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A REVIEW ON PAADA SHARIR WITH SPECIAL REFERENCE TO DEFORMITIES OF MEDIAL LONGITUDINAL ARCH OF FOOT

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ABSTRACT

In Ayurveda *Paada* terminology has come in various contexts like it is one of the *shadanga*, it is one of the *indriya* i.e.*karmeindriya*. It is one of the *pratyanga.* In embryonic life during monthwise development of *garbha, panchapindka* are formed. Out of that *paada* is one of the *pindka*. From *rachanatmak* prospective *paada* have various entity related with it like number of *asthi, sandhi, snayu, peshi, kurcha*. The knowledge of foot anatomy is essential for therapeutic as well as diagnostic purpose. While describing longevity measurement *of pratyangas* plays key role. If it resembles to prestated value then the person is considered as *deerghayu. Sarata parikshan* is also one of the *parikshya bhav* to determine longetivity in which various measurements of *pratyangas* are taken. Hence *Paada* sharir has its significance in Ayurvedic and modern prospective. The detailed measurements of normal human foot *(paada)* is given by *Acharya sushruta* in 35th chapter of *sutra sthana.* The foot is the region of the body distal to the leg and consists of 28 bones. These bones are arranged in to longitudinal and transverse arches with the support of various muscles and ligaments. 3 main arches of foot are medial longitudinal arch, lateral longitudinal arch and transverse arch. They allow the foot to support the weight of the body in the erect posture with the least weight. Foot arch deformities include congenital and acquired conditions. Sedentary life style of modern era also contribute to the acquired deformities of foot arches mainly of the medial longitudinal arch of foot. The purpose of this article is to review the *paada sharira* in classics and compare it with the acquired deformities

of medial longitudinal arch of foot so that people can correct or modify their life style in order to maintain their foot arches and can lead a better healthy life.

KEYWORDS: *Paada sharir*, Foot arches, Medial longitudinal arch, Pes planus, Pes cavus.

INTRODUCTION

Ayurveda is the ancient Indian medical system that rely on a natural and holistic approach to physical and mental health. *Sharir rachana* is the branch of *Ayurveda* which deals with the structure of human body. *Acharya susruta*, one among the *brihat trayis* has paid great attention towards the structural organization of the human body. *Ayurvedic* literature pertaining to *sharir rachana* furnishes detaliled description on measurements of body and its elements.

In *ayurveda* anterior portion of *paada* is called as *prapadam* or *padagram. Paada, pad, angrhi, charana* are synonyms of *paada*. *Parshni* is situated inferior to *gulpha* portion of a *paada* which is also root of *paada* of both men and women. It is also called as posterior portion of *paada.*[1] Bones described by *Charaka* for *paada- anguli* are 30 and for *paada-shalaka* are 10.[2] Same description is given by *Sushruta* for number of *Pada anguli*. Next *charaka* has described the bones of *pada adhisthana* as 2 and of *Parshni*- 2, *Gulpha*-4. *Sushruta* has quoted number of bones as 10 of *tala, kurcha* and *gulpha* region.[3] According to *Kashyapa parshni* are 2 in number.[4] The number of *Parshni* is also same as per *Sushruta*. The *Parshni* region denotes the heel region. *Paada* is considered as one of the *karmeindriaya*.[5]

During the 2nd month of intra embryonic life *pancha pindka* is formed i.e. *hast, pada, shira*.[6] According to *Sushruta paada* is one of the part of *shadanga sharir*.[7] There are 16 *kandara* out of these 4 are present in foot region.[8] Also out of six *kurcha* two are present in *paada* region.[9] Out of 17 *sandhi* in limb region are present in 4 phalanges, 2in thumb,1 each in *janu,nitamb, vankshan* so total are 17 *sandhi* are present in each lower limb.[10] In each limb there are 150 *snayu*, out of that 30 *snayu* are present in all toes each toe having 6 snayu. 30 are present in *tala, kurcha, gulpha* region.[11] In *Paada Kshipra, Talahriday, Kurcha, Kurchashira, Gulpha marma* are present.[12]

