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Medial Longitudinal Arch Dimensions in Adult Bangladeshi Male Medical Students - A Radiographic Approach

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Abstract

Context: *The anatomy and shape of a person's medial longitudinal arch can dictate the types of injuries to which that person is susceptible. Many studies were carried out in various populations to determine normal values of different radiographic dimensions of medial longitudinal arch. However, there is no published article on this topic in Bangladesh. So, this study was aimed to establish the standard data of different medial longitudinal arch radiographic dimensions in adult Bangladeshi male and to make comparison with previous studies on other populations.*

Materials & Methods: *Digital radiographs of left foot in lateral view in bilateral standing position were taken from 50 male students of Sir Salimullah Medical College, Dhaka aged between 21 to 26 years without any history of foot deformities and injuries. These radiographs of foot were imaged with a digital camera according to scale and were transferred to a computer. From these images navicular height, calcaneal inclination angle, medial arch angle and calcaneal-first metatarsal angle were measured by MB ruler software.*

Results:*The mean±SD of the navicular height was 4.90±0.72 cm (range 3.23–6.98 cm), calcaneal inclination angle was 30.82±5.99° (range 15.82°–42.17°), medial arch angle was 109.96±9.09° (range 91.15°–129.42°) and calcaneal-first metatarsal angle was 118.89±10.91° (range 98.53°–148.33°).*

Key words: *Radiographic dimensions, medial longitudinal arch, Bangladeshi male*

Introduction

Human is unique among the primates since he has adopted an upright posture and a bipedal mode of locomotion. Its evolution from that of quadruped mammals to bipedal foot of humans includes the formation of foot arches and adduction of first metatarsal bone.[1] The human foot has two longitudinal arches (medial and lateral) and a transverse arch. The bones that form the medial longitudinal arch are calcaneus, talus, navicular, the three cuneiform bones and the medial three metatarsal bones.[2] Functionally, both longitudinal arches act as a unit with the transverse arch, spreading the weight in all directions. The medial longitudinal arch also has an important role in shock absorption and propulsion during walking, running and jumping.[3]

Of the three arches, the medial longitudinal arch is the largest and clinically the most important. Based on the morphology of medial longitudinal arch foot can be classified into three types: (i) normal foot, (ii) low arched or flat foot (Pes planus) and(iii) high arched or clawfoot (Pes cavus). In flat foot, the medial longitudinal arch is depressed or collapsed with the medial side of the foot coming into complete or near complete contact with the ground and in claw foot, the medial longitudinal arch is unduly high.[4] These variations in arch height have

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a considerable influence on lower limb gait kinematics, functional ability, and predisposition to musculoskeletal injury.[5] For example, low arched runners exhibit more medial injuries of soft tissue structures, particularly at the knee. The most common injuries include general knee pain, patellar tendinitis and plantar fasciitis.[6] On the other hand, high arched runners exhibit more lateral injuries of bony structures particularly at the foot and ankle. The most common injuries include lateral ankle sprain, stress fractures of the fifth metatarsal, and iliotibial band friction syndrome.[6]

The different dimensions of medial longitudinal arch can be studied by visual observation, anthropometric measures, footprint measures and radiographic measures.[7]Among these methods, radiographic measurements are regarded as most important for assessing skeletal alignment of foot in a static weight bearing position.[7]Because interpretation of other measures is confounded by soft tissues overlying skeletal structure of foot. Therefore, different angular and linear foot measurements derived from digital radiograph are often used to validate clinical measures of foot.

Many studies were carried out in different parts of the world to determine normal values of different radiographic dimensions of medial longitudinal arch. So far it is known that there is no published article on this topic in Bangladesh. Moreover, since racial differences have some influence on the anatomical structures,[8] it is necessary to find out the normal values of different radiographic dimensions of medial longitudinal arch for each population to avoid misdiagnosis. So, the present study was designed to provide the normal values of different radiographic dimensions of medial longitudinal arch of adult Bangladeshi male and to make comparison with those values reported by previous studies in other population.

Materials and Methods

This study was a cross sectional descriptive type of study carried out at the Department of Anatomy, Sir Salimullah Medical College, Dhaka from January 2017 to December 2017. A total of 50 male medical and dental students aged between 21 and 26 years of Sir Salimullah Medical College were recruited by purposive sampling method. Nationality and age of the study subject was confirmed from his national identity card. Those with any apparent disease, injury, deformity or disorder related to foot were excluded from the study. Ethical approval for the study was obtained from the Ethical Committee of Sir Salimullah Medical College, Dhaka.

Digital radiographs of left foot in lateral view were taken in the Radiology and Imaging Department of SSMC & MH. The subject was in standing position and the cassette was placed against the lateral aspect of the left foot. The X-ray beam was given from medial side of foot, perpendicular to the cassette and centered on the lateral cuneiform.[9]

These digital radiographs of left foot were imaged with a digital camera according to scale and were transferred to a computer. From these images different dimensions of medial longitudinal arch - navicular height (NH),calcaneal inclination angle (CIA), medial arch angle (MAA), and calcaneal-1st metatarsal angle (C1MA) were measured. These dimensions are shown in photograph 1 & 2.

