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Foot Arch Parameters in Adult

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Abstract

Background: Practically the height of the medial longitudinal arch provides acceptable outlook of the arch-height. *Aim:* Aimed to know inter-relationship of the radiological standing arch-heights with the arch-index for correlation and regression so that from the later we can derive the radiographical standing arch-height values indirectly, avoiding the actual maneuver. *Materials and Methods:* 90 subjectsstanding x-rays of foot, linear distance of the centre of the heel (say the point K) and the tip of the second toe (axis of the foot) (say the point J) was measuredfor standing navicular, talar heights were measured, and 'normalised' with the foot length. *Results:* The arch-index showed significant negative correlationsand simple linear regressions with standing navicular height, standing talar height as well asstanding normalised navicular and talar heights analysed in both sexes separately. *Conclusion:* Since arch-index is a time-tested reliable parameter for estimation of arch height so itself can be used regularly for measuring.

Keywords: Arch-Index; Standingnavicular Heights; Standing Talar Heights.

Introduction

The human foot is among the unique features of his anatomy that distinguishes him from other mammals. Its evolution from that of quadruped mammals to bipedal foot of humans includes the formation of foot arches and adduction of first metatarsal bone. These anatomical structures provide humans with the ability to receive and transmit weight to the ground effectively and to adapt to uneven surfaces to facilitate bipedal gait. The foot arches are composed of a longitudinal arch, consisting of medial and lateral parts, and a transverse arch. In fact, the development of the medial longitudinal arch of the foot is the most important stage in the evolution of human bipedal locomotion. Compared to other parts of the body, the foot is greatly affected by anatomical variations, particularly the medial longitudinal arch. These wide ranges of anatomical variations in the foot are consequences of heredity, age, gender, race, environmental conditions, and lifestyle as well as factors associated with footwear.

Foot posture can be classified into three categories based on the morphology of the medial longitudinal arch: (i) a normally aligned (normal) foot, (ii) pronated (low-arched or flat) foot in which the arch is below the normal range with the medial side of the foot coming into complete or near complete contact with the ground, and (iii) supinated (high-arched) foot in which the height of medial longitudinal arch is abnormally high.Variations in foot posture are thought to influence the function of the lower limb and may therefore play a role in predisposition to overuse injury. Despite these observations, there is still considerable disagreement regarding the most appropriate method for categorizing foot type [1]. A wide array of techniques have been used, including visual observation , various footprint parameters , measurement of frontal plane heel position and assessment of the position of the navicular tuberosity [2,3].

Normal values of several parameters of arches of the foot have been studied among various

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populations. However, despite its clinical significance, studies on arches of the foot inindia isvery limited. Hence we studied the normal ranges of foot arch parameters in adult inpopulation of local area, to find the effect of gender on these parameters and to make comparison with those values reported by previous studies in other population by using a radiographic approach.

Materials and Methods

This study was carried out at the Department of the Anatomy. A total of 90 consented subjects (50 males, 40 females) that have no history of lower extremity deformity, lumbosacral injury, neurological disorder, or any systemic disease affecting the lower extremity were randomly recruited to participate in the study. The study was approved by the Research and Ethics Committee.

X-rays of their left foot were obtained in standing position with both legs straight keeping aside to bear the body weight equally, as referred in literature [4,5]. From each set of X-ray film 'height of the talar dome' (henceforth mentioned as Talar Height); 'height of the navicular tuberosity' (henceforth mentioned as Navicular Height) and the 'truncated foot length' (henceforth mentioned as Foot length) were measured The 'truncated foot length' (FL) was determined by the distance of posterior calcanean tuberosity to the head of the first metatarsal excluding the phalanges. After that, a washable inkpad was rubbed on the plantar aspect of the subject's left foot and he/she was instructed to stand in same posture followed during x-ray, on a calibrated graph-sheet provided; so that it totally covers his/her left foot. Thus the standard imprint of the weightbearing left foot was taken, which was considered to be the foot-print of a 50% body-weight bearing foot (the other 50% of the body weight was borne by the right foot, whose print was not taken).

Following the description in literature in the footprint, the linear distance of the centre of the heel (say the point K) and the tip of the second toe (axis of the foot) (say the point J) was measured [6]. Next perpendicular line was drawn tangential to most anterior point of the main body of the foot print. Their point of intersection was marked (say the point L). Next the line LK was divided in equal three parts. Ultimately the main body of the footprint was divided in three areas from those points with the perpendiculars from the foot axis. The anterior, middle and posterior areas were marked as A, B, C respectively. Their areas were determined (in sq.cm). Arch Index = B ÷ [A+B+C].

Fig. 1: Radiography for measurement of navicular height, talar height and truncated foot length

Values were put for statistical analysis in SPSS version 12.0 software for required analysis. Prediction of significant relationship amongst the pair of variables was determined by the "Correlation coefficient"

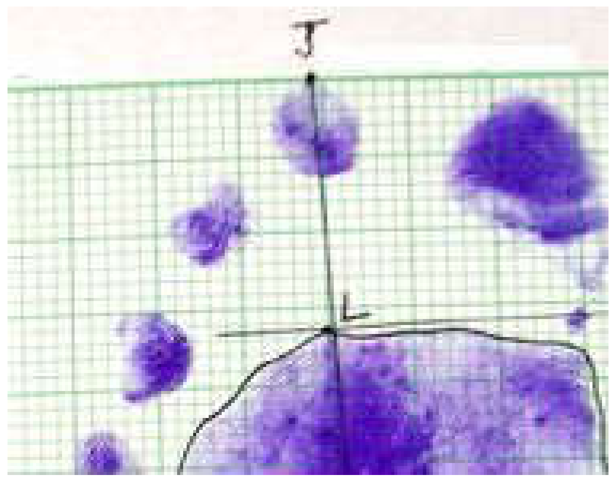

Fig. 2: Left footprint illustration to estimation of the arch index from a footprint

Results

Among 90 adult subjects, we could include 50 (55%) male and 40 (45%) females.