Paada praman sharir

- Length of *angushta* and second *angula* – 2 *angula*[13]

- 3rd, 4th, and 5th finger – 1\5 less in length than its successor
- Fore foot and arch of foot – 4 *angula* long and *5 angula* broad
- Heel – 5 *angula* long and 4 *angula* broad
- Foot – 14 *angula* long
- Circumferance of foot, ankle, calf and knee – 14 *angula* in its centre.[14]

Foot arches

Foot arches are formed by tarsal and metatarsal bones and strengthened by ligaments and tendons. According to Grey's anatomy[15,16] the human foot has two longitudinal arches and one transverse arch.

Medial Longitudinal Arch (MLA)

It is formed by the nine bones, from distal to proximal

I. First 3 meta-tarsals
II. Three cuneiform bones
III. Navicular bone
IV. Talus
V. Calcaneum

The MLA is present on medial aspect of foot, and larger than the lateral longitudinal arch. It is a dynamic arch (it changes of the height during locomotion). It goes downwards to absorb weight and springs back up to return energy to the lower limb during walking.

Lateral Longitudinal Arch (LLA)

It is formed by four bones, from lateral to medial

I. 4th meta-tarsal
II. 5th meta- tarsal
III. Cuboid bone
IV. Calcaneum

Lateral longitudinal arch is at lateral aspect of the foot, and smaller than the MLA. It is more stable than the MLA and support the body weight.

Transverse Arch

It is a partial arch (hemi arch), only becomes a complete arch when the two feet are put together. The weight on the foot is not distributed evenly across all the bones of the foot. There are six bones sharing the body weight.

- Posteriorly, the calcaneum supports most of the weight
- Anteriorly, the weight is distributed evenly across the distal heads of the 5 meta-tarsals

Actually, the weight of the first metatarsal is not supported by the head. Rather there are two small sesamoid bones formed in flexor halluces longus that support the weight of the first metatarsal. So, there are seven points of contact/weight distribution (1 calcaneum, 4 lateral metatarsals, 2 sesamoid bones=7).

These arches are present since birth but in infants, feet appear to be flat because of presence of fat.[17] These arches become prominent when the child starts walking and the foot starts the bearing of the body weight.

Techniques used to determine morphology of mla

Feiss line

In 1909 Feiss Ho[18] described the Feiss line. Draw dots on medial malleolus and 1st MTP joint draw a line connecting the dots and observe the navicular tubercle in weight bearing and non-weight bearing position.

- In Non-weight bearing the navicular tubercle is present below the line that indicates the congenital pes planus.
- In weight bearing the navicular tubercle is present below the line that indicates the functional pes planus.
- If navicular tubercle is present above the line in weight bearing and Non- weight bearing position that indicates the pes cavus

Great toe extension test

In 1982 Rose GK[19] used Great toe extension test. The test is extension of the great toe at the metatarso-phalangeal joint. In normal weight-bearing foot has two effects: elevation of the MLA and lateral rotation of the tibia. If the arch is present the both effects are seen. If arch is not present the both effects are not seen

Navicular Drop Test (NDT)

In 1982 Navicular drop test was described by Broady.[20] The NDT is the difference in height of the navicular bone of individual during the non weight bearing and weight bearing position. If navicular drop value is equal or more than 10mm, that indicates the pes planus.

Calcaneal pitch angle

In 1990 Tachdjian MO[21] found the calcaneal pitch angle. A line is drawn from the plantar surface of the calcaneum to the inferior border of the distal articular surface. The angle made between this line and the transverse plane is the calcaneal pitch angle and it is also called as calcaneal inclination.

