Comparison of Foot Posture in Runners (Sprinters) and Non-Runners in Indian Population- An Observational Study

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Abstract

Introduction : The foot and ankle are located most distally in the lower limb and are responsible for allowing effective weight reception and generating torque required for propulsion during dynamic activities. Proper foot motion specifically subtalar pronation and supination are critical to achieving these functions. The normal foot transitions between pronation and supination to optimize adaptability versus stability as needed but foot mal alignments may negatively affect the lower leg to function optimally during weight bearing stance.

Aim : To compare the foot posture of Indian Runners and Non- Runners.

Objectives : (1) To determine the foot posture of runners in Indian Population. (2) To determine the foot posture of non-runners in Indian population. (3) To compare the foot posture of Indian runners and non-runners.

Method: 30 runners and 30 non-runners participated in the study. Footprint indices and Navicular drop was calculated. Foot print indices i.e. Arch angle, Chippaux- Smirak index, Staheli index, Arch length index, arch index, footprint index, truncated arch index were calculated using an ink pad and Navicular drop were calculated of the dominant feet.

Results: The normality of data was checked by using Shapiro-Wilk test which shows data was of parametric type. Comparison between the groups was done by unpaired t-test The arch index and truncated arch index were significantly higher in runners than non-runner and Staheli index was significantly higher in Non-runner than runners.

Conclusion: The result of this study shows that Runners have more pronated foot as compared to Non-runner.

***Keywords**: Foot Posture, Runners, Navicular Drop, Footprint Indices.*

Introduction

When humans adopted a bipedal posture and gave up the use of the upper extremities for movement, body weight was transmitted from the vertebral column through the pelvis and lower extremities, especially the feet[1]. The foot became the contact point with the ground and evolved so that it could easily adapt to changes in both weight and the ground surface to absorb forces while walking or standing and to facilitate rotational movements[2 3]. For this purpose, its structure forms an arch on a bony skeleton strengthen by ligaments and muscles, unlike the feet of other primate's[4,5].

The foot and ankle are located most distally in the lower limb and are responsible for allowing effective weight reception and generating torque required for propulsion during dynamic activities[6]. Proper foot motion specifically subtalar pronation and supination are critical to achieving these functions. The normal foot transitions between pronation and supination to optimize adaptability versus stability as needed but foot mal alignments may negatively affect the lower leg to function optimally during weight bearing stance. Considering that the foot is the most distal segment in the lower extremity chain and represents a relatively small base of support upon which the body maintains balance, it seems reasonable that even minor biomechanical alterations in the support surface may influence postural-control strategies[7].

Aims and Objectives

To determine the foot posture of runners (Sprinters) in Indian Population

· To determine the foot posture of non-runners (Non-sprinters) in Indian population.

· To compare the foot posture of Indian Runners and Non- Runners.

Hypothesis

H_0- There is no significant Difference in foot posture of runners (Sprinters) and non-runner in Indian population.

H_1- There is a significant Difference in foot posture of runners (Sprinters) and non-runner in Indian population

Operational Defination

SPRINTERS: Sprinters are the athletes who races up to and including the 400m. Subjects included were involved in the sprinting events and participated in competitions at inter collage level. The subjects are also participating in competitions till date.

Methodology

· Research Design: Comparative Study

· Sample Size: 60 Subjects

· Sample Source: New Delhi

· Inclusion Criteria:

o Asymptomatic Males and Females

o Runners and Non-runners

o Age Group 18 to 25 years

o Willing to participate in the study

· Exclusion Criteria:[89]

o Any history of Systemic disease, neurological disorder, cardiovascular disorder, malignancy, unhealed scars or wounds on lower extremity, vestibular problem foot surgery or Back problem for more than one year.

· Instrumentations:

o Instruments and Tool used:

§ Black marker

§ 3*5 index card

§ Measuring tape

§ Washable ink pad

§ Centimeter calibrated Graph Sheet

Procedure

Potential subjects of age group 18 to 25 years were apprised of the procedure and its potential risks and benefits and the evaluation was done. Subjects those who fulfill the study's inclusive and exclusive criteria and give their consent form were included in the study. Prior to testing, the subjects were familiarized with the testing procedure

Measuring the Navicular Drop:

The subject was placed in a sitting position with their feet flat on a firm surface and with the knees flexed to 90* and ankle in neutral position. After that the most prominent point of the Navicular tubercle while maintain subtalar neutral position was identified and marked with a pen. Subtalar neutral position was established when talar depressions are equal on medial and lateral side of the ankle.

While maintaining the subtalar neutral position, index card was placed in the inner aspect of the hind foot, with the card placed from the floor in a vertical position passing the Navicular bone. The level of the most prominent point of the Navicular tuberclue was marked on the card.

The subject was then asked to stand without changing the position of the feet and to distribute equal weight on the both feet. In the standing position, the most prominent point of the Navicular relative to the floor s again identified and marked on the card. Finally, the difference between the original heights of the Navicular tuberclue in sitting position as assessed with a measuring tape.

