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To Assess the Effect of Heel Pain on Static Lower Extremity Alignment in Athletes

Dr. Ayasha Jhajjaria[1], Nitesh[2] and Dr. Jitin Kumar[3]

[1]Assistant Professor, Department of Physiotherapy, Jagannath University, Delhi NCR, Bahadurgarh

[2]Young Researcher, Department of Physiotherapy, Jagannath University, Delhi NCR, Bahadurgarh

[3]Consultant Physiotherapist, RS Gaur Global Multi-Speciality Hospital, Jhajjar

Abstract: Background: Heel pain is a common musculoskeletal complaint among athletes and is often associated with altered foot biomechanics. Changes in foot structure may influence the alignment of the entire lower extremity and increase the risk of further musculoskeletal problems.

Objective: The present study aimed to determine the effect of heel pain on static lower extremity alignment and to investigate the interrelationship among various lower limb alignment parameters in athletes with heel pain.

Methods: A comparative study was conducted on athletes with heel pain and those without heel pain. Static lower extremity alignment parameters assessed included Q angle, tibiofemoral angle, tibial torsion, rearfoot angle, navicular drop, bicondylar width of femur, hip internal and external rotation angles, and intermalleolar distance. Each parameter was measured three times and the average value was recorded to ensure reliability. Measurements were randomly taken from either the right or left leg to prevent data inflation.

Results: The results showed statistically significant differences ($p \leq 0.05$) between athletes with heel pain and those without heel pain in Q angle, tibiofemoral angle, tibial torsion, rearfoot angle, and navicular drop. Athletes with heel pain demonstrated increased navicular drop indicating excessive pronation and greater rearfoot valgus alignment. A strong positive correlation was observed between Q angle and tibiofemoral angle, while moderate correlations were found among navicular drop, rearfoot angle, and tibial torsion. No significant differences were observed in bicondylar width of femur, hip rotation angles, or intermalleolar distance.

Conclusion: Heel pain is associated with significant alterations in static lower extremity alignment. These biomechanical changes may lead to compensatory adjustments in the lower limb and increase the risk of further injuries in athletes. Further studies including dynamic alignment parameters are recommended.

Key words: navicular drop, rearfoot angle, tibial torsion, heel pain, Q angle

Introduction: Athletes accept risk of physical injury every time they prepare for competition through practice or step onto the competitive fields of play, some athletes to a greater degree than others. There is a normalization of this risk acceptance within the culture of sport. The foot has been recognized as one of the most dynamic, reactive and adaptive organs of the body which balance the individual in the static or dynamic status of standing, walking, running and other allied manoeuvres directly or indirectly. It serves as an instrument to absorb shock, to adapt, to act as a rigid lever of propulsion and to help transfer the body weight forward.

Running is the part of every sport mainly basketball, cricket, sprint running, marathon running, football etc, thus also associated with various injuries. Running injuries result from a combination of extrinsic factors (training errors, old shoes, running surface, surface interface) and intrinsic factors (poor flexibility, malalignment, anthropometry, previous injury, running experience).

In the athletic population who involve in running and jumping activities the most common is overuse injuries of foot. Overuse injuries have been defined as chronic injuries related to constant repetitive stress without adequate recovery time. Overuse is considered to be a common cause of heel pain in the growing athlete as well as in the adult. This type of injury can strike different structures, including the bone, Planter Fascia, Achilles tendon, or a bursa, depending on which is the weakest link when exposed to different kinds of stresses. As long as the physis of the calcaneal bone in adolescents has not fused, the apophysis is a frequent target for overuse injuries.

Nguyen, Boling, Levine, and Shultz in 2009 done a study to determine relationships between lower extremity alignment and the quadriceps angle and concluded that greater tibiofemoral angle and femoral anteversion were significant predictors of greater Q angle in both male and female.15 However so far studies have evaluated the relationship between the foot alignment

with heel pain but further studies have to be done so as to be more precise about the relation of heel pain with the lower limb alignment measures. Thus, the purpose of the study is to investigate the relationship between the static lower limb alignment measures (Bicondylar width of femur, Hip internal rotation angle, Hip external rotation angle, Intermalleolar distance, Quadriceps angle, Tibiofemoral angle, Tibial torsion, Rear foot angle and Navicular drop) in heel pain athletes.

