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Original Research Article

A COMPARATIVE STUDY OF FOOTPRINTS OF BASKET BALL PLAYERS VERSUS NON PLAYING INDIVIDUALS

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ABSTRACT

Aim: To compare footprints of basketball players with those of non-playing individuals.

Background: The human foot and ankle are the last segments and their joint, the last within the complex kinetic chain of the lower limb as a whole. The foot is one of the most important interaction parts of the body with the ground, especially in the upright posture. During growth, the foot changes not only its dimensions but also its shape. The lower leg, ankle and foot are the most commonly affected region causing pain and disability in athlete, especially in track & field. A high impact sport like Basketball with the high involvement of foot in the game may cause the anatomy of the foot to change. This may also lead to change in the arch of the foot and predispose it to the injury.

Methodology:50 basketball players and 50 non playing healthy individuals were selected as per inclusion criteria. Demographic data like age, gender, height, weight, BMI and any injury in last 6 months were recorded for all study participants. For obtaining foot prints, ink was applied to the feet of the subjects. The subjects were then asked to step on graph paper in standing position, leaving a clear impression of foot's plantar surface on the paper. The various distances in cms were taken using a transparent ruler. The flat index and arch index was also calculated.

Result: Statistical analysis of the above graph showed significant difference in A, C, D,G between basketball and non-playing individuals. The other values (B, E, F,C/E) were not found to be statistically different.

Conclusion: The distance A (from 1st toe to heel),distance D(metatarsal distance),distance C(length of the longitudinal arch contour) and distance G(narrowest distance of the foot) are increased in basketball players as compared to non playing individuals. Also the Arch index is more in basketball players which indicated a relatively flatter feet in basketball players as compared to non players. This indicates a flatter feet in basketball players as compared to non playing individuals.

KEYWORDS: footprints, basketball, flat index, Arch index.

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INTRODUCTION

The human foot and ankle are the last segments and their joint, the last within the complex kinetic chain of the lower limb as a whole [1]. The foot is one of the most important interaction parts of the body with the ground, especially in the upright posture [2].

The foot and ankle consist of a complex arrangement of structures and joints that allow the foot to be flexible and accommodating in early stance phase whereas rigid in the late stance phase [3]. During growth, the foot changes not only its dimensions but also its shape. Large variation is displayed in the normal population at different ages, especially concerning characteristics of the medial longitudinal arch. Based on the structure of the medial longitudinal arch, 3 types of foot have been proposed

1. Normally aligned or Normal foot
2. Low arched or Pronated or Pes Planus
3. High Arched or Supinated foot or Pes Cavus

Normally aligned foot is defined as the foot in which the bisection of the posterior of the calcaneus is perpendicular to the ground and its arch height is within the normal range. Pronated foot is defined as the foot in which the calcaneus is everted and its arch is low or absent. Supinated foot is defined as the foot in which the calcaneus is inverted and its arch is high [2]. Deformation of foot arch is crucial for force transfer and shock absorption, especially in impact sports such as jump or sprint [2]. Besides studies on arch development, foot morphologic characteristics, both low-arched (flat) feet and high-arched feet have been reported to be associated with a higher risk of injury among physically active people.Different sporting events can cause different sorts of injuries in the foot and ankle. There exists a specific association between arch type and sports injury. A study by Gerard A. Malanga, MD showed that high arch players exhibited more bony, ankle and lateral injuries but low arch players revealed a higher risk of soft tissue, knee & medial injuries [4]. It is also believed that the arch height is functionally significant for the mechanics of the foot, although no correlation has been found between arch height and performance in jumping, running, lifting and weight bearing [5].

The lower leg, ankle and foot are the most commonly affected region causing pain and disability in athlete, especially in track & field, Lawn tennis, football, hockey, basketball, netball, handball etc. Measuring the change of foot arch during sports activities would be helpful for better understanding of the possible mechanism of sport injury.