Normal Value is 20-30°

Low 10-20° indicative of pes planus

High ≥30° indicative of pes cavus

Arch Index (AI)

The truncated foot was divided in to three equal regions: A- fore foot, B - mid foot and C-heel. Then arch index was calculated by dividing the mid foot region (B) by the entire foot print area (A+B+C)[22,23]

AI=B/A+B+C

Plantar Arch Index (PAI)

It is also called as Staheli Arch Index; it shows a relationship between central and posterior regions of the foot prints.[24] PAI is measured by dividing the value of central region of the foot (B) by the value of parallel line on wider zone of the heel area (C) and multiplying by 100. A lower index value means a higher arch.PAI=B/C×100%

Types of foot prints

In 1992 According to Udaya Bhaskar Rao the foot prints were classified as normal arch, high arched and low arched foot. First a line was drawn on the medial border of the foot print.[25] The midpoint of this line is A, and midfoot region is BC. If the distance between A and B was less than 1 cm, the foot was considered as low arched flat foot. If the distance between B and C was less than 1 cm, the foot was considered as high arched foot. All other foot prints were considered normal foot. All other foot prints were considered normal foot.

Pes planus or flat foot

The term "flat foot" implies that the longitudinal arch of the foot has collapsed, so that on standing, the medial border of the foot almost touches the ground - it is usually bilateral but if unilateral, it usually indicates abnormal bone and joint pathology in the abnormal foot (either congenital or acquired). Most children are born with flat feet, and in the first decade of life, most children develop a normal arch in the foot, when they start to walk. Only if the deformity persists or presents in adolescence or adulthood, as a result of trauma, is it considered abnormal.

The use of shoe modifications and inserts in the development of the longitudinal arch of the foot are not effective, and are unnecessary, because there is a normal spontaneous improvement in the development of the longitudinal arch, in children, during the first decade of life.

Classification of Flat Foot (Children)

1. **Congenital:** i.e. born with deformity. It is universal in the first two years of life and the foot is flexible. It is usually asymptomatic, but if symptomatic and the foot is rigid it may be secondary to tarsal coalition, accessory navicular bone, vertical talus, tight heel cord or cerebral palsy.[26]
2. **Peroneal spastic flat foot:** It is associated with pain in children and young adults, is usually associated with a congenital coalition (bone or cartilage) of the bones of the hind foot, i.e. calcaneo-navicular and talo-calcaneal coalition. If painful and diagnosed early in childhood, excision of the abnormal bony bar may relieve pain and restore mobility. In adults, if pain is associated with degenerative joint changes, surgical fusion of the affected joints may be advised.

Acquired Flat Foot (Adults)

These diseases must be excluded:

1. Trauma - fractures of the talus, os calcis or mid foot resulting in post-traumatic osteo-arthritis of the hind foot or mid foot.
2. Rupture or stretching of the tibialis posterior tendon.
3. Rheumatoid arthritis.
4. Diabetes - Charcot neuropathic foot.
5. Neuromuscular disease eg. Polio.

In adults, the flexible flat foot may be regarded as the normal contour of a strong and stable foot, rather than the result of weakness in foot structure or weakness of the muscles which motivate the foot.

A flexible flat foot, in adults, is of little consequence as a cause of disability. There are no universally accepted clinical or radiographic definitions of the normal range of height of the longitudinal arch. The point at which a low normal arch becomes a flat foot is, therefore, unknown. A myth exists that people with flat feet will have difficulty at work or when involved in recreational activities. During World War II, thousands of men were rejected from military service, because they had asymptomatic flat feet. Athletes are not impeded by this condition. Perhaps one in one thousand adults with flat feet will have pain from the condition.

Long term studies, in children with flexible flat feet, suggest that the natural history would indicate a good prognosis without treatment, for most patients. Long term studies indicate that flexible flat foot, in children and adults, is a physiological variant and like any other variant may occasionally cause disability. Harris and Beath found flat foot deformity in approximately 23 percent of 3,619 patients whom they examined. Two thirds of these adult patients showed no disability. Approximately 25 percent of those patients with flat feet had a contracture of the Achilles' tendon with good mobility of the hind foot complex.

