Obese pronated foot posture may increase the risk of chronic plantar heel pain than normal pronated foot posture: a case control study

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Abstract. Obese pronated foot posture individuals may increase the risk of chronic plantar heel pain than normal pronated foot posture individuals. The purpose of the study was to see the affect of chronic plantar heel pain in obese pronated foot posture individuals than the normal pronated foot posture individuals. *Methods*. Eighty participants with chronic plantar heel pain included in the study. Two groups were compared on the basis of body mass index (BMI), foot posture as measured by foot posture index (FPI), ankle ROM measured by goniometry. 100 point scoring system was used for pain and foot function and Standing Heel Rise test for calf endurance. *Results*. t –test demonstrated that the chronic plantar heel pain group A had significantly greater BMI, a more pronated foot posture and the limitation of pain and function than group B. No difference was identified between the decreased dorsiflexion range of motion and decreased calf endurance. *Conclusion*. Results of this study showed that the obese with pronated foot posture and increased BMI are more affected the chronic plantar heel pain than normal pronated foot posture individuals. Chronic plantar heel pain is affected much more in Group A. Pain and function is also affected much more in the group A than group B on the basis of 100 Point Scoring System. Decreased dorsiflexion range of motion and decreased calf endurance do not play the role in chronic plantar heel pain.
Keywords: *heel pain, pronated foot, foot posture.*

Introduction

Chronic plantar heel pain (also referred to as “heel pain” or “first step pain”) is a chronic inflammation caused by excessive stretching of the plantar fascia

Plantar fasciitis often leads to heel pain (1, 2, 3).

Heel pain can result from several causes including traumatic, mechanical, neurologic, and arthritic conditions. The specific cause of plantar fasciitis is unclear, although some suggest it is due to the abnormal biomechanics overstressing the plantar fascia (4).

The plantar fascia or plantar aponeurosis is the investing subcutaneous fascia of sole of the foot and forms a strong linkage between the calcaneus and toes. It originates from medial tuberosity of calcaneum and inserted at the proximal phalanx of metatarsal (5, 6).

In the United States, more than two million individuals are treated for heel pain on an annual basis, accounting for 11-15% of professional visits related to foot pain. It is estimated that 10 percent of the U.S. population will experience plantar heel pain during the course of a lifetime (7). As 10% of the population may present with heel pain over the course of their lives, a familiarity with the diagnosis and risk factors for heel pain is important for both primary care and specialty practitioner (8).

Normal foot alignment occurred when the subtalar joint and the foot were in neutral position between midstance and heel-off during walking (5, 9, 10, 11).

Clinicians should consider limited ankle dorsiflexion range of motion and a high body mass index in nonathletic populations as factors predisposing patients to the development of heel pain /plantar fasciitis **(**12).

It is multifactorial in etiology. Intrinsic factors include age, excessive foot pronation, obesity and limited ankle dorsiflexion; extrinsic factors include occupational prolonged weight bearing, inappropriate shoe wear, and rapid increases in activity level (1).