A high impact sport like Basketball with the high involvement of foot in the game may cause the anatomy of the foot to change. This may also lead to change in the arch of the foot and predispose it to the injury. Some of the common causes of overuse injuries in athletes are training errors, poor shoe selection & abnormal posture of the foot and ankle. Analysing the weight pressure appearing under the foot resulted in varied ideas and opinions. The arch structure might be associated with different injury patterns.

Several methods have been used to define and categorize arch structure. Visual observation has been proved to be unreliable. Footprint measures could not describe the bony characteristics properly. However, they could be used to assess the arch dynamically and have been used to provide the arch change [2].

Thus, this study was performed in order to obtain footprint information in basketball players and to compare footprint measurements with general, healthy normal individuals.

MATERIAL AND METHODOLOGY

Materials: Ink roller, Paint brush,Plastic ruler, Paper

Sample Design

Sample size: 100

50 basketball players (25 males & 25 females),

50 normal non-playing healthy individuals (25 males & 25 females)

Sampling: Convenient sampling

Study Design

Type of study: Comparative Study

Duration of study: 1 year

Place of study: Metropolitan city

Selection Criteria

Inclusion Criteria

1. Basketball players (25 males and 25 females) and normal healthy individuals (25 males and 25 females) in the age group of 18 – 35 years.

2. Minimum Level of expertise of the players was 'STATE-Level' and the minimum years of playing the game was 5 years.

Exclusion Criteria

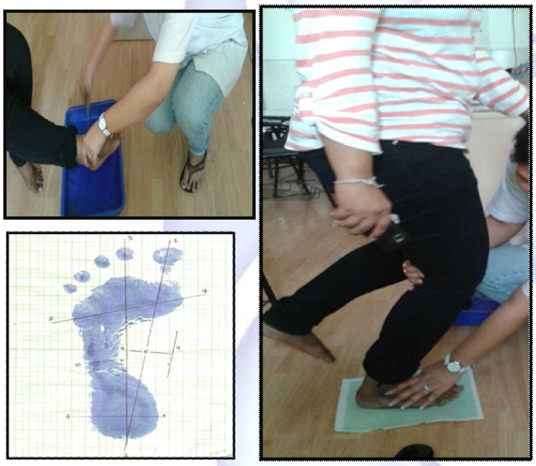
1. Any history of neurological / musculoskeletal disorder / trauma of the foot, in the past 6 months.

2. Non players who were into any other sporting activity.

Procedure: 50 basketball players and 50 non playing healthy individuals were selected who matched our inclusion criteria. Demographic data regarding age, gender, height, weight, BMI and any past injury in last 6 months were recorded for all study participants.

For obtaining foot prints, ink was applied to the feet of the subjects. The subjects were then asked to step on graph paper in standing position, leaving a clear impression of foot's plantar surface on the paper. Post the creation of impression, the subjects were asked to lift the foot from paper. The various distances in centimeters were taken using a transparent ruler as shown in the figure 1.

Fig. 1: Foot Measurements.