A rigid flat foot, characterized by restricted subtalar movement, ie. Lack of inversion and eversion was associated with congenital abnormalities of the bone, ie. Calcaneo-navicular fusion or talo-calaneal fusion and caused pain and disability in only one out of four patients in this small special group of patients with flat feet.

In adults, treatment is not needed unless symptoms of tiredness are present. Adults with flat feet or indeed with normal arches of the foot, may develop a nagging discomfort in the feet after standing or walking a long time. These adults are sometimes helped by an arch support, but advice about standard foot wear, weight reduction, the use of running shoes and work boots (with or without arch supports) is usually just as effective. Arch supports tend to be overprescribed and are very expensive.

Foot exercises will do nothing to correct the deformity, or alleviate symptoms of tiredness in the foot. In adults with flat feet, most patients are free from pain and their minor

physiological variant, ie. flat feet does not interfere with work, sports or recreational activities. However, some patients with flat feet do complain that after standing or walking on a concrete surface (work place) that their feet hurt, and this probably implies a foot strain, which is the result of a subacute or chronic strain of the ligaments of the foot and does not relate to an acute traumatic injury.

Foot strain may be caused in a normal foot, by excessive standing or walking (army recruits). The main symptoms are prolonged aching in the foot, which is worse on standing and walking. It is important to exclude peripheral vascular disease, degenerative disc disease of the lumbar spine, arthritis of the foot in adults or neuro-muscular disease, before attributing these symptoms to simple foot strain. In later life, pain may arise from arthritis of the hind foot or mid foot consequent upon prolonged mal-alignment of these joints. Treatment may include alteration of work with reduced time in standing or walking and modification of lifestyle, including conversion to a desk job rather than a labourer type of job. Arch supports may help, but in general advice about appropriate foot wear and weight reduction are appropriate.

Occasionally, the patient will give a history of change in work habit, such as increased walking or standing for long periods of time on a hard floor, or possibly having sustained a mild or moderate injury to the foot. As a result of foot discomfort, the patient may start to walk in an abnormal manner, which will secondarily cause a strain on other areas of the foot. This type of problem can occur in a normal foot as well as in a flat foot, although the “flat foot” seems to be somewhat more prone to becoming symptomatic, after a change in work habits.

In adults, treatment is not needed unless symptoms of tiredness are present. Arch supports may afford temporary relief. If successful, they need to be replaced every two or three years, and should be combined with advice about sensible foot wear and weight reduction. If the symptoms of long established flat feet in adults are related to superimposed arthritis of the hind foot or mid foot, surgical procedures such as an osteotomy to correct the deformity or surgical fusion of the hind foot or mid foot are sometimes advised. Please remember that hind foot and mid foot surgical procedures place increased stress on the ankle joint over the years ahead.

Pes cavus (High arched foot)

Pes cavus is a foot with an abnormally high plantar longitudinal arch. People who have this condition will place too much weight and stress on the ball and heel of the foot while standing and/or walking.

The spectrum of associated deformities observed with pes cavus includes clawing of the toes, posterior hind foot deformity (described as an increased calcaneal angle), contracture of the plantar fascia, and cock-up deformity of the great toe. This can cause increased weight bearing for the metatarsal heads and associated Metatarsalgia and calluses.[27]

Etiology of pes cavus

The etiology can be attributed to the brain, spinal cord, peripheral nerves, or structural problems of the foot. When motor imbalance begins before maturation of the skeleton, there can be a substantial change in healthy bone morphology. When cavus is acquired after skeletal maturity, there may be little or no change in the morphology.