Aim and Objectives:

Aim: The aim is to investigate the effect of heel pain on static lower extremity alignment measures and to study the interrelationship between the measures.

Objectives: To assess the relation of heel pain with static lower extremity alignment.

To assess the static lower extremity alignment without heel pain.

Hypothesis:

Experimental Hypothesis

There will be the significant relation between the static lower extremity alignment measures in the athletes with heel pain.

Null Hypothesis:

There will be no significant relation between the static lower extremity alignment measures in the athletes with heel pain.

Significance of the Study:

To understand the interrelationship between the various components of static lower limb alignment parameters will help to treat foot disorders. If heel pain is found to be correlated with static lower extremity alignment measures, it will help to decrease the abnormal stresses on the tissue structures hence preventing injuries.

METHODOLOGY

Study type: Cross-sectional study

Sampling: Convenient Sampling

Sample Size: The data of 44 athletes involved in sports in which running was a major part was collected.

The sample was grouped under two categories:

(i) Group 1: Athletes without heel pain, no. of subjects= 22

(ii) Group 2: Athletes with heel pain, no. of subjects= 22

Inclusion Criteria

- 15-25 years of age.
- The subjects were athletes with playing experience of 2 years or more.
- Subjects with a history of unilateral heel pain for at least 3 months or more.
- The subjects who fulfilled the criteria of FAAM- Foot and Ankle Ability Measure questionnaire were included in heel pain group- responded to 19 questions out of 21 in ADL activities and respond 7 out of 8 in sport.
- These two symptoms should be present:

1. Pain worse in the morning or on the initial steps after long periods of rest. The pain often improves with walking but worsens after a long day or rigorous training.
2. Plantar / posterior heel pain with tenderness in medial tubercle of calcaneus /calcaneal tendon insertion respectively.

Exclusion Criteria

- Subjects with a history of congenital deformity
- History of Surgery to either lower extremity
- Neurological problems to either lower extremity
- Traumatic injury to either lower extremity

Outcome Measures

- Bicondylar width of femur
- Intermalleolar distance
- Quadriceps angle
- Hip internal rotation angle
- Hip external rotation angle
- Tibiofemoral angle
- Tibial torsion
- Rear foot alignment or calcaneal (Achilles) angle
- Navicular Drop

Instrumentations/ Scales

- Pen/ Pencil/ Non Permanent Marker
- Paper
- Goniometer
- Sliding Caliper
- Stadiometer
- Weighing machine
- Measuring Scale
- FAAM (Foot and Ankle Ability Measure questionnaire)34

Procedure

- Total 70 subjects were screened according to the inclusion and exclusion from Out of which 44 subjects were included in the study. All procedures were explained to subjects prior to the screening measurements and informed consent was taken from all subjects involved in the study.
- Age, height and weight were recorded of each subject. Age and height were measured by standardised stadiometer and weighing machine respectively.
- All the lower extremity alignment measures were recorded three times and an average was calculated.
- Measurements for all static lower limb alignment parameters were randomly selected from either the left or right leg for each subject in group 1.

Static lower extremity measurements include:

- Hip internal rotation angle
- Hip external rotation angle
- Bicondylar width of femur
- Intermalleolar distance
- Quadriceps angle
- Tibiofemoral angle
- Tibial torsion
- Rear foot alignment or calcaneal (Achilles) angle
- Navicular drop test

Hip range of motion:

The subject was in sitting position with hip and knee flexed 90°; hip was then rotated internally and externally to a firm end feel and the angles relative to the initial position and was measured in degrees by goniometer.

Bicondylar width of femur and Intermalleolar distance:
With subject standing upright the bicondylar width and intermalleolar distance was measured by sliding calliper.