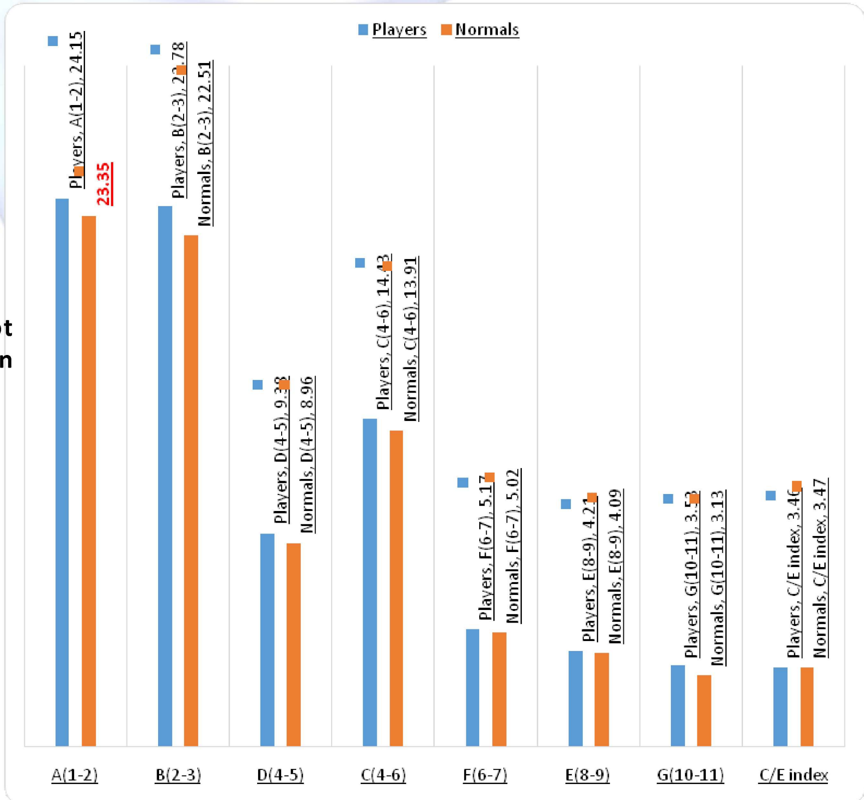
In taking foot length measurements, the points of reference at the different parts of the foot print were assigned including the point number 1 to 11. The definition of the length and distance was determined as follows.

Distance between point no 1 and 2 was the length measured from point first toe to heel (A).Distance between point no 2 and 3 was the length measured from point second toe to heel (B). Distance between point no 4 and 5 was the metatarsal distance(D). Distance between point no 4 and 6 was the length of the base of the longitudinal arch contour (C).Distance between point no 6 and 7 was the widest part of the heel(F).Distance between point No.8 and No.9 was the width of the footprint that did not touch the ground or longitudinal arch contour (E).Distance between No.10 and No.11 was the narrowest part of the footprint (G).The Flat Index was calculated from dividing C by E (FI=C /E).Arch index measurement (Staheli index) : was measured by dividing the narrow-est distance of the foot (G) by widest distance of the foot (F) i.e. Distance (G)/ Distance (F)

Above measurements were considered in assessment of the footprints.

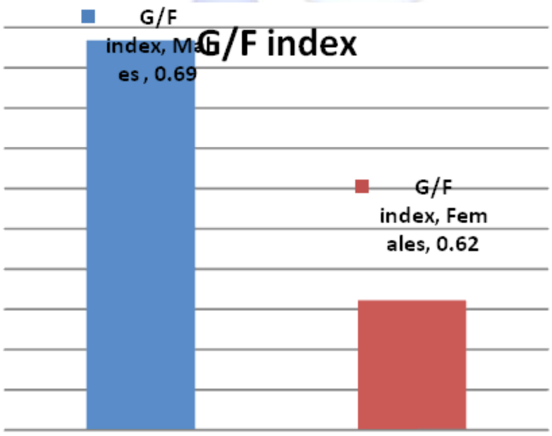
RESULTS

Comparison between the foot prints of basketball players and non players.



BB PLAYERS	Mean+/_ SD	NON PLAYERS	Mean+/_ SD	P VALUE
A	24.15±1.551	A	23.354±1.364	0.0075
B	23.780±1.45	B	22.508±4.405	0.0553
C	14.43±0.1407	C	13.91±0.1138	0.0045
D	9.384±0.6182	D	8.962±0.6919	0.0018
E	4.210±0.0729	E	4.094±0.0883	0.3138
F	5.166±0.0711	F	5.020±0.057	0.1126
G	3.528±0.1048	G	3.128±0.092	0.005
C/E	3.462±0.046	C/E	3.471±0.078	0.916

Comparison between arch index of basketball players and non players.



Arch Index

BB PLAYERS	Mean+/_ SD	NON PLAYERS	Mean+/_ SD	P VALUE
G/F	0.6866±0.021	G/F	0.6222±0.0166	0.0333

Comparison between the various footprint measurements between basketball players and non-players was done using two-tailed unpaired 'T' test. Data was analysed using SPSS version 16. Level of significance was fixed at 0.05.

