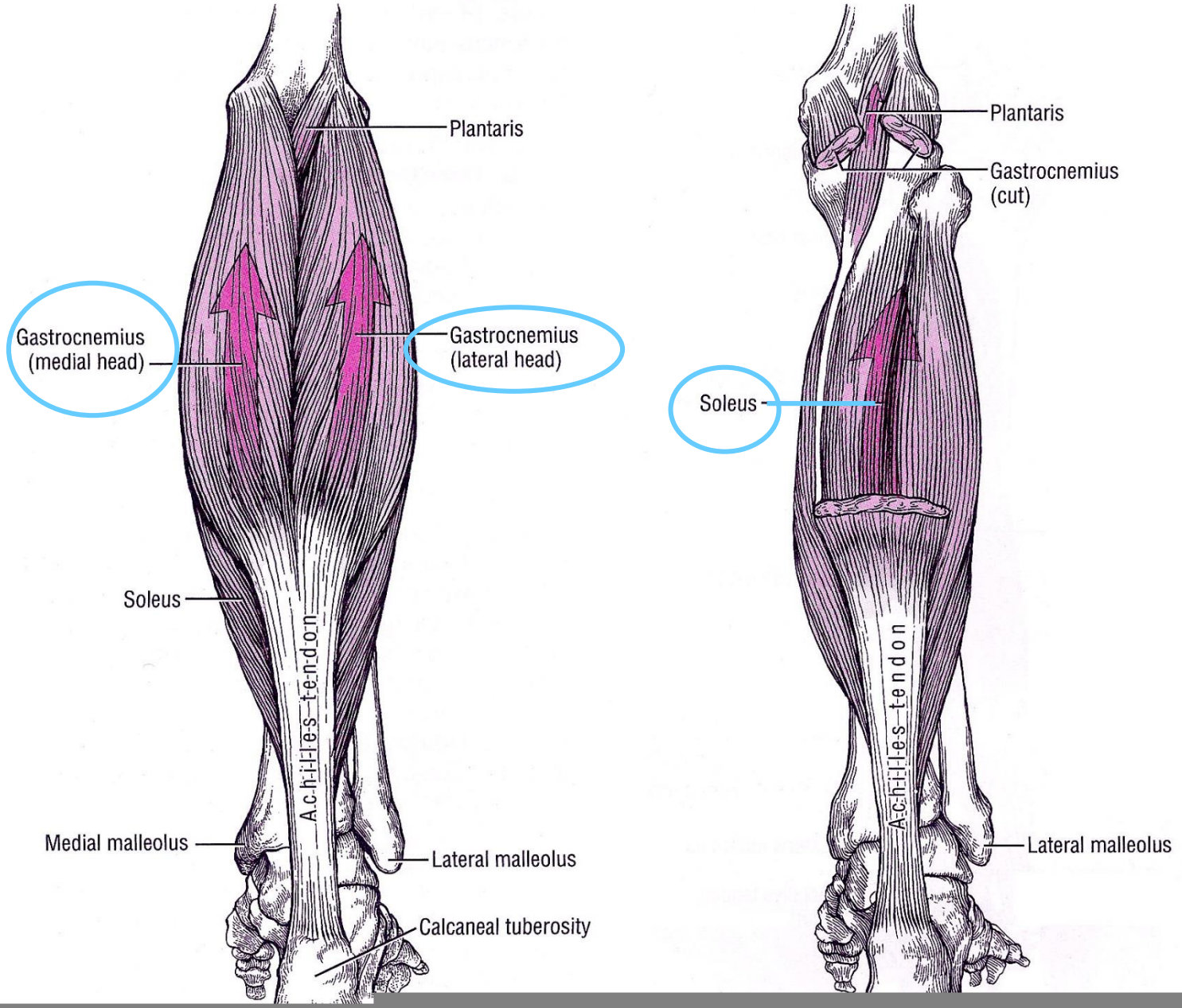
flexão / extensão

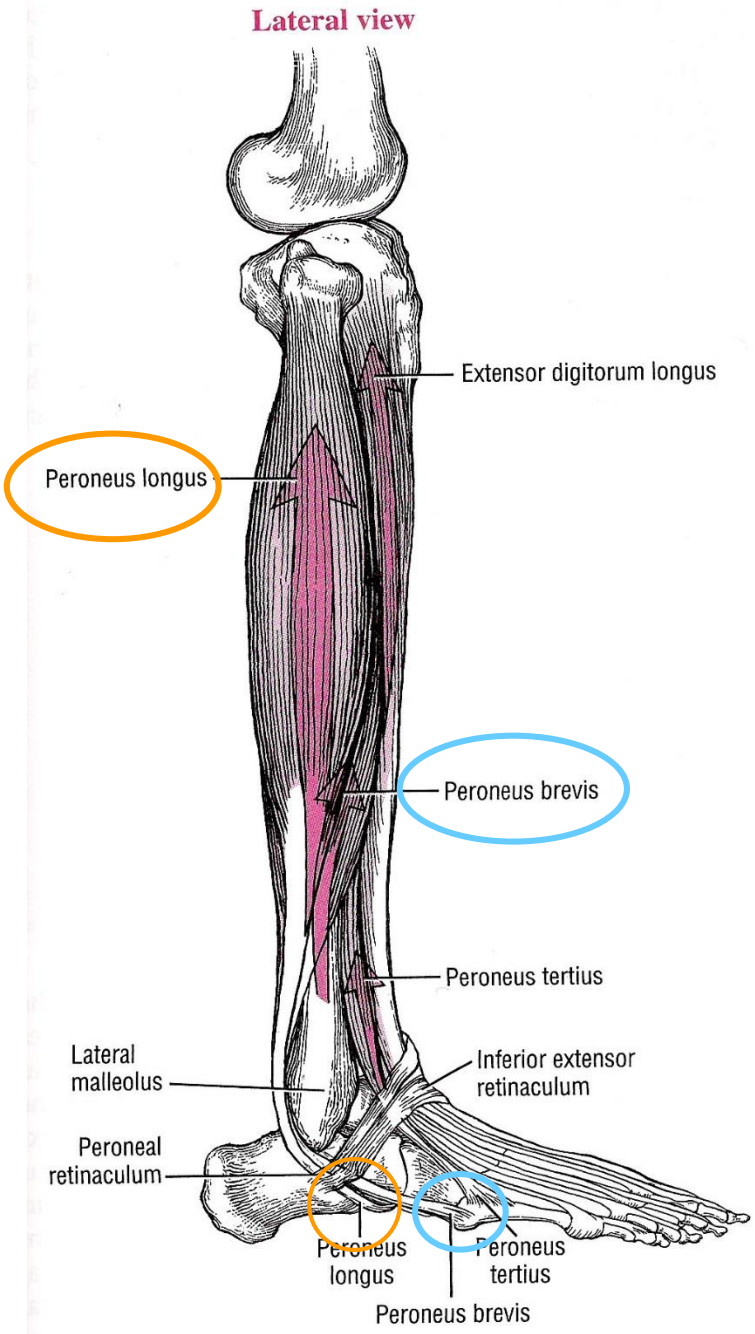

DORSIFLEXION
INVERSION
DORSIFLEXION
EVERSION
Extensor hallucis longus
Tibialis anterior
Extensor digitorum longus
Talocrural
joint axis
Peroneus tertius
Tibia
Fibula
Tibialis posterior
Peroneus brevis
Flexor digitorum longus
Peroneus longus
Flexor hallucis longus
Achilles tendon
Subtalar
joint axis
PLANTAR FLEXION
INVERSION
PLANTAR FLEXION
EVERSION

"TIFE"

MÚSCULOS INTRÍNSECOS




Plantaris
Gastrocnemius (medial head)
Gastrocnemius (lateral head)
Soleus
Achilles tendon
Medial malleolus
Lateral malleolus
Calcaneal tuberosity
Plantaris
Gastrocnemius (cut)
Soleus
Achilles tendon
Lateral malleolus


