ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Study of Medial Longitudinal Arch in the Marathwada Region: An Observational Cross-sectional Study.

Santosh Dattaray Sawai*.

Assistant Professor, Department of Anatomy, Prathima Institute of Medical Sciences, Nagunur, Karimnagar, Telangana, India.

ABSTRACT

The medial longitudinal arch (MLA) is the principal weight-bearing arch of the human foot and plays a crucial role in maintaining balance, shock absorption, gait efficiency, and locomotion. Variations in the morphology of the medial longitudinal arch may predispose individuals to musculoskeletal disorders involving the foot, ankle, knee, hip, and spine. Regional anthropometric data regarding MLA morphology are scarce in the Marathwada population. A hospital-based observational cross-sectional study was conducted over one year among 40 healthy adults aged 18–40 years. Participants were selected using convenience sampling after obtaining informed consent. Footprints were obtained using the wet footprint method, and the Arch Index was calculated. Demographic characteristics including age, sex, height, weight, BMI, and dominant foot were recorded. Data were analyzed using descriptive statistics, Chi-square test, and Student's t-test, with $p<0.05$ considered statistically significant. Among 40 participants, 65% demonstrated a normal medial longitudinal arch, 25% exhibited low arches, and 10% had high arches. Low arches were comparatively more common among overweight individuals. The majority of adults in the Marathwada region possess a normal medial longitudinal arch. Routine screening of foot arch morphology may facilitate early identification of biomechanical abnormalities and aid in preventing lower limb musculoskeletal disorders. Footprint-based methods and the Navicular Drop Test remain reliable, reproducible clinical tools for MLA assessment.

Keywords - Medial longitudinal arch, Footprint analysis, Marathwada.

https://doi.org/10.33887/rjpbcs/2023.14.6.93

***Corresponding author**

INTRODUCTION

The human foot is a highly specialized anatomical structure that provides stability, flexibility, and propulsion during standing and locomotion [1]. Among its three arches, the medial longitudinal arch (MLA) is the most important because it absorbs impact forces, distributes body weight, and stores elastic energy during walking and running. Alterations in the height of the MLA can influence lower limb biomechanics, resulting in abnormal plantar pressure distribution, impaired gait mechanics, and increased susceptibility to conditions such as pes planus, pes cavus, plantar fasciitis, Achilles tendinopathy, and knee pain [2, 3].

Several clinical methods are available to assess the MLA, including footprint analysis, the Arch Index, the Staheli Index, the Chippaux-Smirak Index, and the Navicular Drop Test. Footprint-based assessment is inexpensive, non-invasive, and suitable for epidemiological studies, making it particularly useful in resource-limited settings [4,5].

METHODOLOGY

This observational cross-sectional study was conducted in the Department of Anatomy at a tertiary care teaching institute in the Marathwada region over a period of one year after obtaining approval from the Institutional Ethics Committee. A total of 40 healthy adult volunteers aged 18–40 years were enrolled using convenience sampling after obtaining written informed consent. Individuals with congenital foot deformities, previous foot or ankle fractures, foot surgery, neurological disorders affecting gait, diabetes with peripheral neuropathy, rheumatoid arthritis, pregnancy, or any condition influencing foot morphology were excluded. Demographic data including age, sex, height, weight, body mass index (BMI), and dominant foot were recorded using a predesigned data collection form.

Assessment of the medial longitudinal arch was performed using the wet footprint method under standardized conditions. Participants were instructed to wet the plantar surface of both feet and stand comfortably on a white paper sheet with equal weight distributed on both limbs to obtain clear footprints. The footprints were analyzed using the Arch Index (AI) by dividing the midfoot contact area by the total footprint area after excluding the toes. Based on the Arch Index, feet were classified as having a normal arch, low arch (pes planus), or high arch (pes cavus). Data were entered into Microsoft Excel and analyzed using SPSS version 26.0. Descriptive statistics were expressed as mean ± standard deviation and percentages. Associations between categorical variables were assessed using the Chi-square test, while continuous variables were analyzed using Student's *t*-test. A *p*-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1. Demographic Characteristics of Study Participants (n = 40)