Q angle:
The Q angle was measured with the subject's knee and hip in extension i.e. in standing position, and the quadriceps muscle relaxed. First, centre of patella was marked by non-permanent marker, the centre axis of a long-arm goniometer was placed over the centre of the patella. Then, the proximal tibia was palpated and the lower goniometer arm was aligned along the patellar tendon to the tibial tubercle. The upper arm of the goniometer was pointed directly at the anterior superior iliac spine (ASIS). The angle measured by the goniometer was the Q angle.

Tibiofemoral angle:
With the subject standing upright; the center axis of a long-arm goniometer was placed over the center of the patella. The long upper arm of the goniometer was pointed on the bisection of femur and lower arm along the bisection of tibia and the degree was measured to estimate the femoral and tibial alignment.

Rear foot alignment (Achilles or calcaneal angle):
With the subject lying prone, one leg extended and the other leg externally rotated and bent at the knee at approximately 90°, the calcaneus and one third of extended lower leg was marked for rearfoot measurements. A line drawn bisecting the lower one third of the extended leg and another line drawn bisecting the calcaneus. Inversion and eversion of the calcaneal position was determined in degrees with a goniometer. Inversion angle is marked in positive degrees and eversion angle marked in negative degrees.

Tibial torsion:
Selected leg was measured in supine position. Femur positioned so that a line between the epicondyes was parallel to the horizontal plane. Angle between the true vertical and line bisecting the bimalleolar axis was measured with a goniometer marked in degree.

Navicular drop test:
The navicular tuberosity was palpated at its greatest prominence and marked with marker. The first measurement was the distance from the navicular tuberosity to the floor, taken while the subject was seated and non-weight bearing in subtalar neutral position. The second measurement was taken with the subject standing in a weight bearing position. Navicular drop was calculated as the difference in arch height between the seated and standing measurements by measuring scale in mm.

RESULT:

Independent T- Test was used to compare the variables between two groups (Group 1- No Heel Pain Group and Group 2- Heel pain Group).
Karl Pearson coefficient was used to find the correlation between different lower extremity measures within group 2 subjects. Results were considered significant if p value < 0.05.

Table1: Descriptive statistics of Demographic details with mean and S.D. values of
two groups

	AGE (yrs)	HEIGHT (m)	WEIGHT (kgs)	BMI (kg/m^2)
GROUP 1	18.59 ± 2.87	1.7 ± 0.07	61.61 ± 6.88	20.25 ± 2.00
GROUP 2	19.32 ± 2.85	1.6 ± 0.08	60.73 ± 12.71	21.1 ± 3.21
t value	-0.84	0.24	0.29	-1.06
P value	0.40	0.22	0.77	0.29