Lateral view
Extensor digitorum longus
Peroneus longus
Peroneus brevis
Peroneus tertius
Lateral malleolus
Inferior extensor retinaculum
Peroneal retinaculum
Peroneus longus
Peroneus tertius
Peroneus brevis

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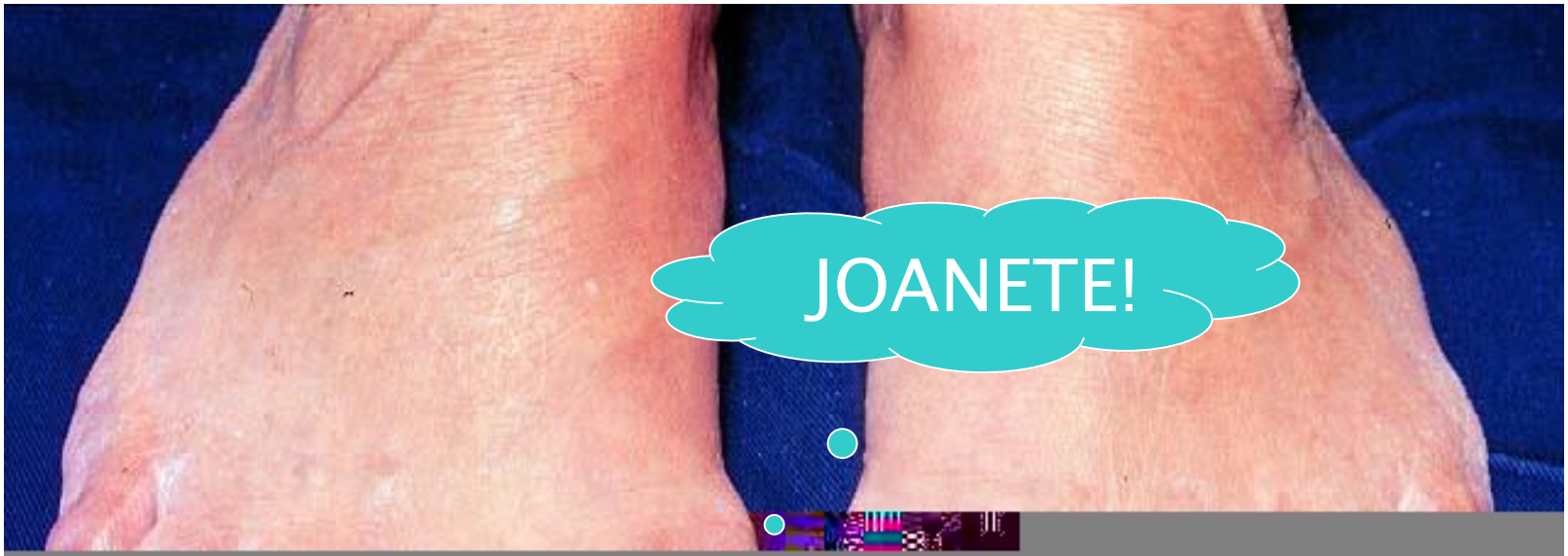
Hálux Valgo



