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Characteristic of foot morphology and their relationship to gender, Age, Body mass index and bilateral asymmetry in Indian adults with normal and symptomatic foot

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Abstract

Introduction: The human foot, the foundation for bipedal locomotion, is a complex adaptation that evolved through extensive remodelling of the hind appendage of our arboreal primate forebears (Susman 1983).Different characteristics of foot morphology are commonly accompanied by altering lower extremity biomechanical characteristics and foot function. Clarifying what factors affect foot morphology is helpful in understanding the basis of foot deformity and foot dysfunction. As the direction of change in foot morphology caused by ageing can be assumed theoretically, it should be possible to judge whether ageing or secular changes are more important in determining the foot morphology of Indian adults.

Aims: The aim of this study was to investigate characteristics of foot morphology and whether related factors such as gender, age, body mass index (BMI) and bilateral asymmetry have an impact on foot morphology.

Material and Methodology and Implications: The present study is planned in the Department of Orthopaedics, AIIMS Raipur CG. One hundred asymptomatic adults were included in this cross-sectional study. Participants will be categorised by gender, age, BMI and left and right foot respectively to compare foot morphology differences. The characteristics of foot morphology are measured by taking measurements, foot prints on graph paper, photographs Fig 1. All measurements were done by one person to avoid error that could be caused by individual differences or any discomfort. The parameters obtained from the participants include: age, gender, foot length, foot breadth and foot height of the subjects

Result: Symptomatic foot population were overweight compared to asymptomatic population and hence forth had a higher BMI .Mean arch height was lower with mean of 3.5224 in symptomatic foot compared to asyptomatic foot that was 3.9663.Mean arch height index in right foot – weight bearing was 0.2492 compared to non weight bearing foot that was 0.2312

Conclusion: Using arch index values obtained from imprint over paper to classify foot type as high arched ,normal , low arched ,based on defined ranges gives an idea about the cause of foot pathology and also the socio- demographical parameters responsible for foot morphology.

Keywords: Foot Morphology, Symptomatic foot, BMI

Introduction

The human foot, the foundation for bipedal locomotion, is a complex adaptation that evolved through extensive remodelling of the hind appendage of our arboreal primate forebears (Susman 1983). Different characteristics of foot morphology are commonly accompanied by altering lower extremity biomechanical characteristics and foot function. Clarifying what factors affect foot morphology is helpful in understanding the basis of foot deformity and foot dysfunction.

As the direction of change in foot morphology caused by ageing can be assumed theoretically, it should be possible to judge whether ageing or secular changes are more important in determining the foot morphology of Indian adults. Overweight go along with other complications, such as cardiovascular diseases, and also musculoskeletal disorders, particularly of the lower limbs and feet which are exposed to the additional mass daily.

Structurally, the foot can be classified as one of three foot types: pescavus (high arch), neutrally aligned (normal arch), or pesplanus (flat foot, low arch).Pescavus feet have a high medial arch, an adducted forefoot and an inverted hindfoot. The foot may be rigid and non reducible. Neutrally aligned feet have a normal (well formed) medial arch, and the hindfoot is well aligned, i.e., the calcaneus is perpendicular to the floor. Pesplanus feet have a low medial arch, an abducted forefoot, and an everted hindfoot. These feet are usually flexible and reducible.

In the present study, we are investigating characteristics of foot morphology and whether related factors such as gender, age, body mass index (BMI) and bilateral asymmetry have an impact on foot morphology in aymptomatic young adults and non traumatic foot in patients and correlating the variation among them.

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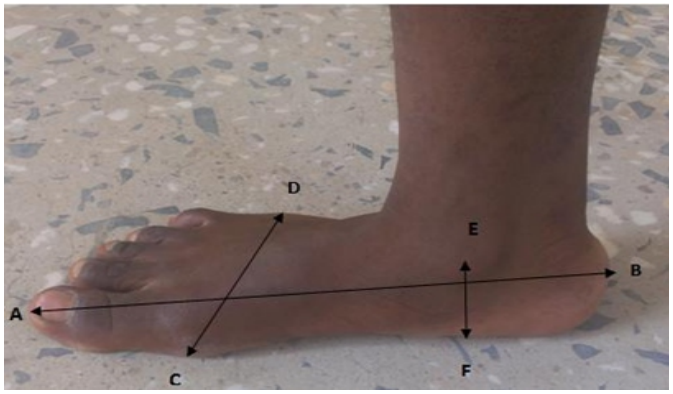
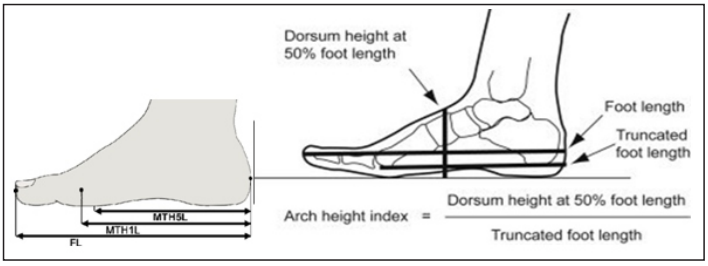
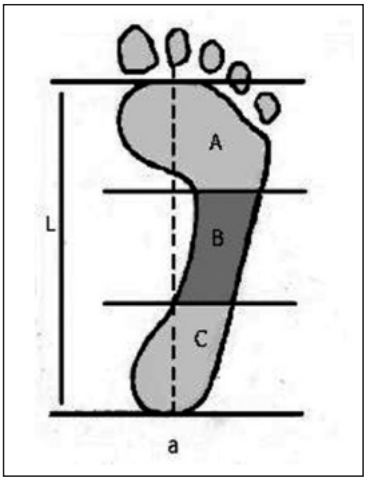