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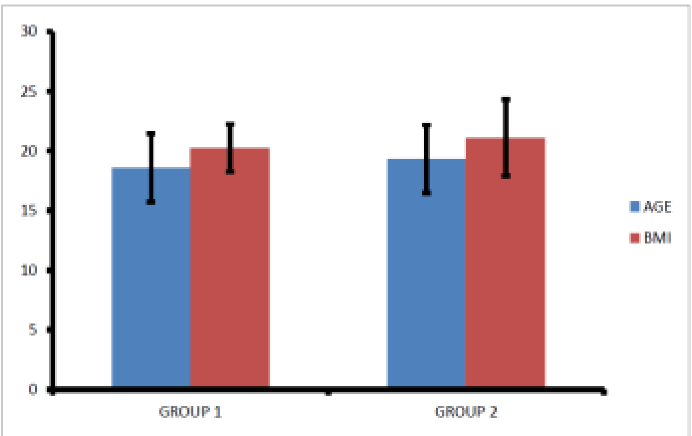
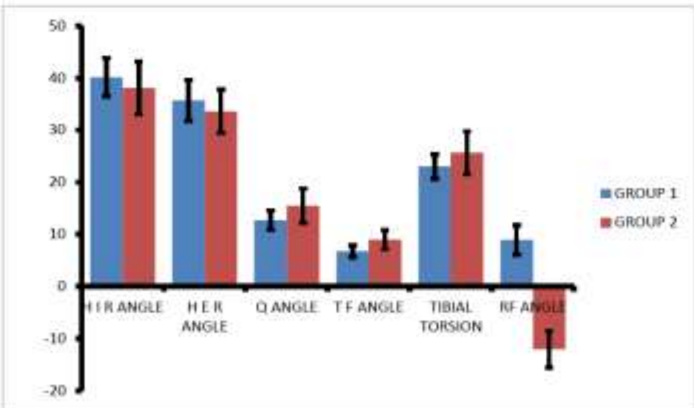
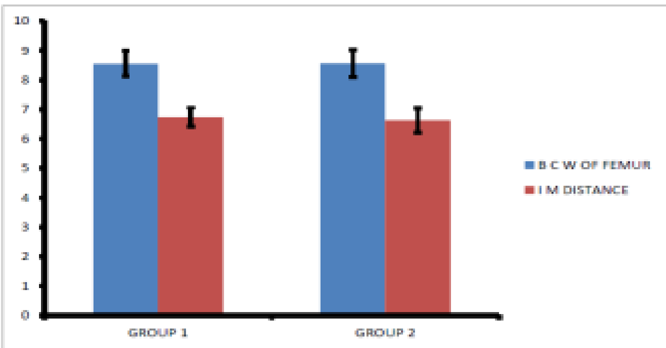


The Bar diagram depicting the mean and S.D. of age (in yrs) and BMI (kg/m2) of the group 1 and group 2.



The Bar Diagram depicting the mean and S.D. values of Hip Internal Rotation angle, Hip External Rotation angle, Q angle, Tibio-Femoral angle, Tibial Torsion and Rear Foot angle (in degrees) of Group 1 and Group 2. Of which the Q Angle, Tibio-Femoral angle, Tibial Torsion and Rear Foot angle showed statistically significant difference between the two groups (p≤ 0.05).



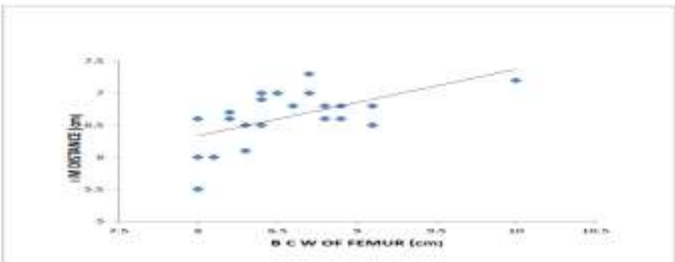
The Bar Diagram depicting the mean and S.D. values of Bicondylar Width of Femur and Intermalleolar Distance (in cm) of Group 1 and Group 2, these variables showed no significant difference between the two groups (p≥ 0.05)

HEEL PAIN GROUP VARIABLES		BCW OF FEMUR (cm)	HER ANGLE (degree)	IM DISTANCE (cm)	Q ANGLE (degree)	TF ANGLE (degree)	TIBIAL TORSION (degree)	RF ANGLE (degree)	NAVICULAR DROP (mm)
HIR ANGLE (degree)	r	-0.269	0.166	-.431*	0.004	0.011	0.115	-0.166	-0.209
	p value	0.226	0.461	0.045	0.984	0.963	0.61	0.459	0.351

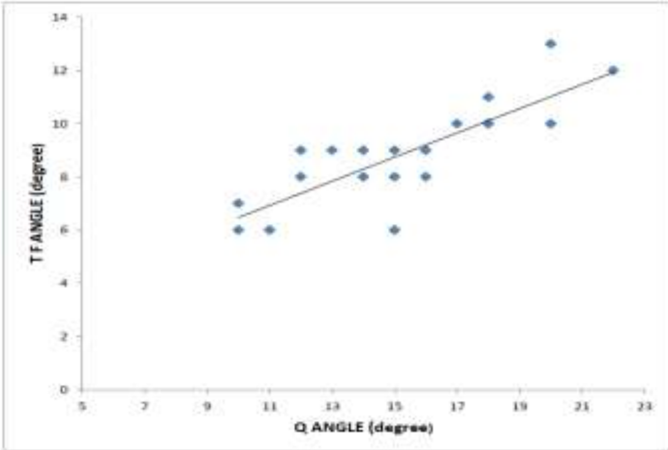
*. Correlation is significant at the 0.05 level.