Two-thirds of adults with symptomatic cavus foot have an underlying neurologic condition, most commonly: Charcot-Marie-Tooth (CMT) disease, spinal dysraphism, polyneuritis, Intraspinal tumors, poliomyelitis, syringomyelia, Friedreich ataxia, cerebral palsy, and spinal cord tumors, can cause muscle imbalances that lead to elevated arches.[28] A patient with a new-onset unilateral deformity but without a history of trauma must be evaluated for spinal tumors. The cause and deforming mechanism underlying pes cavus are complex and not well understood. Factors considered influential in the development of pes cavus include muscle weakness and imbalance in neuromuscular disease, residual effects of congenital clubfoot, post-traumatic bone malformation, contracture of the plantar fascia, and shortening of the Achilles tendon.[29]

Charcot-Marie-Tooth disease also known as Hereditary Motor and Sensory Neuropathy (HMSN), it is genetically heterogeneous and usually presents in the first decade of life with delayed motor milestones, distal muscle weakness, clumsiness, and frequent falls. By adulthood, Charcot-Marie-Tooth disease can cause painful foot deformities such as pes cavus. Although it is a relatively common disorder affecting the foot and ankle, little is known about the distribution of muscle weakness, severity of orthopaedic deformities, or types of foot pain experienced. There are no cures or effective courses of treatment to halt the progression of any form of Charcot-Marie-Tooth disease.[30]

The development of the cavus foot structure seen in Charcot-Marie-Tooth disease has been previously linked to an imbalance of muscle strength around the foot and ankle. A hypothetical model proposed by various authors describes a relationship whereby weak evertor muscles are overpowered by stronger invertor muscles, causing an adducted forefoot and inverted rearfoot. Similarly, weak dorsiflexors are overpowered by stronger plantarflexors, causing a plantarflexed first metatarsal and anterior pes cavus.[31]

Types of pes cavus

Three main types of pes cavus are regularly described in the literature: pes cavovarus, pes calcaneocavus, and 'pure' pes cavus. The three types of pes cavus can be distinguished by their aetiology, clinical signs and radiological appearance.[32]

Pes cavovarus, the most common type of pes cavus, is seen primarily in neuromuscular disorders such as Charcot-Marie-Tooth disease and, in cases of unknown aetiology, is conventionally termed 'idiopathic.[33] Pes cavovarus presents with the calcaneus in varus, the first metatarsal plantarflexed, and a claw-toe deformity.Radiological analysis of pes cavus in Charcot-Marie-Tooth disease shows the forefoot is typically plantarflexed in relation to the rearfoot.[34]

Pes calcaneocavus foot, which is seen primarily following paralysis of the triceps surae due to poliomyelitis, the calcaneus is dorsiflexed and the forefoot is plantarflexed. Radiological analysis of pes calcaneocavus reveals a large talo-calcaneal angle.

In pes cavus, the calcaneus is neither dorsiflexed nor in varus and is highly arched due to a plantarflexed position of the forefoot on the rearfoot.[35] A combination of any or all of these elements can also be seen in a 'combined' type of pes cavus.

Epidemiology

There are few good estimates of prevalence for pes cavus in the general community. While pes cavus has been reported in between 2 and 29% of the adult population, there are several limitations of the prevalence data reported in these studies.[36] Population-based studies suggest the prevalence of the cavus foot is approximately 10%.[37]

Pathogenesis

Multiple theories have been proposed for the pathogenesis of pes cavus. Duchenne described intrinsic muscle imbalances causing an elevated arch. Other theories include the extrinsic

muscle and a combination of the intrinsic and extrinsic muscles being causes of the imbalance. Mann et al. (1992)[38] described the pathogenesis of pes cavus in patients with CMT disease. An agonist and antagonist model for the muscles determines the deformity. In CMT, the anterior tibialis muscle and the peroneus muscle develop weaknesses. Antagonist muscles, posterior tibialis and peroneus longus, pull harder than the other muscles, causing deformity. Specifically, the peroneus longus pulls harder than the weak anterior tibialis causing plantar flexion of the first ray and forefoot valgus. The posterior tibialis pulls harder than the weak peroneus brevis causing forefoot adduction. Intrinsic muscle develops contractures while the long extensor to the toes, recruited to assist in ankle dorsiflexion, causes cock-up or claw toe deformity. With the forefoot valgus and the hindfoot varus, increased stress is placed on the lateral ankle ligaments and instability can occur.