Figure 1: A Picture Showing The Measurements Of Foot Parameters * --AB: Foot Length; CD: Foot Breadth; EF: Foot Height





Aims

The present study is planned in the Department of Orthopaedics, AIIMS Raipur CG with the following aims:

1. To study the foot morphology in asymptomatic young adults.
2. To study the foot morphology in adult patients with non traumatic foot pain.
3. Correlation of the variation among asymptomatic young adults and non traumatic foot in patients with respect to gender ,age and BMI.

Inclusion and Exclusion criteria :

Inclusion criteria:

Patient with asymptomatic and non traumatic foot pain in the age of 18-60 years.

Exclusion criteria:

Subjects under 18 and above 60 years of age and with apparent foot anomalies, inflammation, trauma, deformities and surgery

Material and Methodology and implications

The present study is planned in the Department of Orthopaedics, AIIMS Raipur CG. One hundred asymptomatic adults were included in this cross-sectional study. Participants will be categorised by gender, age, BMI and left and right foot respectively to compare foot morphology differences. The characteristics of foot morphology are measured by taking measurements, foot prints on graph paper, photographs [Fig. 1]. All measurements were done by one person to avoid error that could be caused by individual differences or any discomfort. The parameters obtained from the participants include: age, gender, foot length, foot breadth and foot height of the subjects. Instruments used included transparent metre rule, measuring tape.

Foot height was measured from the most prominent point on the medial malleolus of the tibia to the sole of the foot along the medial aspect of the leg, using a measuring tape.

Foot length was measured with a transparent meter rule with the subject in a relaxed sitting position, with the ankle perpendicular to the foot. It was measured by pinning the posterior prominence of the heel to the tip of the longest toe on the planter aspect of the foot. In some people, the first toe is the longest, in other people; the second toe is the longest. The person kept the foot on a plain sheet paper, the length of the foot is marked by a marker; the points were measured by measuring tape.

Foot breadth was measured between the most medial points on the head of the first metatarsal to the most laterally placed point on the head of the filth metatarsal. The person kept the foot on a plain sheet paper/ graph paper. The breadth of the foot is marked by a marker; the points were measured by measuring tape.

Staheli Index is the ratio of the minimal distance in the mid-foot region to the maximal distance in the rear-foot region.

Prior informed consent for the study was obtained from subjects in English and their Vernacular language. All the subjects were barefoot at the time of recording the measurements. All the measurements for the study were taken with the subjects standing erect against the wall in anatomical position as well as lying. The same tests will be done on 50

Table 1: Comparison of socio-demographic characteristics of study population

Parameters	Asymptomatic young adults		Nontraumatic foot pain adults		P value
	Mean	SD	Mean	SD	
Age	42.07	13.788	47.44	13.5	0.025
Height (cm)	161.62	8.15	158.74	8.94	0.079
Weight	62.85	12.83	68.77	10.81	0.005*
BMI	24.03	4.31	27.27	4.01	0.001*

Table 2: Distribution of gender in study population

Group	Male	Female
Asymptomatic young adults	48.50%	51.50%
Nontraumatic foot pain adults	40%	60%

Table 2: Comparison of foot parameters between the two groups

Parameters	Side	Asymptomatic young adults		Nontraumatic foot pain adults		P value
		Mean	SD	Mean	SD	
Foot length	Right	22.9378	1.82618	22.858	1.55932	0.782
	Left	23.0449	1.7762	22.882	1.46353	0.553
Truncated Foot length	Right	18.7878	1.41715	19.012	1.37033	0.354
	Left	18.9255	1.38953	19.09	1.27251	0.473
Foot Breadth	Right	8.9163	0.77695	9.018	1.17346	0.581
	Left	8.8847	0.83386	8.956	1.03749	0.675
Foot Height	Right	5.9576	0.83853	5.8	0.98	0.339
	Left	5.863	0.79279	5.672	1.09135	0.279