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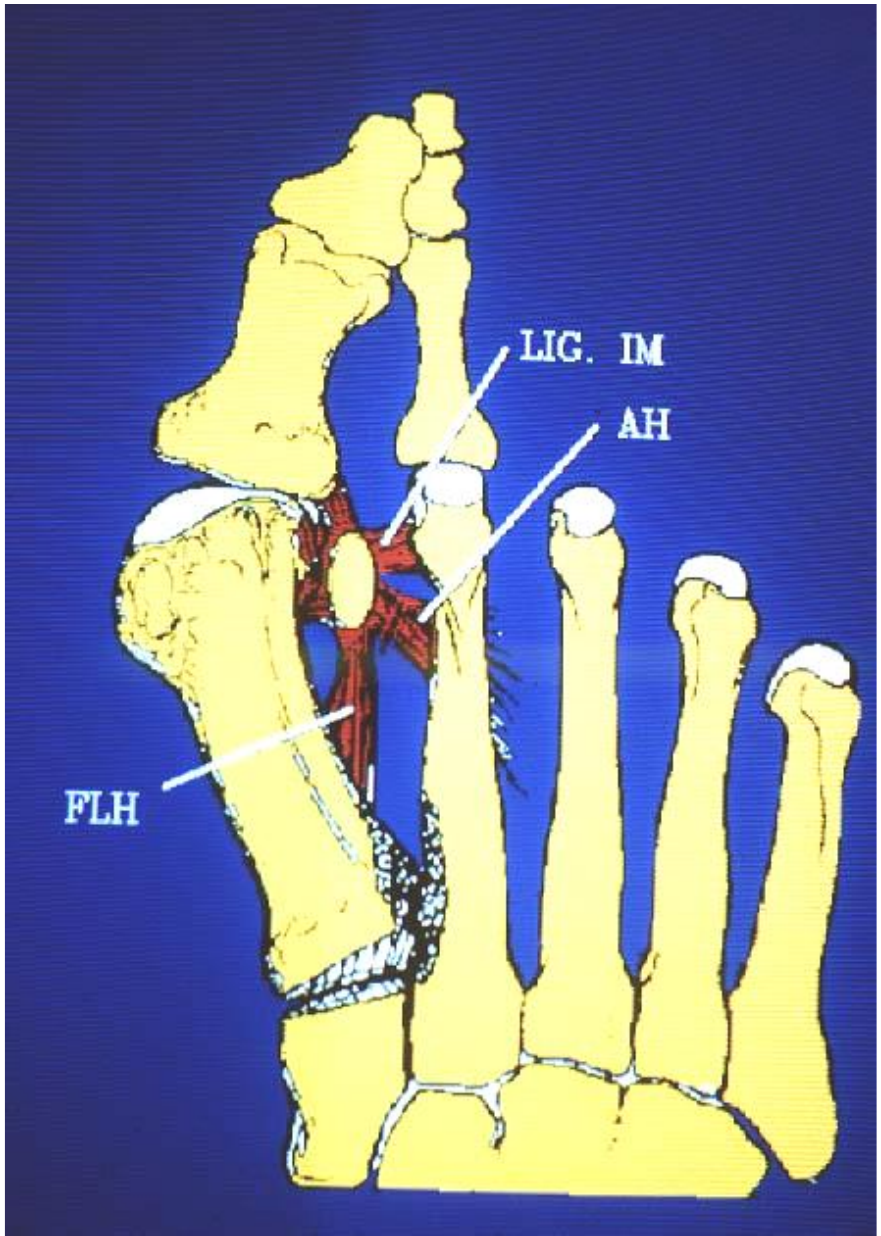