DISCUSSION

This study was initiated to garner in depth insights about the impact of participation in Basketball on the footprints of individuals. The procedure used was by comparing the footprints with respect to various parameters like distance between 1st and second toe to heel, metatarsal distance, flatfoot index and arch index. It was observed that the distance A (from first toe to heel), distance D (metatarsal distance),distance C (length of the base of the longitudinal arch contour),distance G(narrowest part of the foot print) and Staheli Arch Index were statistically significant in basketball players when compared to non-players. However the other distances like distance B (from second toe to heel),E (the width of the footprint that did not touch the ground or longitudinal arch contour), distance F (widest distance of the foot) and C/E (flat index) of the footprint were not statistically significant.

Normal Foot Biomechanics: The foot is an especially complicated structure, with 12 bones, 14 phalanges, and 108 ligaments. The bones of the foot are traditionally divided into three functional segments. These are the hindfoot (posterior segment),composed of the talus and calcaneus, the midfoot (middle segment), composed of the navicular, cuboid and three cuneiform bones; and the forefoot (anterior segment) composed of the metatarsals and the phalanges.

The foot typically is characterised as having three arches:- 2 longitudinal arches ie Medial, Lateral and 1 Transverse arch.The shape and arrangement of the bones are partially responsible for stability of plantar arches. These arches are maintained and supported by the wedging of the interlocking tarsal and metatarsal bones, tightening of the ligaments of the plantar aspect of the foot and the extrinsic muscle of the foot and the tendon.[6]

Medial longitudinal archis formed by calcaneal tuberosity, Talus, Navicular, 3 cuneiforms and 1st to 3rd metatarsals and supported by the Tibialis anterior, Tibialis posterior, Flexor digitorumlongus, Flexor hallucislongus, Abductor hallucis and Flexor digitorumbrevis muscle along with the plantar fascia and the plantar calcaneonavicular ligament [6].

Lateral longitudinal arch is formed by calcaneus,cuboid, 4th and 5th metatarsals and it is supported by peroneus longus, peroneus brevis, peroneus, abductor digiti minimiand flexor digitorum musclesalong with the plantar fascia and the long and the short plantar ligaments [6].

The longitudinal arches are anchored posteriorly at the calcaneus and anteriorly at the metatarsal heads. The longitudinal arch is continuous both medially and laterally through the foot, but because the arch is higher medially, the medial side is usually the side of reference [7].

Transverse arch is formed by navicular, cuneiforms, cuboid,metatarsal bones.It is supported by the tibialis posterior,tibialis anterior and peroneus longus muscles along with the plantar fascia. This arch is completely reduced at the level of the metatarsal heads,with all the metatarsal heads parallel to the weight bearing surface [7].

The foot is designed to accept weight during early stance phase and adapt to various surface shapes and, to accomplish this weight bearing mobility function the plantar arches must be flexible enough mainly to allow the foot to dampen the impact of weight bearing forces and to adapt to changes in the supporting surfaces [7].

To accomplish weight bearing stability functions, the arches must allow [7]:

1) Distribution of weight through the foot for proper weight bearing and

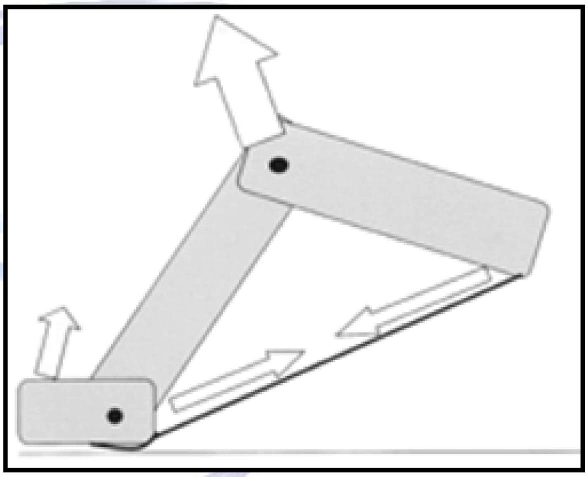
2) Conversion of the flexible foot to a rigid lever.

