The Arches of the Foot

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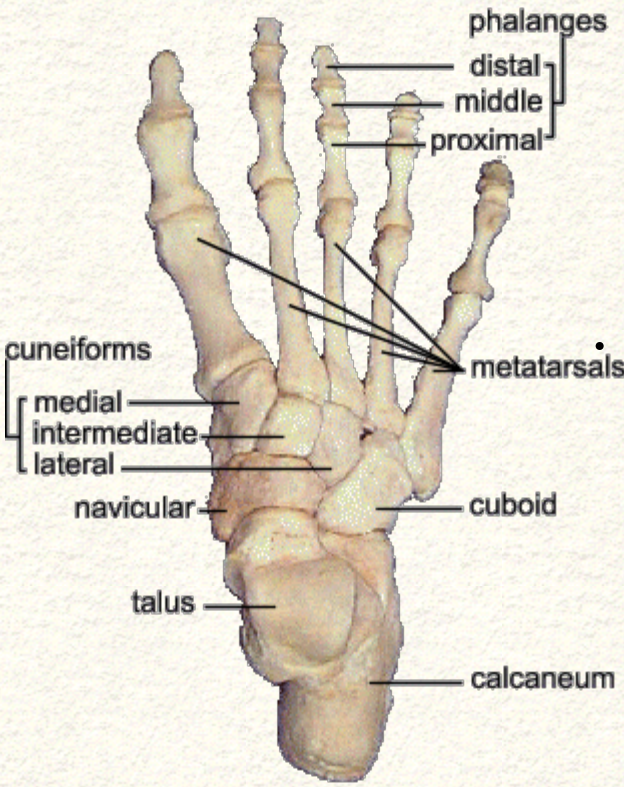
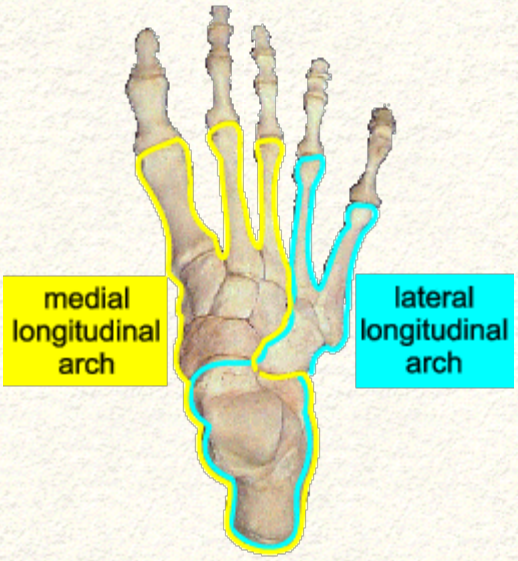


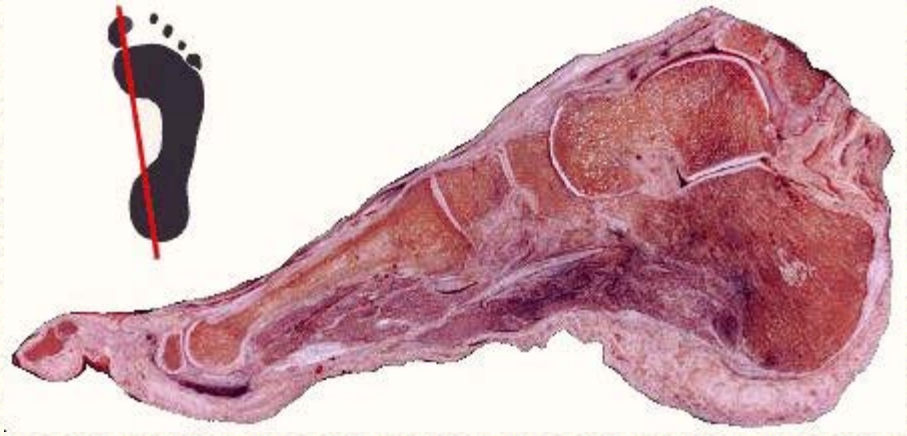
Introduction:

The foot exhibits both longitudinal and transverse arches. These arches are maintained by:

- the shape of the foot bones
- the activity of muscles
- a wide variety of ligaments (plus the tendons of muscles acting as ligaments)