Clinically relevant anatomy

Clinically it is an abnormal elevation of the medial arch in weight bearing. Biomechanically, cavus is defined as a varus hindfoot, high calcaneal pitch, high-pitched midfoot and plantarflexed and adducted forefoot. When the angle between the talus and calcaneus is narrowed, the os naviculare moves to a superior position to the cuboid, instead of medial to it. This makes it difficult for the Chopart-joint to function.The talus is the connector of the foot and the ankle. In a neutral foot, the foot rotates around the talus and the cuboid follows the calcaneus.

Characteristics

During the gait cycle, the foot remains locked in hindfoot inversion and forefoot varus throughout the stance phase, causing less stress dissipation. This can result in metatarsalgia, stress fracture of the fifth metatarsal, plantar fasciitis, medial longitudinal arch pain, ilio-tibial band syndrome and instability. This locking and unlocking of the Chopart-joint is a critical element in the cavus-foot.

In a cavus foot, the calcaneus is rotated internally beneath the talus, resulting in a narrow anterior-posterior talo-calcaneal angle. Since the cuboid follows the calcaneus, the cuboid is plantar to the navicular, instead of beside it. This locks the midfoot and overloads the lateral side of the foot. Another way to look at the chopart function is to view the foot from the front with the forefoot removed. If an axis, drawn through the two joints, is parallel to the ground, there will be relatively free flexion. The more the axis approaches a vertical orientation, the less flexion will be possible. In extremely high-arched feet, the weight bearing is distributed

unevenly along the metatarsal heads and the lateral border of the feet. Due to high-arched feet there are more chances of contusions of metatarsal head and calcaneum caused by the excessive pressure of weight bearing. Also the foot is prone to osteophyte formation at the junction of the metatarsal bases and the cuneiforms.

Symptoms and Clinical presentation

Patients complain pain, instability, difficulty walking and problems with footwear. The symptoms vary with the degree of deformity,[39] also can present with lateral foot pain from increased weight bearing on the lateral foot.

- The range of complaints reported in the literature include metatarsalgia, pain under the first metatarsal, plantar fasciitis, painful callosities, ankle arthritis, and Achilles tendonitis.
- Keratosis
- Lateral Ankle instability
- Hindfoot varus
- The forefoot plantar flexion
- Hindfoot varus
- Lower limb stress fractures
- Knee pain
- Iliotibial band friction syndrome
- Back pain
- Tripping

Relationship between physical activity and foot arch development in children

A suitable amount of physical activity is crucial for child development. Physical activity (PA) leads to physical fitness (PF). Limited PA may lead to illnesses, metabolic disorders, and musculoskeletal disorders, such as incorrect foot arches. The foot is the fundament of the body posture, in both its static and dynamic functions, regardless of the different measures of foot structure.[40] Proper stabilization of the foot on the ground, along with its proper arches, guarantees correct gait.[41]

There is a strong relationship between the strength and endurance of lower extremity muscles and the structure of the arches of the foot.[42] Various studies showed that decreased physical activity, sedentary lifestyle, and decreased physical fitness influence the arches of the foot.

However, they could not find a significant correlation between the variables. Mueller's studies found that static and dynamic measurements of feet change with a child's age.[43]

S Physical activity is an element of preventive healthcare. It triggers adaptive processes in the body. Studies by Furgał and Adamczyk on nine and ten year old children seem to confirm our findings. They found that less active children had more foot arch disorders. 62.5% of girls and 39.5% of boys who did not perform any physical activity outside their PE lessons had lowered foot arches. Regular physical activity ensured normal foot arches in children.[44]

