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Orthopaedics

Measurement of arch index in adults—an outdoor based preliminary study

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KEYWORDS :

Introduction

In terms of human evolution in the broader context, it is now generally considered that the development of obligate bipedal locomotion was one of the most significant adaptations to occur within the hominid lineage. Of all extant primates, humans are the only obligate bipeds. Highly specialized postcranial adaptations, especially in the lower limb, characterize this unique form of locomotion. The foot is particularly specialized in both its anatomy and its function. This makes perfect sense, because in developing bipedal locomotion, the foot becomes the only structure that directly interfaces with the ground, and subsequently is under strong selection pressure to deal with both balance and propulsion in a highly efficient way. Even in the more arboreal great apes, the lower limb is always the principal limb of locomotion.

But the evolutionary machinations have also extolled a heavy cost by making our feet a true Achilles' heel. Dissipating the body weight has put a strain on the arch of the foot, that it was never designed to bear. Resultantly we have an array of foot disorders ranging from ankle sprain to corns and calluses. But the foot problems that we quite commonly encounter in orthopaedic practices are high arched foot and flat foot.

Flat feet (also called pes planus) is a postural deformity in which the arch of the foot collapses, with the entire sole of the foot coming into complete or near-complete contact with the ground. In some individuals (an estimated 20–30% of the general population) the arch simply never develops in one foot (unilaterally) or both feet (bilaterally). Pes cavus, is a high arch of the foot that does not flatten with weight bearing. No specific radiographic definition of pes cavus exists. The deformity can be located in the forefoot, midfoot, hindfoot, or a combination of these sites [1].

In either case the measurement of foot posture is widely considered to be an important component of musculoskeletal examination in clinical practice and research, as variations in foot posture have been found to influence lower limb gait kinematics, muscle activity, balance and functional ability, and predisposition to overuse injury. Unfortunately, there remains considerable disagreement regarding foot posture categorisation as several techniques have been reported in the literature, including visual observation, footprint parameters, measurement of frontal plane heel position, assessment of the position of the navicular tuberosity and a range of angular measurements obtained from foot radiographs. Each of these techniques has advantages and disadvantages in relation to equipment requirements, the degree of clinical expertise necessary to obtain accurate measurements, reliability and validity considerations, relationship to dynamic foot function and the availability of normative data for comparison purposes [2].

In 1987, Cavanagh and Rogers developed the Arch Index (AI), which represents the ratio of the area of the middle third of a footprint relative to the total area excluding the toes, with a higher ratio indicating a flatter foot. The AI has since been found to have excellent reliability, is highly correlated with navicular height and angular measures determined from radiographs, is sensitive to age-related differences in foot posture, and is correlated with pressures under the midfoot and rearfoot motion when walking [2].

Human foot is the region most affected by anatomical variations in the entire human body, and one of the most important characteristics presenting the highest level of variability is the medial longitudinal arch, and an arch index provides a quantitative measurement of the plantar arch, which can be compared to other measurements [3]. The objective of the present study is to evaluate the Arch Index of representative adult in our environment and note the prevalence of different arch measurement and affect of occupation, daily walking and barefoot walking on the same. The results should relevant both for clinical practice and, perhaps also, for shoemaking industry for the targeted age group.

Objectives:

- To calculate the Arch Index of the adults in the Local population by taking foot print.
- To assess the effect of some selected variables on the Arch Index of the Adults in the local population.

Methodology:

Type of study: Cross-sectional study.

Study duration: The study was conducted from to

Setting: The study was conducted in Outpatient wing of the Dept of Orthopaedics in AGMC and GBPH.

Study Population: All patients aged more than 18 visiting the OPD of Dept of Orthopaedics during the study period.

Inclusion criterion:

- Patients aged >18years
- Patients regarded as clinically normal after an overall orthopaedic study.

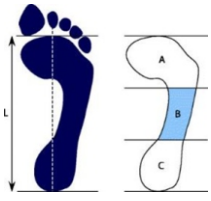
Exclusion criteria:

- Patients unwilling to give consent.
- Mentally unfit for valid consent.
- Patients having abnormal gait
- Patients having single leg
- Patients having relevant clinical conditions like foot deformities, orthopaedic surgeries or serious trauma on limbs.

Sample size: The sample size was 144 adults.

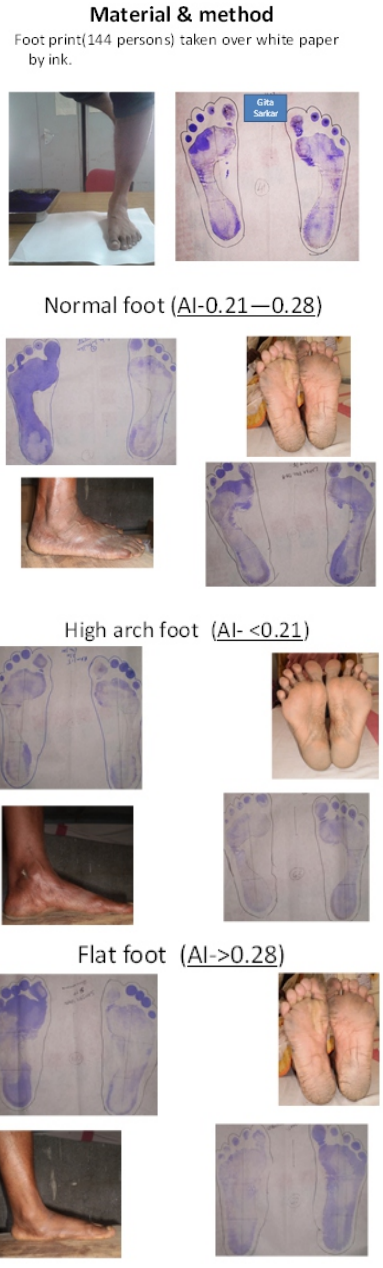
Data Collection:

The foot prints of the participants congruent to the inclusion and exclusion criteria were taken by the investigator. AI was determined by obtaining a fully weight bearing static footprint on a white paper with stamp ink with the participant standing in a relaxed position. A foot axis was then drawn from the centre of the heel to the tip of the second toe, and the footprint divided into equal thirds (excluding the toes) by constructing lines tangential to the foot axis. After taking digital image the foot area and midfoot area were measured using computer graphics software developed by the NIH (USA), and the AI was calculated as the ratio of area of the middle third of the footprint to the entire footprint area. Thus, the lower the arch, the higher is the AI [2].



The length of the footprint excluding the toes (L) is divided into equal thirds. The AI is then calculated as the area of the middle third of the footprint divided by the entire footprint area

(AI = B/A + B + C) [4].



Evaluation criteria:

AI scores ranged from 0.09 to 0.35 (mean 0.24, median 0.24, standard deviation [SD] 0.04) and were normally distributed. Three categories were created: normal (± 2 SD from the mean), high (<2 SD) and low (>2 SD). The AI scores that defined each category were as follows:

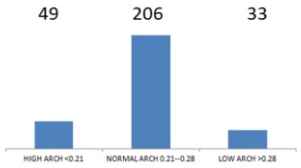
- Normal arch(0.21 to 0.28),
- High arch(<0.21) and
- Low arch (>0.28) [2].

Statistical Analysis:

All analyses were performed using SPSS Statistics version 17.0 (SPSS Inc, Chicago, IL). For purposes of comparing these averages, the following parametric tests were used: Student's t test and paired t Test for two samples and Variance Analysis for more than two grouped samples. In all tests, the adopted significance level was 5% (a = 0.05).

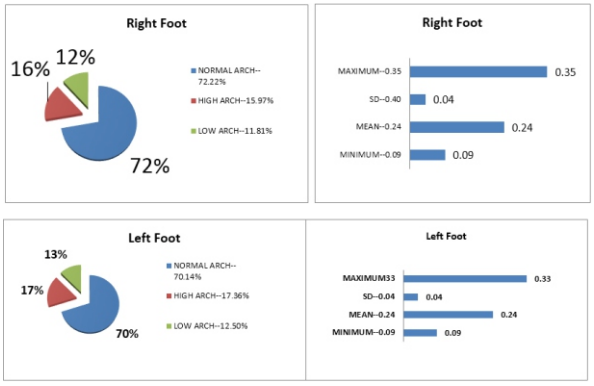
Results:

Fig-1: Types of arches of foot



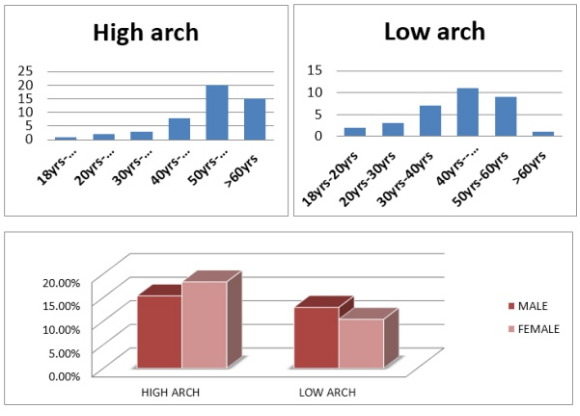
The figure above shows the prevalence of the three categories of AI in the study population. Thus, 71% of the adults in the study were found to have normal arch, 17% had high arch and 11% had low arch.

Fig-2: Variation in right and left foot



The figures above show the variations in the right foot and it is seen that incidence of high arch is 15.97% while low arch is 11.81% and that of normal arch is 72.22%. Whereas in the left foot normal arch is 70.14%, high arch is 17.36% and low arch is 12.50%

Fig-3: Age and Sex distribution



The above bar diagrams show the variations in the high and low arch in adults according to their age and sex. It is seen that the incidence of both arch deformities increased after 40years of age. And while females had higher incidence of high arch, males had higher incidence of low arch in the representative adult population.

Discussion:

- 17% normal people & 11.46% people are having higher & lower arch respectively, though they are not having any foot complaints.
- Arch deformity is more after 40 years of age.
- Higher arch more prevalent in female & in left foot.
- Lower arch more prevalent in male.
- Causes may be various---walking bare foot,walking in hilly area,genetic etc.

Conclusion:

Foot posture can be quickly and reliably categorised as high, normal or low in adults using the AI. This type of screening may therefore be useful for musculoskeletal screening in clinical practice or research settings where more detailed assessments of foot posture are not feasible. The prevalence of different AI in the adult local population

and the effect of certain variables on the same, will help us deal better in terms of interventions as well as counselling with patients coming with different foot problems

Reference:

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