The within group analysis done to investigated the relationship between variables, the results showed that Hip Internal Rotation was negatively correlated with Intermalleolar Distance (r= -0.43, p= 0.045) and it was found to be significant at p≤ 0.05.

The result showed no significant correlation between Hip Internal Rotation Angle and other measures of lower extremity alignment like B C W of Femur, Hip External Rotation Angle, Q angle, T F Angle, Tibial Torsion Angle, R F Angle and Navicular Drop in Group 2 athletes.



The Scatter plot represents the relationship between Bicondylar Width of Femur and Intermalleolar Distance within Group 2 and it was found that B C W and I M D had positive correlation (r = .58) and it was found to be significant at p≤ .05.



The Scatter plot represents the relationship between Q angle and T F angle within Group 2 and it was found that Q angle and T F angle had positive correlation (r = .83) and it was found to be significant at p≤ .01.

Discussion:

In the present study, the aim was to empirically document to which degree and to what extent the heel pain affects the static lower extremity alignment and to investigate the interrelationship between various measures of lower extremity alignment in heel pain group athletes. Measurements for all the parameters were taken three times and an average was considered for the final reading as the intrarater reliability had been found to be better when more than 2 measures were considered for each position.

There was no significant difference was found in lower extremity measures like Bicondylar width of femur, Hip internal and external rotation angles and Intermalleolar distance between the group 1 and group 2.

The results of the present study showed the significantly moderate correlation between Bicondylar Width of femur and Intermalleolar distance (r= .58, p ≤.01) in the heel pain athletes. There was a significantly low correlation found between B C W and RF angle (r = -.48, p< .05), and significantly moderate corelation between B C W and Navicular Drop (r= .53, p< .05) in heel pain group.

The study showed fairly high correlation between Q angle and T F angle (r = .83, p<.01) in heel pain athletes. According to Nguyen, Boling et al. greater tibiofemoral angle was significant predictors of greater Q angle in both male and female. Increased tibiofemoral angle, which represents the valgus angle formed by the anatomical axes of the femur and tibia, would move the patella medially relative to the anterior superior iliac spine and tibial tuberosity laterally thus increasing Q angle.

There was significantly low correlation of Intermalleolar distance with both Hip internal and external rotation angle (r= -.43, p<.05). Navicular drop was found moderately corelated with rearfoot angle (r= -.53, p<.05) in heel pain athletes. Mc Poil in 1996, found that the navicular drop was a significant predictor of maximal rearfoot eversion.27 The individuals may compensate in different ways for the structural positions or malalignments, if the rearfoot motion is limited, compensation for the forefoot may be seen in midfoot. The relationship of midfoot and rearfoot is further strengthened by the findings of Kirsten and Irene3 and Mc Poil
and Cornwall, who determined that the calcaneus and navicular have interdependent motion during walking.
Rearfoot angle was too found significantly moderate corelated with tibial torsion (r=.50, p=<.05) which is accordance to the statement that if the distal tibia is positioned in a more varus position, the calcaneus must evert more to maintain appropriate heel contact in weight given by Tiberio.
The results of the present study indicate a significant difference among the parameters in the group with no heel pain and in the group with heel pain athletes, which showed that changes in foot alignment compensate with the other components of lower extremity which increases the chances of injuries to the structures on which the stress was placed because of the athlete's determined persistence, despite the discomfort or injury that come with competition.

Conclusion:
The present study showed that there is a significant relationship between the various parameters of static lower extremity alignment in heel pain athletes.
The study has also proved that there were changes in the lower extremity alignment parameters in heel pain group as compared to the non-heel pain group.

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