In bilateral stance, each talus receives 50 percent of the body weight. In unilateral stance, the weight bearing talus receives 100 percent of the super imposed body weight. In standing, atleast 50 percent of the weight received by the talus passes through the large posterior subtalar articulation to the calcaneus, and 50 percent or less passes anteriorly through the talo-navicular and calcaneo-cuboid joints to the forefoot [7].

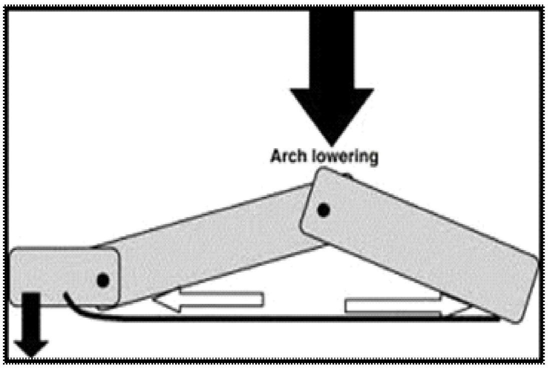
These vertical forces from the body weight travelling downward along the tibia to the foot have a tendency to flatten the medial longitudinal arch. These moments can be countered by the plantar fascia via the **Windlass Mechanism.**

John Hicks in 1954 explained the Windlass mechanism [8] in the foot. A windlass is a device designed to lift a heavy object by tightening a rope or cable.

The plantar fascia simulates a cable attached to the calcaneus and the metatarsophalangeal joints. Dorsiflexion during the propulsive phase of gait winds the plantar fascia around the head of the metatarsals. This shortens the distance between the calcaneus and the metatarsals, and results in elevation of the medial longitudinal arch. **Fig 2**



A **Reverse Windlass Mechanism** has also been proposed [8]. Here during subtalar joint pronation there is unwinding of the windlass and the arch is lowered as the foot elongates. **Fig 3**



It is seen in this study that the distances A (from first toe to heel),distance C (length of thebase of the longitudinal arch contour) and distance D (metatarsal distance)are found to be more in basketball players as compared to non players which indicates that the foot in basketball players is longer and wider than in non players. The distance G i.e.(narrowest part of the footprint) was also found to be more in basketball players which indicates flattening of the arch. The Statheli Arch Index was also observed to be more in basketball players as against non playing individuals. A higher SAI ratio indicates a lower arch [9]. This also means that the arch in basketball players is lower or flatter than in non-playing individuals.

One of the most important types of stress, in terms of its effect on the human body, is the impact force. Impact force has been defined as a force resulting from the collision of two bodies over a relatively short time period. In activities such as landing from jump, impact forces may exceed 10-12 body weights and have duration of less than 10 ms. Impact forces during running vary in magnitude from approximately 1.5 to 5 body weights and last from about 10-30 ms. [10].

The basketball players are involved in activities which include repeated running and jumping (that are high impact load).It is possible that these activities of running and jumping while playing basketball puts a heavy impact force on the feet. This can cause flattening of the arch by putting a heavy load on it and thus 'unwinding the windlass. This is evident by the fact that the feet are found to be longer in basketball players as against non players.

CONCLUSION

The distance A (from 1st toe to heel),distance D(metatarsal distance),distance C(length of the longitudinal arch contour) and distance G(narrowest distance of the foot) are increased in basketball players as compared to non playing individuals. Also the Arch index is more in basketball players which indicated a relatively flatter feet in basketball players as compared to non players. This indicates a flatter feet in basketball players as compared to non-playing individuals.

Clinical Implication: The result and the process of study can be used in structural assessment of ankle and foot complex of players, especially those involved in impact sports.This study can be useful in assessment and shoe modification for players.

Conflicts of interest: None

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