Variable	Value
Sample size	40
Age (years), Mean ± SD	**26.8 ± 5.4**
Height (cm), Mean ± SD	**165.4 ± 8.3**
Weight (kg), Mean ± SD	**64.8 ± 10.5**
BMI (kg/m^2), Mean ± SD	**23.6 ± 3.8**
Male	22 (55%)
Female	18 (45%)
Right foot dominant	36 (90%)
Left foot dominant	4 (10%)

Table 2. Distribution of Medial Longitudinal Arch Types (n = 40)

Arch Type	Number (%)
Normal Arch	**26 (65.0%)**
Low Arch (Pes Planus)	**10 (25.0%)**
High Arch (Pes Cavus)	**4 (10.0%)**
Total	**40 (100%)**

ISSN: 0975-8585

Table 3. Association Between BMI and Medial Longitudinal Arch (Tentative)

BMI Category	Normal Arch	Low Arch	High Arch	Total
Normal BMI (<25 kg/m^2)	20	3	3	26
Overweight (≥25 kg/m^2)	6	7	1	14
Chi-square				**χ^2 = 5.82**
p-value				**0.048***

*Statistically significant (p < 0.05)

Table 4) Gender-wise Distribution of Medial Longitudinal Arch (Tentative)

Gender	Normal	Low	High
Male (n=22)	15	4	3
Female (n=18)	11	6	1
p-value	**0.42**		

Although females demonstrated a relatively higher frequency of low arches than males, the difference was **not statistically significant**.

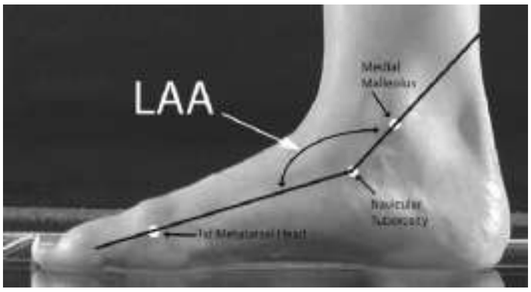

Figure 1: Medial longitudinal arch

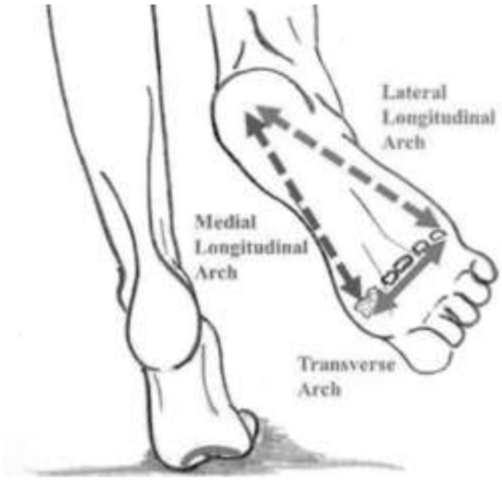

Figure 2: Basic Anatomy – Medial longitudinal arch

DISCUSSION

The medial longitudinal arch (MLA) is the most functionally significant arch of the human foot. It serves as a dynamic structure that distributes body weight, absorbs shock, maintains balance, and contributes to efficient gait. The integrity of the MLA depends upon the coordinated interaction of the bony architecture, plantar ligaments, plantar fascia, intrinsic foot muscles, and extrinsic muscles such as the tibialis posterior and tibialis anterior. Alterations in the morphology of the medial longitudinal arch may lead to abnormal biomechanics, resulting in increased stress on the ankle, knee, hip, and lumbar spine. Consequently, assessment of the MLA has become an important component of orthopedic, anatomical, physiotherapy, and sports medicine research.

The present study was conducted to evaluate the morphology of the medial longitudinal arch among adults residing in the Marathwada region. Using footprint analysis and the Arch Index, the majority of participants (65%) demonstrated a normal medial longitudinal arch, while 25% exhibited pes planus and 10% showed pes cavus. These findings suggest that the normal arch configuration predominates in this regional population, although a considerable proportion exhibits altered arch morphology that may warrant clinical attention [6-8].