Independent t test, p>0.05 – not significant

Table 3: Comparison of Arch Height between the two groups

	Side	Asymptomatic young adults		Nontraumatic foot pain adults		P value
		Mean	SD	Mean	SD	
Non weight bearing	Right	4.7206	0.83815	4.6468	0.97465	0.073
	Left	4.7041	0.90449	4.6362	1.00074	0.319
Weight Bearing	Right	3.9663	0.92189	3.5224	1.3392	0.006*
	Left	3.948	1.01099	3.5612	1.34657	0.063

Independent t test, p>0.05 – not significant, *p<0.05 – significant difference

Table 3. Comparison of Arch Drop between the two groups

Side	Asymptomatic young adults		Nontraumatic foot pain adults		P value
	Mean	SD	Mean	SD	
Right	0.7112	0.31225	0.8667	0.26458	0.232
Left	0.7143	0.33553	0.82	0.3094	0.396

Independent t test, p>0.05 – not significant

Table 4: Comparison of Arch Height Index between the two groups

	Side	Asymptomatic young adults		Nontraumatic foot pain adults		P value
		Mean	SD	Mean	SD	
Non weight bearing	Right	0.2492	0.0533	0.2312	0.07758	0.011*
	Left	0.2467	0.05645	0.2286	0.0772	0.074
Weight Bearing	Right	0.2115	0.05112	0.1869	0.07127	0.011*
	Left	0.2088	0.0567	0.1865	0.07079	0.17

Independent t test, p>0.05 – not significant, *p<0.05 – significant difference

Table 5: Comparison of StaheliFreb Index and Arch Rigidity Index between the two groups

Index	Side	Asymptomatic young adults		Nontraumatic foot pain adults		P value
		Mean	SD	Mean	SD	
StaheliFreb Index	Right	1.64	0.12	1.59	0.14	0.06
	Left	1.67	0.12	1.6	0.14	0.71
Arch Rigidity Index	Right	0.84	0.06	0.8	0.09	0.23
	Left	0.84	0.07	0.81	0.09	0.83

Independent t test, p>0.05 – not significant

adults with foot pain and their foot morphology will be searched for any link as the cause of pain. The results of the study will be statistically analysed. The differences found in the foot in relation to age, sex, BMI, laterality will be assessed statistically.

Results

Demographic data and characteristics of the subjects are shown in table 1and 2.

Mean arch height was lower with mean of 3.5224 in symptomatic foot compared to asyptomatic foot that was 3.9663.

Mean arch height index in right foot – weight bearing was 0.2492 compared to non weight bearing foot that was 0.2312 .

Discussion

Our study which was conducted in AIIMS RAIPUR which is first of its type with present literature and is intended to know the foot morphology among population and their affection to foot has the following end results,

Body weight is an important determinant of the foot morphology due to its long term implications , not only on various systems of the body but also the foot structure ,we found out that 52 percent of the symptomatic people were overweight ,22 percent of the people were obese as compared to 30 percent over weight in asymptomatic people with p value o.oo1which is statistically significant. This implies that BMI is an important indicator of foot pathology .

Normal arch height index is 0.21 to 0.26 and in the present study its 0.1869 on the right weight bearing side that indicates cavus footwith p value 0.001 which is statistically significant .This implies that increased arch might lead to difficulty in putting on footwear, hammertoes, metatarsalgia, sesamoiditis, plantar heel pain, corns and keratosis,ankle sprains, and stress fractures.

Foot length in eastern Indian population had a mean value of 24.5 with SD of 1.297 as compared to our study which was 22.858 with SD of 1.56.

Normal arch height index is 0.21 to 0.26 and in the present study its 0.1869 on the right weight bearing side that indicates cavusfoot.An increased arch might lead to difficulty in putting on footwear, hammertoes, metatarsalgia, sesamoiditis, plantar heel pain, corns and keratosis,ankle sprains, and stress fractures.This can be concluded that most of the Indian population has cavus foot which is responsible for foot pathology.

Stahelifreb index, arch rigidity index, arch drop and foot parameters are not statistically significant.

Limitation of the study

The lack of literature , standardization of data collection methods and approaches for measurements are limitations of this study.

Conclusion

Using arch index values obtained from imprint over paper to classify foot type as high arched ,normal , low arched ,based on defined ranges gives an idea about the cause of foot pathology and also the socio- demographical parameters responsible for foot morphology.

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