Measuring the Footprint indices:

Seven footprint indices was calculated: the arch(Clarke) angle, Chippaux-Smirak index, Staheli index, Arch length index, Arch index, Footprint index and Truncated arch index using the ink pad. The subject was instructed to stand on a washable inkpad with totally covering the plantar aspect of the dominant foot. Then he/she was instructed to stand on a cm-calibrated graph sheet provided, so that it totally covers his/her dominant foot.

Arch (Clark) angle:

This is the angle between the line connecting the medial side-most points of the heel and metatarsal regions and the line connecting the lateral most point on the medial foot border to the medial most point of the metatarsal region[10.11.12]. Normal values for the Clarke's angle are considered in intervals from 42* to 54*. Higher value indicates High-arched foot and Lower values indicates flatfoot.

Chippaux Smirak index:

This is the ratio of the minimum width of the midfoot arch region to the maximum width of the forefoot[13]. The minimum CSI value, 0% indicated a high arch, 0.1+_ 29.9% indicated a normal arch, 30+_ 39.9% indicated an intermediary arch, 40+ 44.9% indicated a lowered arch and a percentage of 45% or above indicated a morphological flat arch foot.

Staheli index:

This is the ratio of minimum width of the midfoot arch region to the maximum width of the rearfoot[14].

Arch length index:

This is the ratio of the length of the line between the medial area-most points of the metatarsal and heel region to the border length of the arch outline between these points[15].

Arch index:

This is the ratio of the area of the middle third of the toeless footprint to overall toeless footprint area. A line is drawn between the center point of the second toe and the posterior most point on the heel. Two parallel lines perpendicular to this line are drawn to divide the toeless footprint area into equal thirds[13]. An arch index of less than 0.21 has been said to be indicative of a cavus foot, while the greater than 0.26 is indicative of planus foot whereas arch index between 0.21-0.26 corroborate normal arch height.

Footprint index:

This is the ratio of the non-contact area to the contact areas of the toeless footprint. The non-contact area is the area between the medial borderline axis formed by the medial most points of the metatarsal and the heel regions of the footprint and the medial border of the footprint outline. The contact area is the area of the toeless footprint[13].

Truncated arch index:

This is the ratio of the non-contact area (the arch area) to the truncated footprint area. The non-contact area is the area between the medial border line and the medial footprint outline. The truncated footprint area is bounded to the medial borderline axis of the footprint through the medial most points of the metatarsal and heel regions of the footprint[13].

Result

Statistical Analysis

Study design: Comparative study.

Statistical software: The statistical software named SPSS 20.00 was used for data analysis. Microsoft Excel and Word were used to generate graphs and tables.

Test: The normality of data was checked by using Shapiro-Wilk test which shows data was of parametric type. Comparison between with groups was done by unpaired t-test.

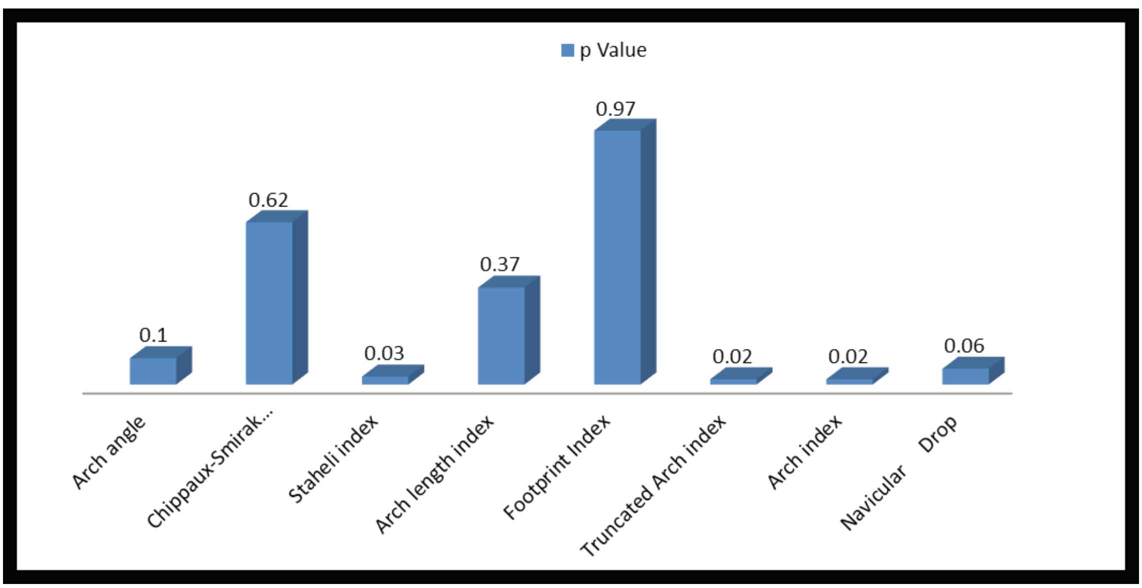
Level of significance (p value) was set to 0.05

