ORIGINAL RESEARCH PAPER
Volume - 11 | Issue - 10 | October - 2022 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

A BRIEF REVIEW OF FOOT AS THE FUNCTIONAL UNIT OF HUMAN BODY.

Anatomy

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ABSTRACT

Foot is the essential part of human body even though without foot we cannot stand. It is the most distal part of the limb which in humans is laced horizontally. During the initial phases of evolution man was quadripedal then he became bipedal. Homosapiens are wise men with bipedal and erect posture. So the upper limbs were free and lower limb are mainly for stability. Foot is a structure on which entire body weight is putting a pressure on particular weight bearing areas. In the present article foot has been elaborated from its functional perspective regarding its biomechanics.

KEYWORDS

foot, biomechanics, inversion, eversion, foot arches.

INTRODUCTION

The distal portion of leg, upon which an individual stands and walks; in human the tarsus, metatarsus, phalanges, and the surrounding tissue.[1] Foot is composed of numerous bones connected by ligaments, it has considerable flexibility that allows it to deform with each ground contact, thereby absorbing much of shock. Furthermore the tarsal and metatarsal bones are arranged in longitudinal and transeverse arches passively supported and actively restrained by flexible tendons that add to the weight bearing capabilities and resiliency of foot. Thus much smaller forces of longer duration are transmitted through the skeletal system. The arches distribute weight over the pedal platform(foot),acting not only shock absorber of foot but also as springboards for propelling it during walking,running and jumping. The resilient arches add to the foot's ability to adapt to changes in surface contour.[2,3]

AIM AND OBJECTIVE-

The present study aims at studying the foot arches and mechanism of transmission of body weight on foot and influencing the functional anatomy of foot.

MATERIAL AND METHODOLOGY-

For understanding the concept of Functional anatomy of foot various modern lexicons such as Moore, Snell's Clinical anatomy were consulted. Published evidence were screened meticulously information was collected and presented analytically to fortify the textual statements.

Transmission of Body weight

From tibia it is transmitted to talus

⇩

Then transmits posteriorly to calcaneus

⇩

Anteriorly to ball of foot which is made up of seasmoids of 1st metatarsal and head of 2nd metatarsal

⇩

That weight or pressure is shared laterally with the heads of 3rd-5th metatarsal as necessary for balance and comfort

⇩

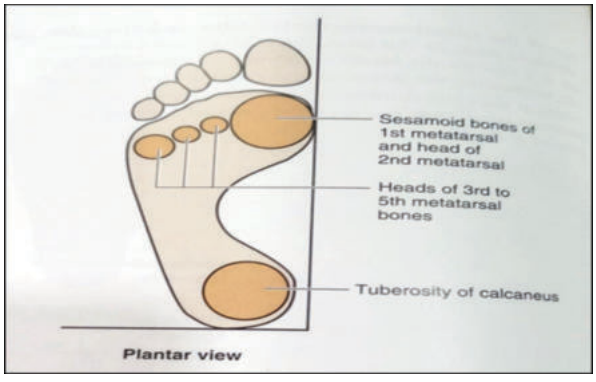
During standing elastic arches becomes slightly flattened by body weight

⇩

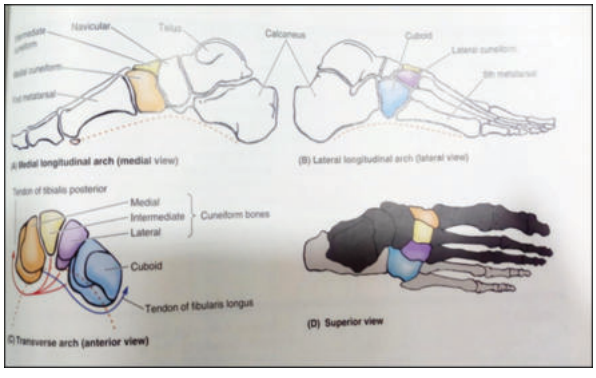
When body weight is removed arches normally resume their curvature[4]

Arches of Foot[5,6]

Medial longitudinal arch	Lateral longitudinal arch	Transeverse arch
Calcaneus, talus, navicular , 3 cuneiform, first 3 metatarsal bones	Calcaneum, Cuboid, 4th & 5th metatarsal bone	Bases of metatarsal bones, cuboid & 3 cuneiform bones.



Weight bearing areas of foot



Arches of Foot

MECHANISM OF ARCH SUPPORT

Design of Stone bridge

1. The shape of stones-

- Most effective way of supporting arch
- Wedge shaped bone with thin edge lying inferiorly
- It applies particularly to important stone that occupies the centre of arch & is referred to as **keystone**.

2. Staples-

- **Inferior edges of the stones are tied together**
- It is accomplished by interlocking the stones or
- Binding their lower edges together with metal staples
- It counteracts the tendancy of lower edges of stones to separate when the arch is weight bearing.

3. The use of tie beams-

- When span of bridge is large and foundation at either end are insecure.
- A tie beam connecting the ends effectively
- Prevents seperation of pillars & consequent sagging of the arch

4. A suspension bridge-

- Maintaince of arch depends on multiple supports suspending the arch **from a cable above the level of bridge**

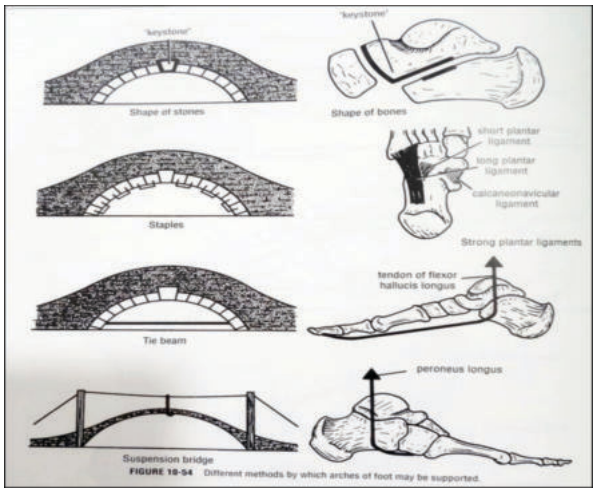


FIGURE 10-54 Different methods by which arches of foot may be supported.