The mean-values of the navicular heighton Standingin males is 3.54 ±0.77 cm and in females3.09 ±0.81 cm. In both the groups the arch-index noted to bear significant negative correlation (Correlation coefficient -0.73 with p=0.000, and -0.76 with p=0.000) with the absolute value of navicular heighton Standing(NHSTD).

Similar trend also noted for 'normalised navicular heighton standing (NNHSTD)', with which arch-index maintained correlation -0.61 (p=0.000) and -0.80 (p=0.001) in male and female groups respectively.

The mean-values of the talar height on standing in males is 7.79±0.6 cm and in females7.04±0.42 cm respectively.

Significant negative correlation is documented for the dependence of talar height on standing (THSTD) on arch-index of an individual, as studied in both the sex-groups (Coefficients as -0.84 with p=0.000 and -0.64 with p=0.028 in males and females respectively).

Dependency of the 'normalised talar height on standing (NTHSTD)' was also confirmed with the arch-index as studied group-wise with correlation coefficient 0.84/p=0.000 and -0.64/p=0.001 in males and females respectively.

Table 1: Navicular heighton standing(NHSTD) from arch index in both sexes

	Male(N=50)		**Female(N=40)**	
	Arch index	**NHSTD**	**Arch index**	**NHSTD**
Mean	0.21	3.54	0.24	3.09
SD	0.04	0.77	0.03	0.81
Correlation coefficient	-0.73		-0.76	
Regression coefficient	-15.91		-8.87	
Std.Error of estimate	0.59		0.24	

Table 2: Normalised navicular heighton standing (NNHSTD) from arch index in both sexes

	Male(N=50)		**Female(N=40)**	
	Arch index	**NNHSTD**	**Arch index**	**NNHSTD**
Mean	0.23	0.19	0.24	0.14
SD	0.04	0.02	0.03	0.03
Correlation coefficient	-0.61		-0.8	
Regression coefficient	-0.56		-0.83	
Std.Error of estimate	0.03		0.02	

Table 3: Talar height on standing (THSTD) from arch index in both sexes

	Male(N=50)		**Female(N=40)**	
	Arch index	**THSTD**	**Arch index**	**THSTD**
Mean	0.21	7.79	0.25	7.04
SD	0.04	0.6	0.03	0.42
Correlation Coefficient	-0.84		-0.64	
Regression Coefficient	-13.56		-9.54	
Std.Errorof Estimate	0.36		0.35	

Table 4: Normalised talar height on standing (NTHSTD) from arch index in both sexes

	Male(N=50)		**Female(N=40)**	
	Arch index	**NTHSTD**	**Arch index**	**NTHSTD**
Mean	0.23	0.4	0.24	0.37
SD	0.04	0.02	0.03	0.04
Correlation coefficient	-0.84		-0.64	
Regression coefficient	-0.39		-1.29	
Std.Error of estimate	0.41		0.61	

Discussion

The values of the absolute standing navicular height, standing talar height as well asthose of 'normalised' standing navicular and talar heights and even the arch-index, asstudied here no doubt corroborate earlier studies [8-13]. We documented slight gender preponderance of the standingarch-heights values in male than in females which correlates with study ofHironmoy Roy et al [14], The arch-index showed significant negative correlations and simple linear regressions with standing navicular height, standing talar height as well as standing normalised navicular and talar heights analysed in both sexes separately with supporting mathematical equations. So far the values of arch-indicesare concerned, though almost 60% of the study population has normal arch, butnearly 36% has higher arches, which might be for their habitat in this areas.

The standing navicular height (NHSTD), talar height (THSTD) and normalisednavicular height (NNHSTD) along with normalised talar height (NTHSTD) individually has been correlated with the arch-index at the margin of statistical significance. Findings of majorities of previous studies were same with the presentone. Patrick S Igbibi [15] determined the arch index of able-bodied indigenous Kenyan and Tanzanian individuals free of foot pain by using their dynamic footprints to classify the foot arch type. Males had a significantly higher arch index than females in both groups, and the prevalence of pesplanus in Kenyans was 432 per 1,000 population, the highest ever documented and twice as high as that in Tanzanians (203 per 1,000 population) [10]. Gilmour JC et al [16] described in both feet of two hundred and seventy two children aged between five years six months and ten years and eleven months were studied using a footprint technique called the arch index (AI), and the vertical height of the navicular (NH) as non-invasive techniques of objective measures of the medial longitudinal arch (MLA). In addition to age the study investigated the influence of gender, limb dominance, and body weight. The study found the existence of a relationship between the two measures of the MLA. There was no significant difference in NH measures between males and females and body weight did not affect the NH.

Conclusion

Since arch-index is a time-tested reliable parameter for estimation of arch height so itself can be used regularly for measuring such. Radiographical arch-heightestimation though preferred by clinicians, but usually approached in a wrong way tomeasure it in supine posture instead of measuring it in standing posture because ofheavy crowd with limited radiological machineries and expertisation.

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