When subtalar joint is pronated during weight bearing activities, dorsiflexion can occur at subtalar joint and midtarsal joints and at the talocrural joint, so increase subtalar pronation before heel off can compensate for limited dorsiflexion at talocrural joint (13).
Increased body weight and increased body mass index (BMI) have been shown to be significant risk factors for heel pain, with a BMI of more than 30 kg/m^2 (14).
Prolonged standing is recognized as a risk factor in the development of foot pain including plantar fasciitis. Other risk factors associated with foot pain included with recreational causes, hard floors /hard sole footwear and systemic diseases such as gout **(**15).
It is important to understand that all heel pain is not from plantar fasciitis.
Other medical problems can cause foot and heel pain. Diabetes and blood vessel disease, both serious medical problems, can cause heel pain. Arthritis, traumatic injury and bruising, gout, stress fractures (caused by repeated stress on bone), and other diseases can also cause heel pain. Rarely, tumors (either benign or cancerous) or infections can cause heel pain**.**
Pathogenesis of chronic plantar heel pain is not well understood. Repetitive activation of the windlass mechanism, as one might seen in runners or in standing workers, may result in Mechanical overload and excessive stress produce microscopic tears in the fascia which subsequently evoke an inflammatory repair process(5, 7).
The most common symptom associated with heel pain is pain and discomfort in the inferior heel region, which is aggravated on weight-bearing after a period of non weight bearing patients will often note that they have excruciating pain when arising from bed in the morning, but the discomfort will slowly subside during the next 30-45 minutes.
If the patients have a long commute to work, they can also report that their heels were not painful during the commute but that the pain commenced immediately as they attempted to weight-bear again on the involved extremity (2,16).
Tenderness Maximal at the origin of the fascia, which lies medially, just anterior to the calcaneal prominence. Pressure on this point reproduces the pain, which may then radiate anteriorly along the fascia, even on the lateral side.
There is usually little or no swelling (17).
A “windlass” is the tightening of 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 metatarsal.
This winding of the plantar fascia shortens the distance between the calcaneus and metatarsals to elevate the medial longitudinal arch. The plantar fascia shortening that results from hallux dorsiflexion is the essence of the windlass mechanism principle (18).
Chronic plantar heel pain is usually treated conservatively. However, many commonly used treatments have not been proven to improve the symptoms of plantar fasciitis.
Effective treatments for heel pain include the following: Rest and icing (2,25), exercises, (14,7,19-21).
Heel lifts would increase the ankle dorsiflexion excursion and time to heel off and change maximal knee extension **(**22), iontophoresis (23), ultrasound (19, 24), pain medications (10, 25, 17), protected footwear and insoles (25, 26), change and modulation of footwear (27), splinting and casting (26), taping (28, 29), orthotics (30, 31), acupuncture, shockwave therapy radiotherapy laser therapy (24), myofascial release for plantar fasciitis treatment protocol of heel pain, surgery, operative and post operative treatment of heel pain (31).

Methods

Total 80 subjects with plantar fascitis aged in between 40-60 years are included in this study. The population of study constitutes the subjects of heel pain from the Lok Priya Hospital Modinagar, and various private patients around the Ghaziabad.
Inclusion criteria: obese pronated foot individuals (BMI>30Kg/m^2); normal pronated foot individuals (BMI<25 Kg/m^2); participants with a history of plantar heel pain and tenderness arising in the morning or on recommencing activity after period of rest; individuals of age group between 40 to 60 years
Exclusion criteria: any history of trauma to the heel within previous 12 weeks; symptoms lasting less than 6 months; pregnancy; any skin lesion over the plantar aspect of heel pain; participant who had received the

corticosteroid injections; orthotic device or surgical patients of foot; previous radio - therapy to foot; lymphatic edema, rheumatic or vascular diseases

Procedure. 80 participants with painful heel pain will be recruited from the community and randomly allocated to a group A or group B using lottery method. The two groups were compared on the basis of body mass index (BMI), foot posture as measured by foot posture index (FPI), ankle ROM measured by goniometry, 100 point scoring system is used for pain and foot function, Standing Heel Rise test is used for calf endurance.

Body Mass Index (BMI) measurement. Height and weight is measured by the help of inch tape and weighing machine. Height is measured to meter by measuring a point on the wall perpendicular to the superior aspect of the skull and weight calculated in kilogram.

Foot posture index (FPI) was used to assess foot posture. Prior to data collection, both the A and B group investigator is instructed by the same person with experience in the use of the index. The FPI is a system for observing and rating static foot posture, incorporating six criteria with the participant standing in a relaxed bipedal position. These criteria include (i) talar head palpation, (ii) observation of curves above and below the lateral malleoli, (iii) frontal plane alignment of the calcaneus, (iv) prominence of the talonavicular joint, (v) congruence of the medial longitudinal arch, and (vi) abduction/adduction of the forefoot on the rearfoot. Each of these criteria was scored on a 5-point scale (ranging from -2 to +2) and the results combined, resulting in a summative score ranging from -12 (highly supinated) to +12 (highly pronated).

Ankle range of motion. Subjects were seated on the edge of plinth with the lower leg over the bed unsupported , and ankle in a comfortable relaxed position, usually in some plantarflexion. Landmarks used are: dorsiflexion and plantar flexion: ankle joint.

Dorsi flexion: center the fulcrum of the goniometer over the lateral aspect of the lateral malleolus, then align the proximal arm with the lateral midline of fibula, using the head of fibula for reference, then align the distal arm parallel to the lateral aspect of the fifth metatarsal. Although it is easier to palpate and align the distal arm parallel to the fifth metatarsal. At the end of the plantar flexion range of motion, the examiner uses one hand to maintain plantar flexion and to align the distal goniometer arm. The examiner holds the dorsum and sides of the subject foot to avoid exerting pressure on toes and the goniometer other hand is used to stabilize the tibia and align the proximal arm of the goniometer.