Children of superior physical fitness did not have transversely flat feet, and that longitudinally flat feet were most common in children whose physical fitness was lowest. The foot is one of the links of the human kinematic chain. Twomey and McIntosh conducted a three-dimensional gait analysis of subject with healthy and flat feet. They found increased outer rotation in the hip and a different positioning of the lower limb axis in subjects with flat feet.[45] This shows that a disorder of foot arches negatively affects the functioning of the whole body and the body posture.[46] According to the American Orthopaedic Foot and Ankle Society, the issue of flat feet or high foot arches rarely requires specialist treatment.[47] Well-designed footwear and regular physical activity support the correct development of the arches of the foot.[48,49]

The association between high arched feet, plantar pressure Distribution and Body posture

Studies proved that even a slight increase in the arching of the foot in the range that is often not considered as pathological causes visible changes in the distribution of foot loads both between limbs and between the fore and rear foot. Slight elevation of the foot's longitudinal arch may influence the tissues of whole body. They observed increase in forefoot load may result in foot overloading, and what should be underlined is that this may be related to compensatory reactions within the trunk. Observations suggest that the consequences of foot high-arching may be present throughout the entire body.

Moreover, one-side foot high-arching may be related to asymmetric alignment in the shoulder girdle. There will be increased forefoot and rear foot load in high-arched feet, with the forefoot significantly more loaded. This is a clinically unfavorable phenomenon because forefoot overloading is considered as a pathological pattern of foot load. It was observed that below normal feet, the pressure is slightly higher on the heel than on the forefoot. High-

arched feet have signifcant reduction in the weight-bearing area, as well as an increase in the load of the forefoot.[50,51,52]

Studies proved that in subjects with high-arched feet, plantar pressure and force in the forefoot were higher than in subjects with planus feet.[53] Subjects with high-arched feet had greater force in the medial forefoot region. Burns et al.15 have observed that about 70% of the subjects with pes cavus reported musculoskeletal foot pain compared to the 23% of individuals with a normal foot type. High-arched feet have a reduced ground contact area, which is rigid and non-shock absorbent and therefore, they are at a greater risk of lower limb overuse injury than in the case of a normal foot. It was also suggested that poor distribution of loads in a high-arched foot may induce associated pathology and pain in other areas of the body because of repeated micro-trauma to the legs over an extended period of time.[54,55]

Compensatory reactions in body

People with high-arched feet who present increased forefoot load also demonstrate decreased forward trunk inclination in comparison to subjects with normal feet. This decrease in total trunk inclination may be considered as a compensatory reaction when higher loads are shifted to the forefoot. It has been previously suggested that the reduced weight-bearing area under the foot may probably be related to a decrease in afferent proprioceptive stimulation which changes postural corrective reactions.[56] Also, because the plantar muscle together with plantar fascia control the maintenance of the longitudinal foot arch, plantar fascia innervation plays an important role in proprioception, stability and control of foot movements.[57]

Postural Stability and Arch deformities

It was noted by some authors that healthy individuals with different architectural foot types demonstrated some differences in postural control and in subjects with high-arched feet, more proprioceptive stimulation is present in the backfoot.[58] Postural stability is affected by foot type under both static and dynamic conditions. Subjects with high-arched feet have better postural control in the posterior and posterio-lateral directions, and foot type should be considered during the clinical evaluation of balance measurements.[59]

In patients with one-sided elevation of the foot arch, we can observe asymmetrical limb loading, in which greater pressure was directed to the limb with the correct arch of the foot. Asymmetric limb loading may create an unfavourable tension within the myofascial chains and can lead to alterations in the parts of the body distal from the foot.[60] Shoulder height

asymmetry is observed in people with one-sided high-arching of the foot. It was reported that unilateral or asymmetric overpronation of the foot produce a functional difference in lower limb length and a lateral tilt of the pelvis to the side with increased foot pronation. Most of the studies have reported the influence of low-arched or hyperpronated feet on pelvic and lumbar spine alignment.