Tables and Graphs

	Runners(Sprinters)	Non-runners
Age(years)	20.56±1.59	21.36±1.9
Weight(kg)	51±3.08	48.13±3.71
Height(cm)	170.1±3.36	169±3.60

	Variables	Runners(Sprinters)	Non-runners	t	P
Footprint indices		**Mean±SD**	**Mean±SD**		
	Arch angle	49.23±5.83	46.30±7072	1.65	0.10
	Chippaux-Smirak index	0.32±0.8	0.31±0.11	0.48	0.62
	Staheli index	0.56±0.13	0.36±0.14	-2.13	0.03
	Arch length Index	3.27±0.90	3.09±0.64	0.89	0.37
	Footprint Index	0.24±0.05	0.24±0.09	-0.33	0.97
	Truncated Arch index	0.35±0.07	0.30±0.09	2.25	0.02
	Arch index	0.19±0.06	0.079±0.07	-2.26	0.02
Navicular Drop		0.58±0.11	0.51±0.15	1.87	0.06

Table 1 Mean and SD of Age, Height and weight and Comparison of Footprint indices and Navicular drop of Runners (Sprinters) and non-runners. of runners (Sprinters) and Non-runner



Graph 1 Showing p value of all the variables.

For Dominant foot, Arch index, and Truncated arch index were significantly higher in runners (Sprinter) and Non- runner (Non-sprinter) ($p<0.05$). Whereas Staheli index was higher in

Non-runners (Non-Sprinters)

Discussion

This study was about the differences in foot posture of sprinters and non-runners. The study included 30 subjects in each group. In this study arch index and truncated arch index of right foot was found to be higher for sprinters whereas Staheli index was higher for non-sprinters. For left foot arch length index and truncated arch index was higher for sprinters whereas Staheli index was higher for non-sprinters.

These differences can be due to the difference in muscle function and force distribution between runners and non –runners. Powerful muscles strength in lower extremity was usually considered to be required for excellent performances in running and foot arch would then be functionally changed for compensation. The primary extrinsic muscles, such as the posterior tibial, flexor halluces longus, flexor digitorum longus, and wabductor hallicus longus, and the intrinsic muscles of the foot are dynamic supporters of MLA and do not become active until walking.[4,16,17]

Certain muscles in the foot and ankle either depress or support the arch, and their insuffiency may result in changes in the sole. For example, posterior tibial tendon rupture and tenosynovitis results in flat foot[16]. The posterior tibia, peroneus brevis/longus, flexor hallicus longus muscles. Flexor didgitorum longus, and abductor halliucis longus muscls, for example, support the formation of the medial longitudinal arch; whereras the extensor hallicus longus and tibialis anterior muscles have a depressing effect on this arch[17].

Most of the movement in running depends on the lower extremity musces and of course on the foot. Consequentlty, prolonged activation of these muscles might cause lasting changes in the sole of the foot, which would be detected in the static footprint parameters. Although some of the parameters in the present study differed between the sprinters and non-runners, these parameters do not reflect the same processes, as the truncated arch index is directly proportional to the arch height whereas Staheli index are inversely proportional to the arch height. During specific movement in running pressure on the different areas of the sole and resistance to this pressure could have different effect[16].

The result of this study matches with the study done by Dr Cenk Murat Ozer et. al on professional football player and controlled group where they found higher value for Truncated arch index for right foot and arch length index and truncated arch index for left foot.

Urry and wearing[18] studied the arch index and identified statistically significant difference between some contact areas of the sole using ink footprints and electronic images obtained with pressure platforms.

Miyashita and associates have reported that integrated EMG activity of the tibialis anterior and gastrocnemius increases exponentially with increasing speed[19]. Ito.et.al reported that with increasing running speed, the EMG increased during swing but remained the same during support phase[20].

According to Schlee et al[21]., 2009 and Gerlach et al[22].,2005 loading rates have been reported to remain unchanged after a prolonged run above lactate threshold or decrease after a graded exercise test. Perhaps the MLA became less stiff after the run which decreased loading rate.

Conclusion

The result of this study shows that Runners (Sprinters) have more pronated foot as compared to Non- runner.

Clinical relevance

Knowledge of type of foot posture will help to provide an optimal environment for muscle strengthening and/or tendon rehabilitation. After the analysis of the foot posture more focused exercise program can be design to focus on specific part of the foot i.e. rear foot, mid foot or hind foot which is majorly responsible for the alteration in foot posture.

Limitation

· There is no one variable present which can measure every component of foot posture.

· Blinding was not done in the study.

· Only one type of the runners was included in the study.

· Sample size was relatively small.

Further recommendations

· Equal number of male and female can be included in the study.

· All variables can also be measured by different methods and them the results can be correlated to make a universally accepted method.

· Different types of runners can also be included in the study.

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Conflict of Interest - Nil

Ethical Clearance – was taken at Banarsidas chandiwala institute of Physiotherapy.

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