Plantar flexion **-** center the fulcrum of the goniometer over the lateral aspect of the lateral malleolus, then align the proximal arm with the lateral midline of fibula, using the head of fibula for reference, then align the distal arm parallel to the lateral aspect of the fifth metatarsal. Although it is easier to palpate and align the distal arm parallel to the fifth metatarsal. At the end of the plantar flexion range of motion, the examiner uses one hand to maintain plantarflexion and to align the distal goniometer arm. The examiner holds the dorsum and sides of the subject foot to avoid exerting pressure on toes and the goniometer.

100 point scoring system. 100 point scoring system is used for the clinical evaluation for pain and function in plantar fasciitis. In this, 70 points is given for pain and 30 points is given for function. The intensity of pain is measured with a visual analogue scale from 0 to 10. (0 for severe pain; 10 points for no pain).

I. Pain Scores (70 points):

I.1. Pain on maximal distance for level walking (0-45 points)

Distance	Points
0 meter	0
<100 meters	15
<1000 meters	30
>1000 meters	45.

I.2. Pain when the patient begins to walk (0-5 points):

Yes	0
No	5

I.3. Pressure pain (0-20)

(0 point for severe pain; 20 points for no pain)

II. Functional Scores (30 points)

II.1. Pain at work (0-points)

II.2. (0 for severe restriction; 10 points for no restriction)

II.3. Pain during activities of daily living including sports (0-10); (0 for severe restriction; 10 points for no restriction)

Data analysis. Data analysis was done using SPSS-7.0 and STATA 8.0 software packages. All variables were compared between group A

and group B using t – test. General demographic data was also analyzed age, weight, height and BMI and expressed in mean and standard deviation (SD). *t*-test was used to compare the difference in mean and SD between group A and group B.
Variables are then compared between the group. Level of significance was set at $p< 0.01$, to account for the fact that multiple comparisons were made between the two groups.

Results

The results of this study are presented in tables I-VII and figures 1-&.

Table I. Age, height and weight comparison between group A and group B

Background Variables	Group A N=40		Group B N=40		P value
	Mean	SD	Mean	SD	
Age	49.6	6.18	49.53	5.34	0.476NS
Weight	85.48	10.02	63.3	5.76	2.34E-18 '*'
Height	1.64	0.11	1.67	0.07	0.123 NS
BMI	31.59	1.4	22.68	1.7	3.95E-39 '*'

'NS' means not significant; '*'means significant

Table II. Foot posture index comparison between group A and group B

Foot posture index (FPI)	Group A N=40		Group B N=40		P value
	Mean	SD	Mean	SD	
	6.28	1.28	5.13	1.34	9.50E-05'*'

'*' means significant

Table III. Standing heel rise test comparison between group A and group B

Standing heel rise test	Group A N=40		Group B N=40		P value
	Mean	SD	Mean	SD	
	10.98	2.66	11.63	2.84	0.147 NS

'NS' means not significant

Table IV. 100 point scoring system comparison between group A and group B

100 point scoring system	Group A N=40		Group B N=40		P value
	Mean	SD	Mean	SD	
	25.20	8.09	38.13	8.57	5.33E-10'*'

'*' means significant

Table V. Ankle range of motion comparison between group A and group B

Ankle ROM	Group A N=40		Group B N=40		P value
	Mean	SD	Mean	SD	
Dorsiflexion active ROM	49.6	6.18	49.53	5.34	0.241 NS
Dorsiflexion passive ROM	85.48	10.02	63.3	5.76	0.645 NS
Plantarflexion active ROM	1.64	0.11	1.67	0.07	0.381 NS
Plantarflexion passive ROM	31.59	1.4	22.68	1.7	0.828 NS

'NS' means not significant

Table V. Comparision of the standing heel rise test between Group A and Group B

	Group A N=40		Group B N=40		P value
	Mean	SD	Mean	SD	
Standing heel rise test	10.98	2.66	11.63	2.84	0.147 NS

'NS' means not significant

Table VI. Comparision of the 100 point scoring system between Group A and Group B