Measures to protect foot arches

You should walk correctly to protect your feet and feet arches. Your head should be erect, your back straight, and your arms relaxed and swinging freely at your sides. You should step out on your heel, move forward with the weight on the outside of your foot, and complete the step by pushing off the big toe.[61]

Select proper footwears and shoes: In general, the best shoes are well cushioned and have a leather upper, stiff heel counter, and flexible area at the ball of the foot. The heel area should be strong and supportive, but not too stiff. The front of the shoe should be flexible. New shoes should feel comfortable right away, without a breaking in period. There should be plenty of room for all 5 toes.

Getting the correct fit

The best way to prevent nearly all foot problems is to choose well-fitted shoes with a firm sole and soft upper. You should purchase them in the afternoon or after a long walk, when your feet are at their largest size. There should be a ½ inch of space between your longest toe and the tip of the shoe, and the toes should be able to wiggle upward. You should stand when being measured, and both feet should be sized, with shoes bought for the larger foot. It is important to wear the same socks as you would regularly wear with the new shoes.

The sole

Ideally, your shoes should have removable insoles. If you are an older person, thin hardsoles may be the best choice. Elderly people wearing shoes with thick, inflexible soles may be unable to sense the position of their feet relative to the ground, which increases the risk of falling.

The heel

High heels are a major cause of foot problems in women. If you insist on wearing high heels, look for shoes with a wide toe box (the part of the shoe that surrounds the toes), reinforced

heels that are relatively wide, and cushioned insoles. You should also keep the amount of time you spend wearing high heels to a minimum.

Exercise and Sports

The shoes you wear for exercise should be specifically designed for your preferred sport. For instance, a running shoe should cushion your forefoot, while tennis shoes should emphasize ankle support. Buy your shoes at a store with knowledgeable sales people.

Occupational footwear

A number of occupations put the feet in danger. If you are in a high-risk job, you should be sure your footwear is protective.

Insoles

An insole is a flat cushioned insert that is placed inside the shoe. They are designed to reduce shock, provide support for your heels and arches, and absorb moisture and odorInsoles can be purchased in athletic and drug stores. Shoe stores that specialize in foot problems often sell customized insoles that are more expensive. In general, over-the-counter insoles offer enough support for most people's foot problems. Most well-known brands of athletic shoes have built-in insoles.

Yoga to protect foot arches

As we know yoga will improve our body functions like breathing, blood circulation, health of the vital organs and create an overall feeling of balance and well being. A targeted asana practice will help to build strength and alignment of the feet arches.[62] They are

- Tadasana
- Vrikshasana
- Ardha Padma padangustasana
- Vajrasana
- Veerasana
- Gomukhasana
- Sethubandhasana

CONCLUSION

Acharyas of *ayurveda* have described the normal measurements of body and its parts under *praman sharir*. Any deviation from these measurements can be a sign pf deformity or

abnormality. The detailed measurements of normal human foot (*paada*) is given by *Acharya sushruta* in 35th chapter of *sutra sthana*. The human foot is a masterpiece of engineering, uniquely designed with two longitudinal arches and two transverse arches. These springs helps the foot to act as an effective flexible surface essential for adapting to ground planes, shock absorption, weight transfer and locomotion. The morphology of these arches determines the normal biomechanics of foot and entire lower extremity.

Based on the structure of the medial longitudinal arch, three types of foot have been suggested: 1. Normal foot, 2. Low arched foot or pes planus or pronated foot and 3. High arched or pes cavus or supinated foot. Arch function depends on the foot shape, structure of the bones, strength of ligaments and muscular fatigue while factors like race, foot wear, age and gender are found to impact the arrangement of medial longitudinal arch of foot.

Studies in foot arch structure parameters dependent on physical activity and physical fitness are essential for the physiotherapeutic recommendations for everyday functioning of the patients. An explicit proof that physical activity and physical fitness levels are related to foot structure parameters will allow for the inclusion of specific exercises in the therapy of people with foot arch disorders.

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