Foot As Functional Unit

- As a weight bearer and a lever-
- It has 2 important function

a) To support the body weight
b) To serve as a lever to propel the body forward in walking and running.

The Propulsive Action of Foot

Standing Immobile-

Body weight is distributed via the heel behind the heads of metatarsal bones in front.

Walking-

As body weight is thrown forward, the weight is born succesively on the lateral margin of the foot and heads of the metatarsal bones.

As heel rises toes are extented at metatarsophalangeal joint, planter aponeurosis is pulled on, which shortens tie beam,and heightens the longitudinal arch. The slack in long flexor tendons is taken up, thereby increasing their efficiency.

- Body is thrown forward by-
- 1.Action of gastrocnemius and soleus (plantaris) on ankle joint, using foot as a lever.
- 2. toes being strongly flexed by the long and short flexors of the foot, providing final thrust forward.lumbricals and interossei contract and keep the toes extented, so that they do not fold under because of strong action of flexor digitorum longus.
- Long flexor tendons assist in planter flexing ankle joint.

Running-

- When Person runs, weight is borne on the forepart of foot
- Heel doesn't touch ground
- Forward thrust to body is provided by mechanism 1 & 2. [7]

Movements of Foot-

Inversion & Eversion-

Definition-

1. Inversion- The movement in which medial border of foot is raised and sole faces medially is called Inversion.
2. Eversion- It is a movement in which lateral border of foot is raised and sole faces laterally is called Eversion.

It takes place at subtalar & midtarsal joint. Axis- movments takes place along oblique axis. These are rotation movements of foot on talus.

Ankle joint is also called as talocrural joint .its movement are dorsiflexion & planter flexion of foot. These are active movements. Accessory movements are gliding(side to side), rotation, abduction, adduction movements takes place when foot is planter flexed. Dorsiflexion is the movement in which angle between front of leg and dorsum of foot diminished. In Planter flexion angle between leg and foot increases. Heel raises and toes goes downwards.

Planes of Motion of foot and Ankle.

1. Saggital plane-

planter flexion and dorsiflexion,occur mainly, but not exclusively at the ankle, metatarsophalangeal and interphalangeal joints.

2. Coronal plane-

inversion and eversion and takes place predominantly in the talocalcaneal and transeverse tarsal joints.

3. Transeverse plane-

adduction and abduction. This movement takes place at the transeverse tarsal joint and to a some degree of the first tarsometatarsal joint and metatarsophalangeal joint.

4. Three dimensional movement-

a. supination. It is permutation of adduction, inversion and planter flexion
b. pronation – is a blend of abduction, eversion and dorsiflexion.

5. Active movements-

they occur at ankle, talocalcaneonavicular and subtalar jonts. At ankle-dorsi and planter flexion occurs. At talocalcaneonavicular and subtalar joints- mainly inversion and eversion occurs.

Movemnts of ankle joint are chiefly planterflexion and dorsiflexion however for the reason that talus is broader anteriorly than posteriorly, dorsiflexion of the ankle leads to external rotation of the fibula. It indicates that foot externally rotates with dorsiflexion and internally rotates with planter flexion.

Stability is extended upon the ankle by the shape of malleoli and the solidarity of the medial and lateral ligaments and the inferior tibiofibular ligaments.

The subtalar joint along with talonavicular and calcaneocuboid joints,forms the triple joint complex. These joints are accountable for inversion and eversion of the hindfoot and midfoot with most of the movement taking place at talonavicular joint.

The second tarsometatarsal joint is buried relative to the first and third and act as a keystone. Interruption of this joint leads to loss of transeverse arch and acquired flat foot.

Biomechanics

The human foot has developed to allow orthograde bipedal locomotion or upright walking. It is modified for walking,running and jumping as well as standing. During walking there are body displacements like vertical, horizontal and lateral. The forces that operate on the human body are those produced by muscular activity and gravity.

During walking the centre of pressure progresses from the heel to metatarsal area and then the great toe and the pressure pattern can be calculated using a force plate.

The walking cycle is divided into the

1. Stance phase- 62 %
2. Swing phase- 38 %

The stance phase is arranged into three intervals

1. Heel strike to foot flat
2. Flat Foot until the body passes over the ankle.
3. Ankle joint planter flexion to toe-off

During walking up to 12% of the gait cycle is used up with both feet in the stance phase but with running there is a phase when neither foot is in contact with the ground, the float phase. During running the cycle time is reduced but the forces created are very much increased.

The foot can be divided into three parts- the hindfoot-calcaneus,talus
Midfoot- navicular, cuboids, cuneiforms
Forefoot- metatarsals and phalanges. [8]

Functional Importance-

1. These movements are important while walking on uneven & sloping ground.
2. Due to inversion & eversion movement body is enable to move sideways over the foot while the foot is fixed.
3. Those movements are not possible in artificial limb. So person wearing an artificial limb finds difficulty in walking on uneven ground.

Muscles producing Inversion & Eversion.

Invertors of foot- Tibialis anterior & Tibialis posterior
Evertors of foot- Peroneus longus, brevis & tertius. 9

CONCLUSION-

The structure and function of planter arch can considerably affect how the foot and ankle function together. Arches act as shock absorber. Foot provides base for support. It not only accommodate supporting surface during gait but also provides a rigid lever for push off during gait.

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