	Group A N=40		Group B N=40		P value
	Mean	SD	Mean	SD	
100 point scoring system	25.20	8.09	38.13	8.57	5.33E-10'*'

'*' means significant

Table VII.Comparision of the Ankle range of motion between Group A and Group B

Ankle ROM	Group A N=40		Group B N=40		P value
	Mean	SD	Mean	SD	
Dorsiflexion active ROM	49.6	6.18	49.53	5.34	0.241 NS
Dorsiflexion passive ROM	85.48	10.02	63.3	5.76	0.645 NS
Plantarflexion active ROM	1.64	0.11	1.67	0.07	0.381 NS
Plantarflexion Passive ROM	31.59	1.4	22.68	1.7	0.828 NS

'NS' means not significant

Figure 1. Comparison of the age, height, weight and BMI between Group A and Group B

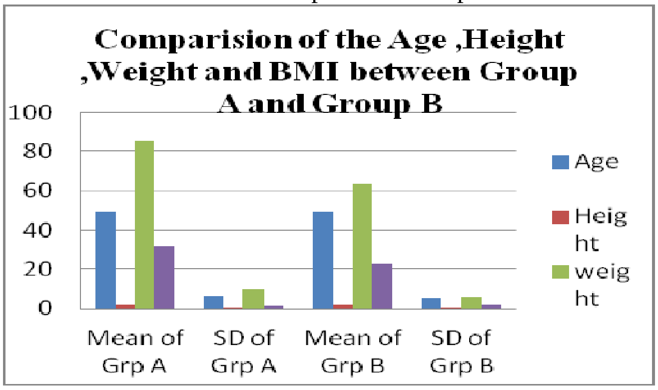


Figure 2. Comparison of the weight between Group A and Group B

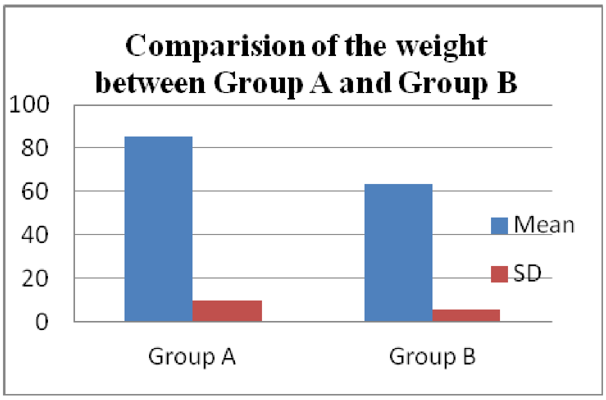


Figure 3. Comparison of the body mass index between Group A and Group B

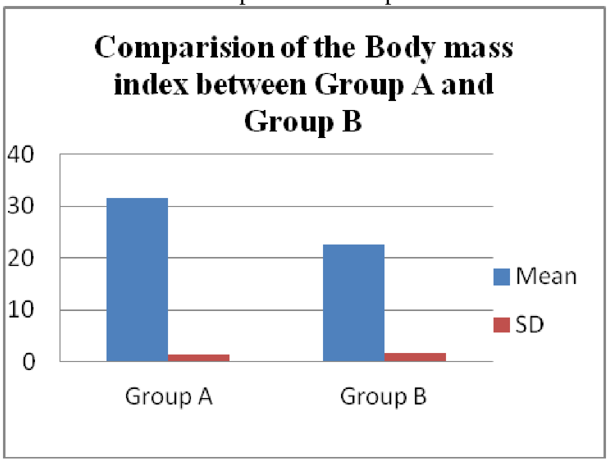


Figure 4. Comparison of the foot posture index between Group A and Group B

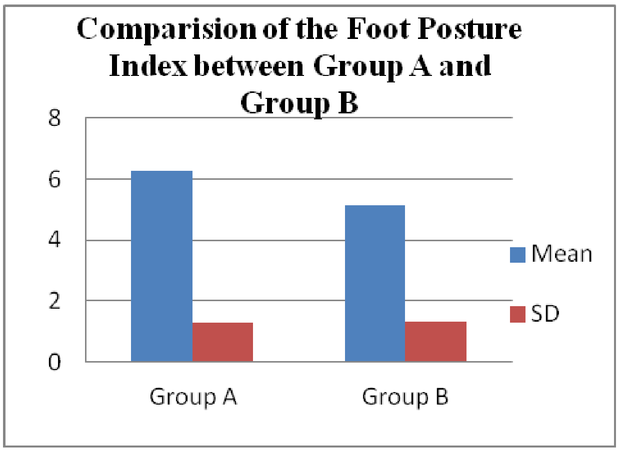


Figure 5. Comparision of the standing heel rise test between Group A and Group B

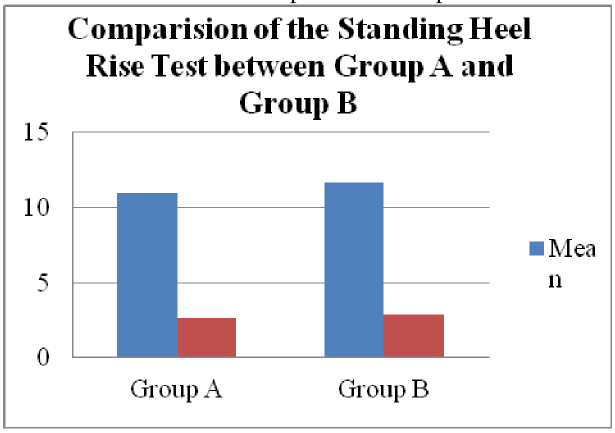