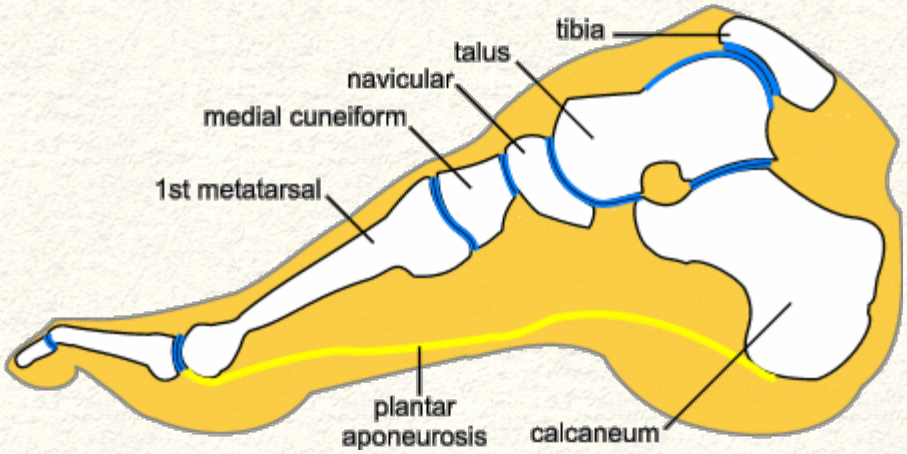
The medial and lateral longitudinal arches of the foot

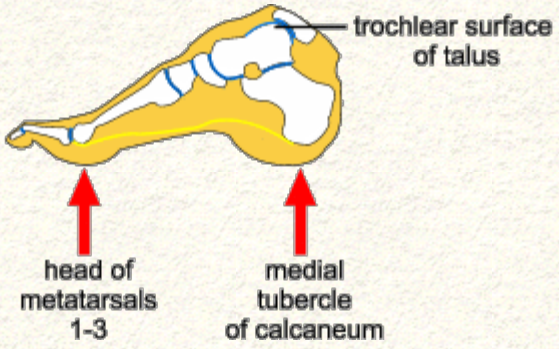




The medial longitudinal arch

This arch is very tall (which is why the medial side of the foot is missing from a footprint ) and is extremely resilient due to its large number of component bones.

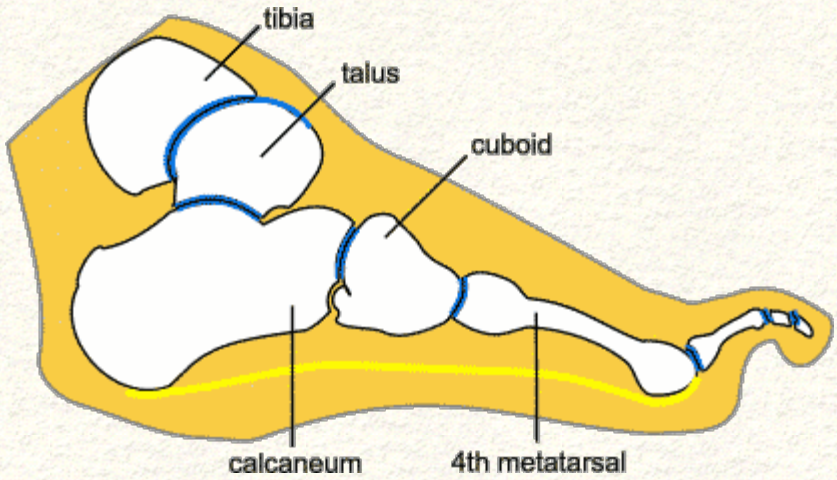




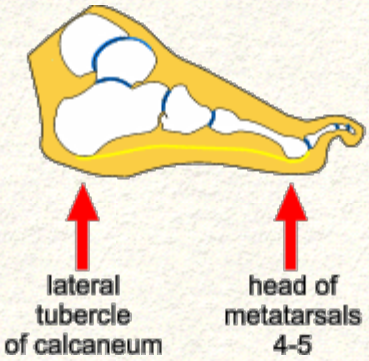
The medial longitudinal arch can be defined in terms of its apex (the trochlear surface of the talus) and its two extremities which are the medial tubercle of the calcaneum and the heads of metatarsals 1-3.

The lateral longitudinal arch

It is difficult to define the apex of the lateral longitudinal arch because although body weight is transmitted into it via the talus, the talus is not part of the arch.

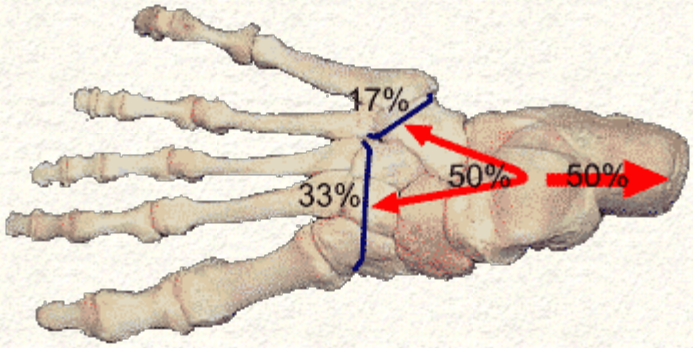


The extremities are the lateral tubercle of the calcaneum and the heads of metatarsals 4-5. This arch is flat and contains relatively few bones.