One of the important observations in the present study was the increased prevalence of low medial longitudinal arches among overweight participants. Excess body weight increases plantar loading, particularly over the midfoot, which may contribute to gradual flattening of the medial longitudinal arch. Increased body mass is also associated with greater strain on the plantar fascia and supporting ligaments, potentially resulting in reduced arch height over time. Similar observations have been reported in several biomechanical studies, where higher BMI correlated with increased plantar pressure, altered gait mechanics, and greater prevalence of flexible flatfoot. These findings emphasize the importance of maintaining an optimal body weight to preserve normal foot biomechanics [9, 10].

The present study also observed a slightly higher prevalence of pes planus among female participants compared with males, although the difference was not statistically significant. This finding is consistent with several previous studies that have reported minor sex-related variations in arch morphology. Such differences have been attributed to anatomical variations in ligamentous laxity, hormonal influences on connective tissues, footwear habits, and differences in muscle strength. However, many investigators have concluded that gender alone is not an independent determinant of medial longitudinal arch morphology, supporting the findings of the present study.

The medial longitudinal arch undergoes continuous adaptation in response to mechanical loading during daily activities. During walking and running, the arch functions as an elastic spring that stores and releases mechanical energy, thereby improving locomotor efficiency. In individuals with pes planus, excessive pronation may increase stress on the plantar fascia, tibialis posterior tendon, and medial structures of the knee. Conversely, individuals with pes cavus often demonstrate reduced shock absorption, increased plantar pressure beneath the heel and metatarsal heads, and a greater susceptibility to stress fractures and lateral ankle instability. Therefore, identifying variations in arch morphology has important preventive and therapeutic implications.

From an anatomical perspective, the MLA is maintained by both static and dynamic stabilizers. The calcaneus, talus, navicular, cuneiforms, and first three metatarsals form the osseous framework, while the spring ligament (plantar calcaneonavicular ligament), long plantar ligament, plantar fascia, and deltoid ligament provide passive support. Dynamic stabilization is achieved through coordinated contraction of the tibialis posterior, tibialis anterior, flexor hallucis longus, flexor digitorum longus, and intrinsic plantar muscles. Weakness or dysfunction of these structures can lead to progressive alteration of arch morphology, reinforcing the need for early recognition through clinical assessment.

The findings of the present study provide preliminary normative data for the Marathwada population. Although the sample size was relatively small, the results contribute valuable regional information that may assist clinicians, anatomists, physiotherapists, sports medicine specialists, and orthopedic surgeons in understanding the distribution of medial longitudinal arch patterns among healthy adults. Such baseline data are useful for screening programmes, footwear recommendations, orthotic prescription, and rehabilitation planning.

The findings of the present study are comparable with observations reported in previous anatomical and biomechanical studies conducted in different populations. Most epidemiological investigations have demonstrated that a **normal medial longitudinal arch is the predominant foot type**, while the prevalence of pes planus and pes cavus varies depending on ethnicity, age, sex, body composition, occupation, and assessment techniques. These differences highlight the importance of establishing region-specific normative data rather than relying solely on international reference values.

The medial longitudinal arch has considerable functional significance beyond maintaining the shape of the foot. It contributes to efficient transmission of body weight from the hindfoot to the forefoot during gait and minimizes energy expenditure by functioning as a dynamic elastic mechanism. During the stance phase of walking, controlled flattening of the arch facilitates shock absorption, whereas restoration of the arch during toe-off enhances propulsion. Alterations in this mechanism may adversely affect gait efficiency and predispose individuals to overuse injuries.

Flattening of the medial longitudinal arch has been associated with several musculoskeletal disorders, including plantar fasciitis, posterior tibial tendon dysfunction, Achilles tendinopathy, patellofemoral pain syndrome, medial tibial stress syndrome, hallux valgus, and chronic low back pain. Excessive foot pronation resulting from pes planus may alter lower limb alignment, leading to increased internal rotation of the tibia and femur. Conversely, pes cavus is characterized by excessive supination, decreased shock absorption, and increased focal plantar pressure, thereby increasing the risk of metatarsalgia, stress fractures, recurrent ankle sprains, and callosities. Early recognition of these abnormalities allows timely implementation of preventive interventions such as footwear modification, strengthening exercises, orthotic support, and physiotherapy [11, 12].