Figure 6. Comparison of the 100 point scoring system between Group A and Group B

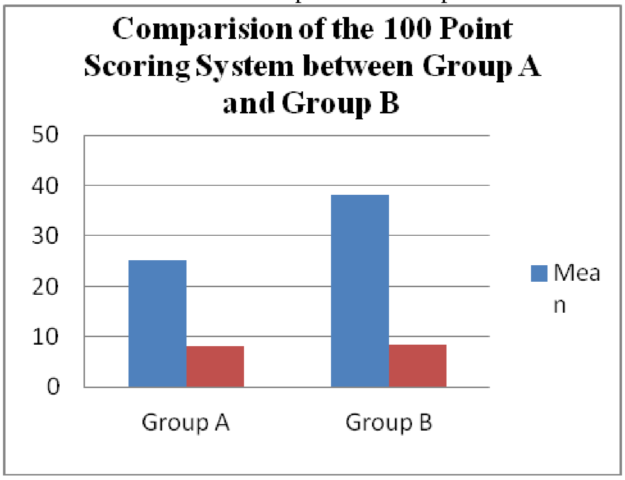
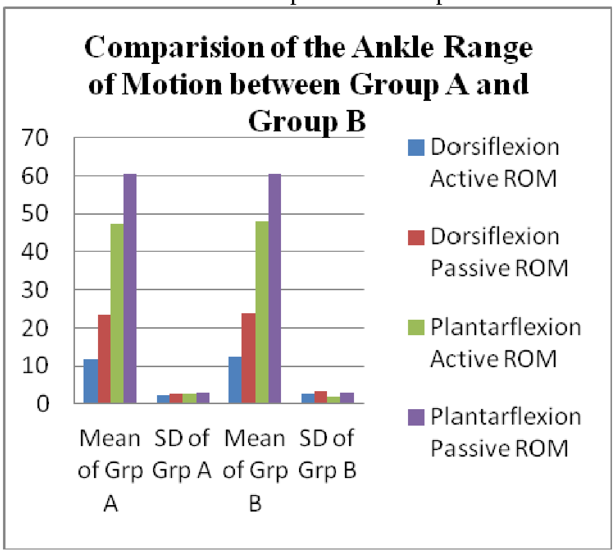


Figure 7. Comparison of the ankle range of motion between Group A and Group B



Eighty subjects (N=80) divided into two groups i.e. Group A (N=40) and Group B (N=40) were evaluated on the basis of Foot Posture Index, BMI, Ankle ROM, Standing Heel Rise Test and 100 Point Scoring System. General demographic data was obtained with respect to age, weight, height.

On observation it was found that there was no significant difference between group A and group B for demographic data .

In group A with N=40 the mean age was 49.6 and SD was 6.18 and for Group B the mean age was 49.53 and SD was 5.34 with a 'p' value of 0.476 and mean height was 1.64 and SD was 0.11 and for Group B the mean was 1.67 and SD was 0.07 with a 'p' value of 0.123 which is Not significant. Similarly, in group A, the mean weight was 85.48 and SD was 10.02 and in Group B mean weight was 63.3 and SD was 5.76'p' with a value for weight and BMI are, 2.34E-18 and 3.95E-39 respectively these are significant.