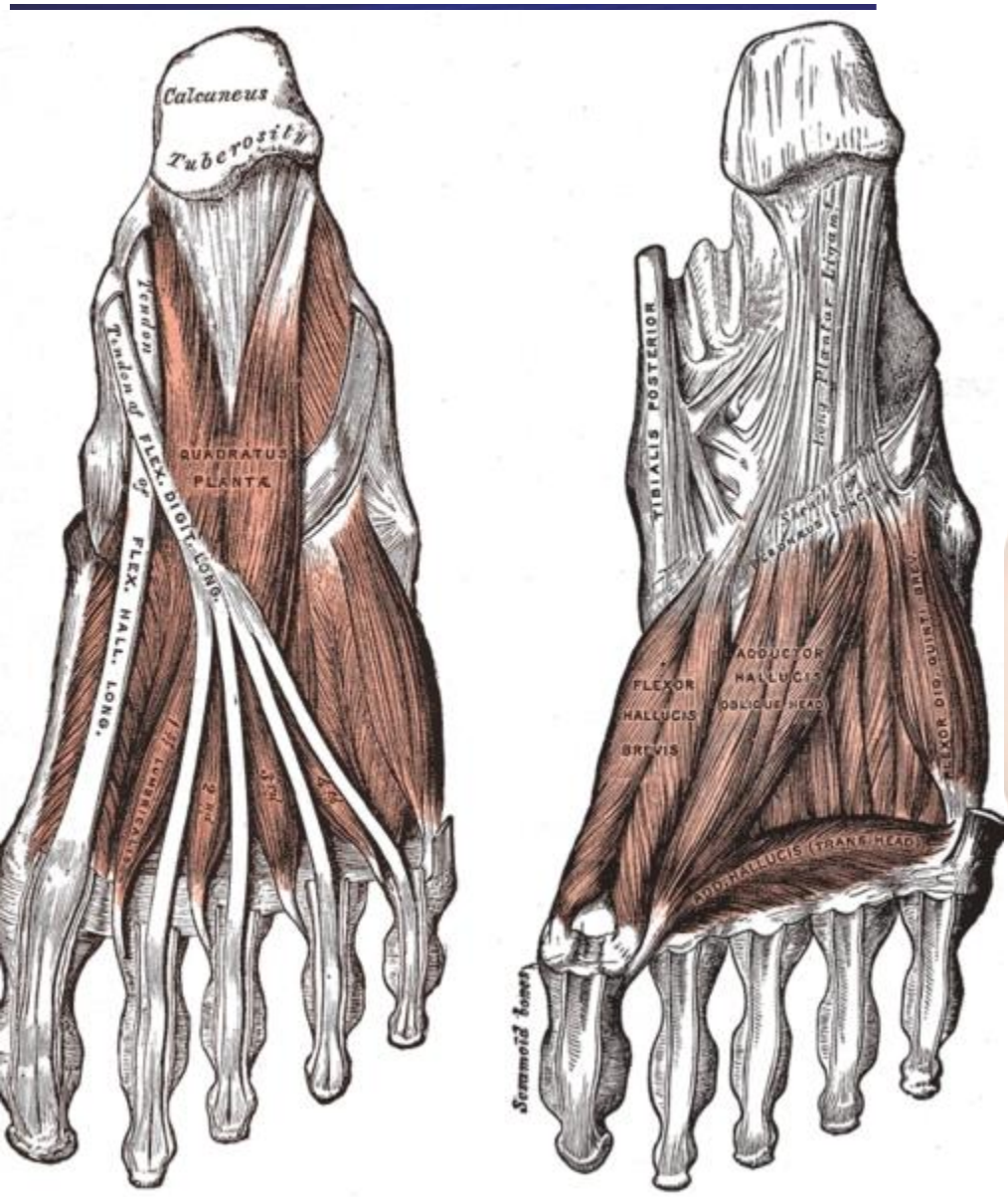
Hálux Valgo