The statistically significant association observed between higher BMI and low medial longitudinal arch further emphasizes the influence of body weight on foot structure. Increased mechanical loading may gradually stretch the ligamentous and fascial supports of the arch, resulting in progressive lowering of the medial longitudinal arch. This finding reinforces the importance of weight management as a preventive strategy for maintaining normal foot biomechanics and reducing the risk of lower extremity musculoskeletal disorders.

CONCLUSION

The present study demonstrated that normal medial longitudinal arch morphology was the predominant pattern among adults in the Marathwada region, while one-quarter of the participants exhibited low arches and a smaller proportion had high arches. A significant association was observed between increased body mass index and low medial longitudinal arch, indicating that excess body weight may influence foot biomechanics and arch integrity.

Footprint analysis using the Arch Index proved to be a practical, reliable, and cost-effective method for evaluating medial longitudinal arch morphology in a community setting. Establishing regional normative data is important for improving the diagnosis and management of foot-related musculoskeletal disorders and may aid in designing preventive healthcare programmes.

REFERENCES

[1] Zuil-Escobar JC, Martínez-Cepa CB, Martín-Urrialde JA, Gómez-Conesa A. Medial longitudinal arch: Accuracy, reliability, and correlation between navicular drop test and footprint parameters. J Manipulative Physiol Ther. 2019;42(8):635–643.

[2] Zuil-Escobar JC, Martínez-Cepa CB, Martín-Urrialde JA, Gómez-Conesa A. Evaluating the medial longitudinal arch of the foot: Correlations, reliability, and accuracy in people with a low arch. Phys Ther. 2019;99(3):364–372.

[3] Buldt AK, Murley GS, Butterworth P, Levinger P, Menz HB, Landorf KB. Foot posture is associated with kinematics of the foot during gait: A comparison of normal, planus and cavus feet. Gait Posture. 2015;42(1):42–48.

[4] Xiong S, Goonetilleke RS, Witana CP, Weerasinghe TW, Au EYL. Foot arch characterization: A review, a new metric, and a comparison. Appl Ergon. 2010;41(5):695–706.

[5] Jonely H, Brismée JM, Sizer PS Jr, James CR. Relationships between clinical measures of static foot posture and plantar pressure during static standing and walking. Clin Biomech. 2011;26(8):873–879.

[6] Fiolkowski P, Brunt D, Bishop M, Woo R, Horodyski M. Intrinsic pedal musculature support of the medial longitudinal arch: An electromyography study. J Foot Ankle Surg. 2003;42(6):327–333.

[7] Bohra R, Chatterjee S, Saha M. Optimising navicular height: A narrative review of physiotherapy interventions focused on the medial longitudinal arch. J Clin Diagn Res. 2022;18(3):YE01–YE06.

[8] Telfer S, Abbott M, Steultjens M, Rafferty D, Woodburn J. Dose–response effects of customised foot orthoses on lower limb muscle activity and plantar pressures in pronated foot type. Gait Posture. 2013;38(3):443–449.
[9] Brody DM. Techniques in the evaluation and treatment of the injured runner. Orthop Clin North Am. 1982;13(3):541–558.
[10] Cavanagh PR, Rodgers MM. The arch index: A useful measure from footprints. J Biomech. 1987;20(5):547–551.
[11] Williams DS III, McClay IS. Measurements used to characterize the foot and the medial longitudinal arch: Reliability and validity. Phys Ther. 2000;80(9):864–871.
[12] Rodríguez IR, Castro-Méndez A, Ojeda-Rodríguez B, Roldán-Fernández L, González-Elena ML, Córdoba-Fernández A. Navicular drop test: A review of validity and reliability. Rev Andal Med Deporte. 2023;16(3–4):1–8.