Weight distribution

In quiet stance body weight is transmitted through the talus bone and passed in equal measure backwards (into the calcaneum) and forwards.



Biomechanics of arch support

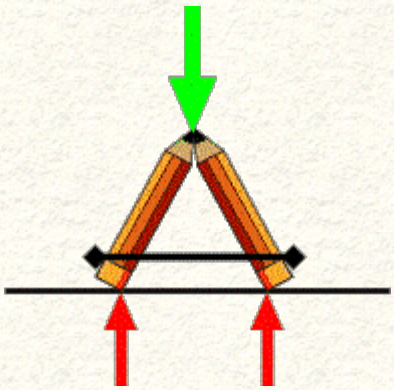
The weight of the body would flatten the longitudinal arches if they were not supported, this can be explained biomechanically in the following way.

Newton's 3rd law: Every action has an equal and opposite reaction.

If we think of the simple arch structure of a pitched roof, the weight of the roof is supported at the two ends. The action of the load has an equal and opposite ground reaction force.

A) *Place two pensl upright (perpendicular) on the table on front of you, and press down gently onto the top .* The force and the resultant force are acting in the same line and the pen should be stable.

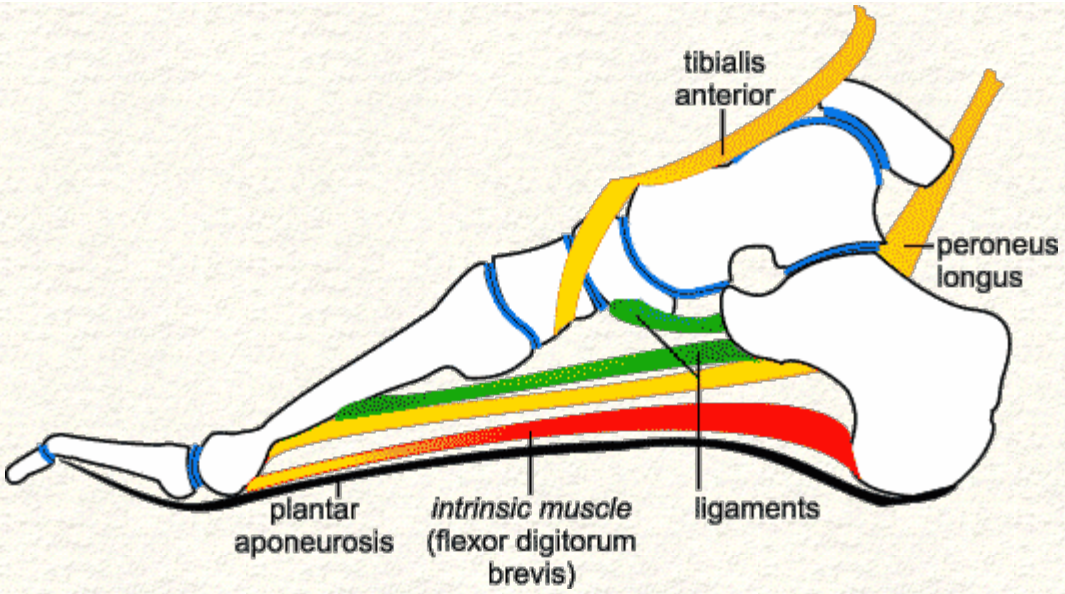
Now try making an arch from two pens, as depicted in the animation. A steady arch can only be achieved by stabilising the pens with your free hand.



In a stable arch the twisting moments are resisted by other structures, e.g a tie-beam in a pitched roof; pictured left. All pitched roofs are stabilised and supported, otherwise they would collapse.