Hálux Valgo



Sacco, ICN

Hálux Valgo



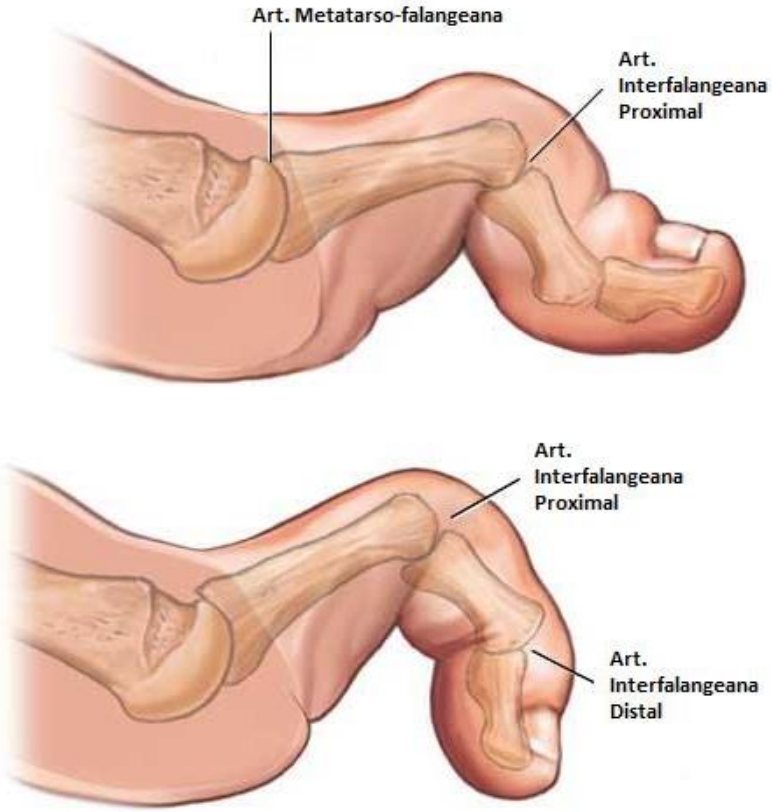
Sacco, ICN

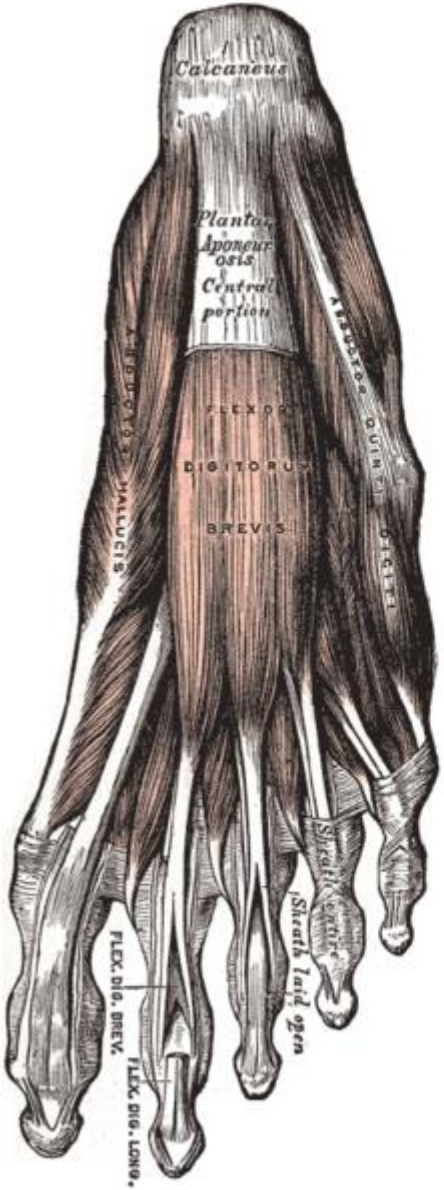
Deformidade de artelhos

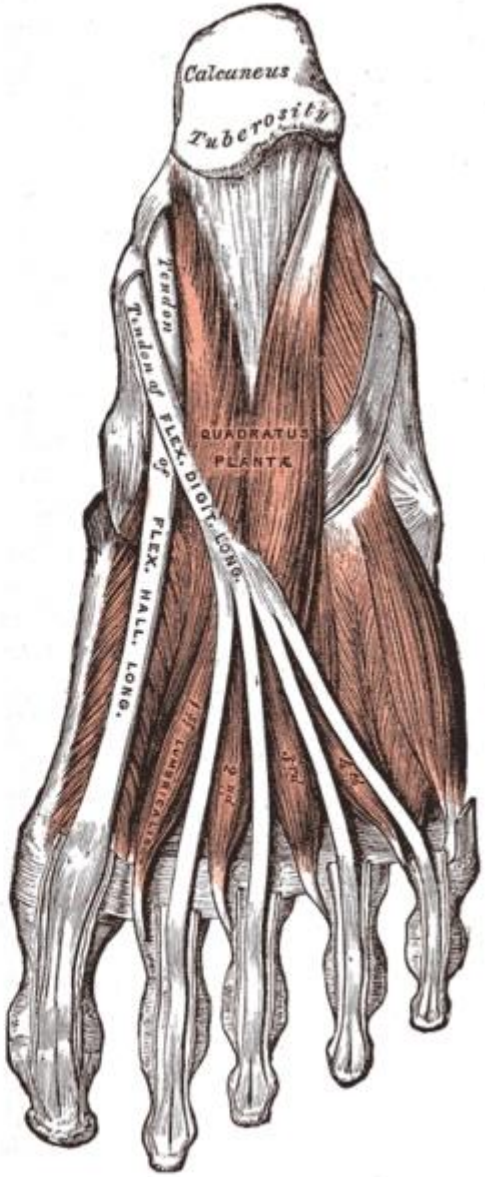
Quais estruturas não estão agindo funcionalmente em um pé com dedos em garra? E em um pé com dedos em martelo?