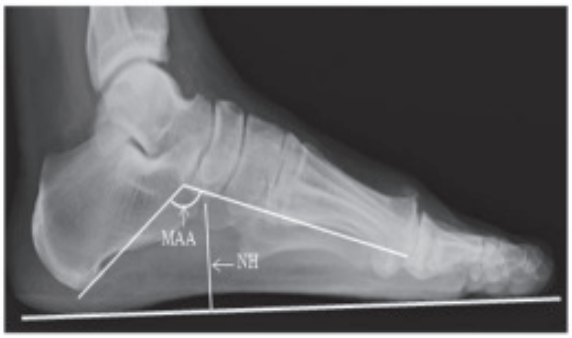

Fig-1: *Digital radiograph of left foot in lateral view showing measurement of navicular height (NH) and medial arch angle (MAA).*

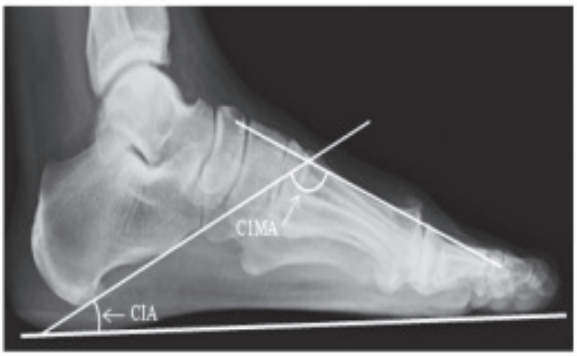

Fig-2: *Digital radiograph of left foot in lateral view showing calcaneal inclination angle (CIA) and calcaneal first metatarsal angle (C1MA).*

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Navicular height is the perpendicular distance from the most inferior aspect of the navicular bone to the horizontal supporting surface,[6]calcaneal inclination angle is the angle between the horizontal supporting surface and a line drawn along the inferior surface of the calcaneus,[6] medial arch angle is the angle between lines drawn from the most inferior point of the calcaneus to the inferior edge of the joint between talus and navicular bones to the inferior point of the first metatarsal head[1]and calcaneal-1st metatarsal angle is the angle between a line along the inferior surface of the calcaneus and another line drawn along the dorsum of the mid shaft of the 1st metatarsal.[10] Measurements of angles and heights were performed by using MB ruler software.

Statistical analyses were performed using IBMSPSS Statistics (version 22) software, Armonk, New York. Normality of the data was checked using Kolmogorov–Smirnov test which showed that data were normally distributed. The descriptive statistics of the parameters were expressed as SD±mean, 95% confidence interval (CI), including minimum and maximum values.

Ethical clearance

The study was approved by Ethical Review committee of Sir Salimullah Medical College, Dhaka.

Results

The mean±SD of the navicular height was 4.90±0.72cm (range 3.23–6.98 cm), calcaneal inclination angle was 30.82±5.99° (range 15.82°-42.17°), medial arch angle was 109.96±9.09° (range 91.15°-129.42°)and calcaneal-1st metatarsal angle was 118.89±10.91° (range 98.53°–148.33°) (Table I).

Table I

Descriptive statistics of the measured dimensions (n=50)

Dimensions	Mean±SD
Navicular Height (cm)	4.90 ± 0.72 (3.23 - 6.98)
Calcaneal inclination angle (°)	30.82 ± 5.99 (15.82 - 42.17)
Medial arch angle (°)	109.96 ± 9.09 (91.15 - 129.42)
Calcaneal first metatarsal angle(°)	118.89±10.91 (98.53 - 148.33)

Figures in parentheses indicate range.
SD = Standard deviation, n = Number of subjects

Discussion

Comparisons of findings reported in other populations with the findings of present study have been made.

The navicular height (NH) is commonly used to determine the arch height of a person and to classify the type of foot. A decrease in the NH below the normal range indicates the presence of flatfoot or pes planus and an increased NH above the normal range indicates high arched foot or pes cavus. In the present study NHs were between 3.23 cm and 6.98 cm with mean±SD 4.90±0.72 cm. The mean NH of the present study population was almost similar to that of Indian[11] but higher than that of Nigerian[6], American[9], Australian[12] and Taiwanese[6] populations.

The calcaneal inclination angle (CIA) measures the inclination of the calcaneus which makes it a good predictor of hindfoot alignment. It decreases in flatfoot. In this study, CIAs were between 15.82° and 42.17° with mean±SD 30.82±5.99°. This mean CIA was higher than that of, American[9,13], Nigerian[6, 14], Australian[7,12] and Taiwanese[6] populations. There were different reports from Turkish population. Akdogan, Akkaya and Kiter[15] found lower mean CIA Yalcin, Esen, Kanatli and Yetkin[16] found higher mean CIA when compared with that of the present study population.

The medial arch angle (MAA)is also used to determine the foot type. In flatfoot, the MAA increases above the normal range and in high arched foot it decreases below the normal range. In our study, MAAs were found between 95.15° and 123.80° with mean±SD was 109.82±7.55°. The mean MAA of the present study population was lower than that of American population.[1]

The calcaneal-first metatarsal angle (C1MA) is a measure of the relationship between forefoot and hindfoot, larger angle indicates hindfoot deformity.[6] C1MAs in this study were between 98.53° and 148.33° with mean±SD 118.89°±10.91°. The mean C1MA of the present study population was lower than that of American[10], Nigerian[6], Australian[7] and Taiwanese[6] populations.

These similarities and dissimilarities might be due to geographical orientation, ethnicity and racial differences.

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As there is no published article on radiographic dimensions of medial longitudinal arch in our country, comparison could not be made between the findings of the present study with previous studies of our country.

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