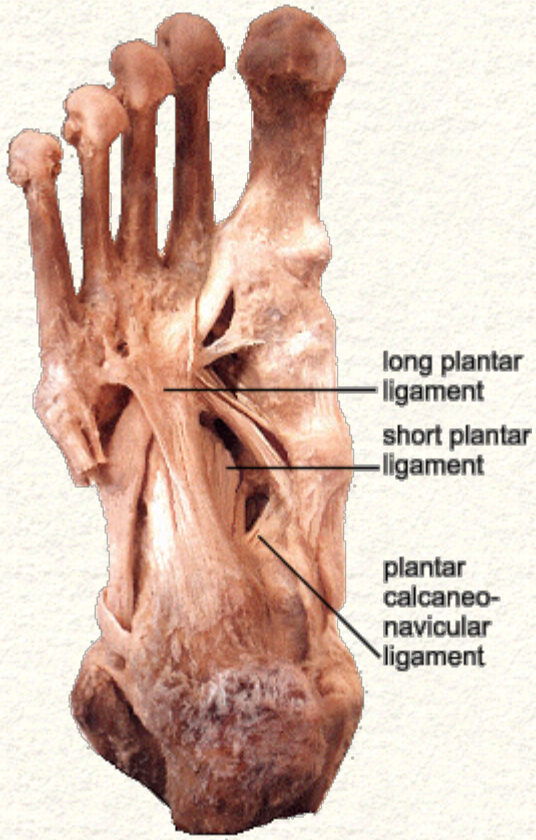
Maintenance of the longitudinal arches

The longitudinal arches are



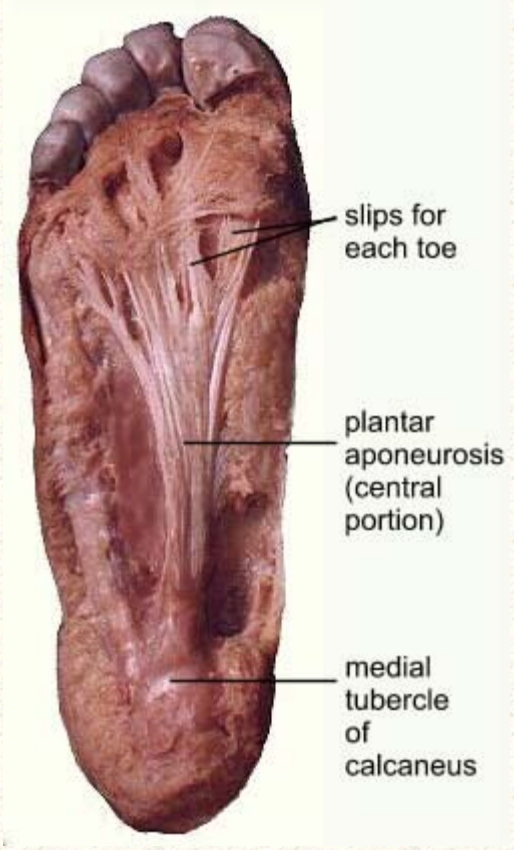
supported and stabilised by:

i. The muscles whose tendons run into the apex of the arches and tend to increase their height (e.g. tibialis anterior)
ii. The muscles whose tendons run into the sole of the foot where they have a longitudinal course. Like ligaments they will prevent the extremities separating (e.g. peroneus longus and small intrinsic muscles which also run longitudinally)
iii. The shape of the bones which allows them to interlock 
iv. A variety of longitudinally arranged ligaments which prevent the extremities separating, for example the long and short plantar ligaments and by the plantar calcaneonavicular ("spring") ligament.



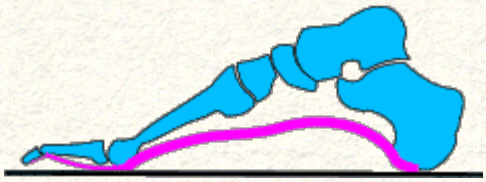
v. The plantar aponeurosis links the extremities of the arches, and acts as the equivalent of a tie

beam in an architectural arch.



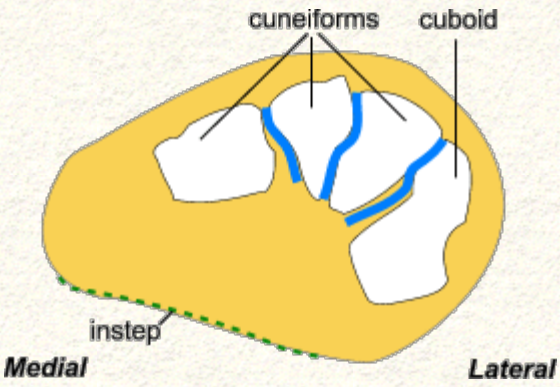
The plantar aponeurosis has slips to the toes. Extending (raising) the toes tightens the plantar aponeurosis and heightens the longitudinal arches.

You can do this activity sitting or standing. Take one of your shoes off and place two fingers on the foot, under the medial arch . Extend (raise) the toes in the foot whilst observing the shape of the foot, in particular the longitudinal arches, and noticing any change in tension in the plantar aponeurosis



You should find that with your toes extended there is a noticeable increase in tension in the plantar aponeurosis and in the height of the medial longitudinal arch.

Transverse arches



The transverse arch is not a true arch, it can be seen to best advantage in the region of the cuneiform bones. This arch is maintained by the same muscles and ligaments as the longitudinal arches. The bony fit is particularly good.

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