Sacco, ICN

Deformidade de artelhos





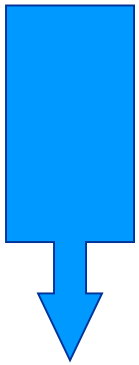


Proeminência Cabeças Metatarsianas

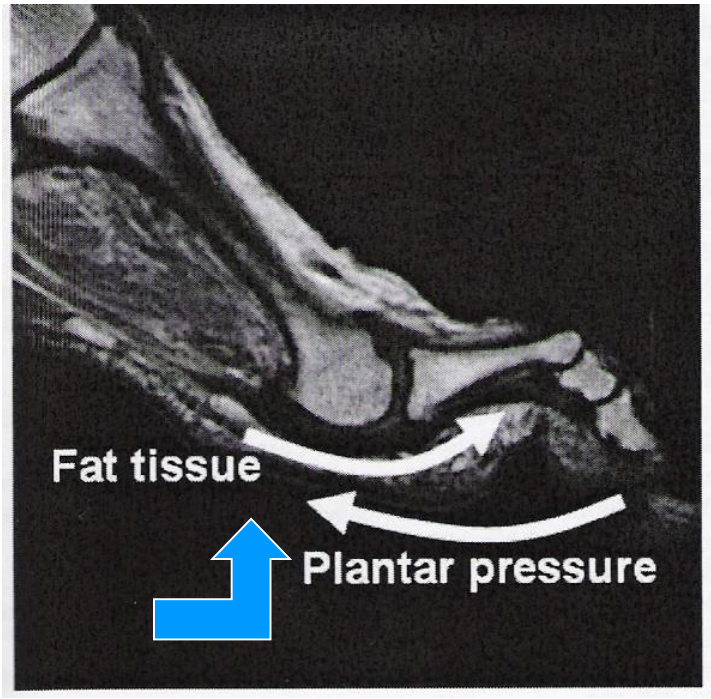
Atrofia coxim adiposo

Arco transverso rebaixado

Dedos em garra



PCM



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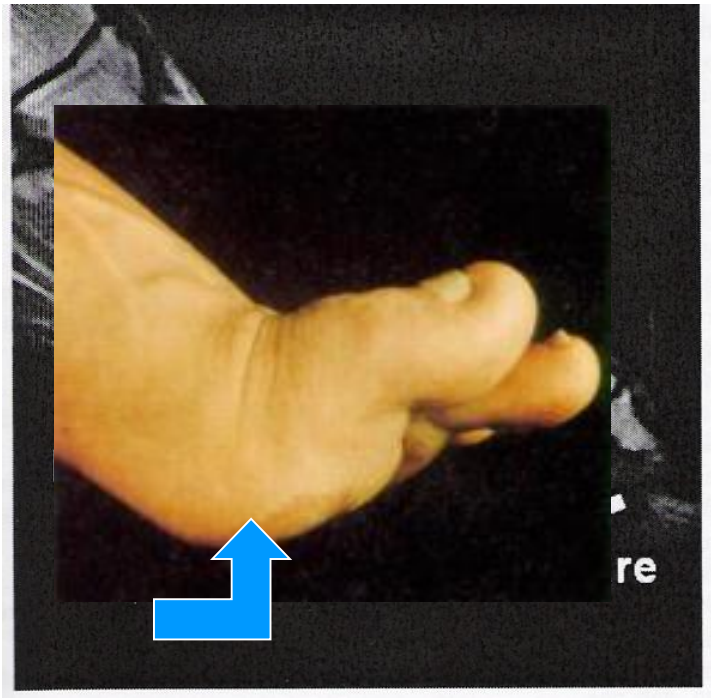

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