Comparision of the BMI of the group A and group B. In group A mean of BMI was 31.59 and SD was 1.40. In Group B mean of BMI 22.68 and SD was 1.70. The p value for the both groups i.e significant. For BMI 'p' value for the Group A and Group B 3.95E-39 that too were significant. It shows that there are significant difference between Group A and Group B.

Comparision of the Weight of the Group A and Group B. In group A, mean and SD of weight was 85.48 and 10.02. In group B, mean and SD of Weight was 63.3 and 5.76. The p value for the both groups was significant. For weight 'p' value at the group A and group B was 2.34E-18. 'p' value for weight was significant. It shows that there are significant difference between group A and group B.

Foot Posture Index. In group A mean of FPI was 6.28 and SD was 1.28. In group B mean of FPI 5.13 and SD was 1.34. The p value for the both groups was significant. For FPI 'p' value for the group A and group B 9.50E-05 that too were significant. It shows that there are significant difference between group A and group B.

Standing Heel Rise Test

In Group A mean of standing Heel Rise Test was 10.98 and SD was 2.66. In group B mean of Standing Heel Rise Test 11.63 and SD was 2.84.

The p value for the both was not significant. For Standing Heel Rise Test 'p' value for the group A and group B 0.147 that too were not significant. It shows that there is no significant difference between group A and group B.

100 Point Scoring System

In group A mean of 100 Point Scoring System was 25.20 and SD was 8.09. In Group B mean of 100 Point Scoring System 38.13 and SD was 8.57. The 'p' value for the both groups was significant. For 100 Point Scoring System 'p' value for the group A and group B 0.5.33E-10 that too were significant. It shows that there are significant difference between group A and group B.

Ankle Range of Motion

In group A mean and SD of dorsiflexion active ROM was 11.80 and 2.47. In Group A mean and SD of dorsiflexion passive ROM was 23.43 and 2.82. In group B mean and SD of plantarflexion active ROM was 47.45 and 2.75. In group B mean and SD of plantarflexion active ROM was 47.93 and 2.02.

The 'p' value of both the group was not significant. p value for dorsiflexion active ROM, Dorsiflexion passive ROM, plantarflexion Active ROM, Plantar flexion passive ROM were 0.120, 0.322, 0.190, 0.414. P value for group A and group B were not significant. It shows that there are no difference between group A and group B.

Discussion

The primary goal of this study was to test the hypothesis that comparative effect of obese pronated foot posture individuals to normal pronated foot posture individuals.

Subjects included in the study had the values of mean age, weight, height and BMI. Overall results of the study indicate the affect of the obese pronated foot posture individuals was much more as compare to normal pronated foot posture individuals. Group A showed the affect of chronic plantar heel pain in obese pronated foot posture individuals hence the results for group A are statistically significant.

These findings suggest that there is a risk of chronic plantar heel pain is more in obese pronated foot posture individuals than normal pronated foot posture individuals.

H.F. Jelinek et al (2008) concluded that increased body weight and increased body mass index (BMI) have been shown to be significant risk factors for plantar fasciitis, with a BMI of more than 30 kg/m (14).

Thomas G McPoil et al (2008) studied that the limited ankle dorsiflexion range of motion and a high body mass index in nonatheletic populations as factors predisposing patients to the development o heel pain (12). In this study, ankle range of motion was not significant. There was no identified association between the ankle range of motion and chronic plantar heel pain.

Damien B Iring et al (2006) studied that chronic plantar heel pain is supported by research indicating that increased strain is placed on the plantar fascia when the foot is placed in a pronated position (1).

Foot width during standing was also significantly increased in obese subjects. For walking, significantly higher peak pressures were also found in both obese males and females. Roland Wong et al (2000) included that the prolong standing and frequent walking pose as a risk factors in the development of foot pain including plantar fasciitis (15). Other risk factors associated with the foot pain included obesity, recreational causes hard floors/hard sole footwear and systemic diseases such as gout.

The identified association between increased ankle dorsiflexion ROM and CPHP was contrary to the common clinical perspective that decreased ankle dorsiflexion ROM is a causative factor for CPHP. This hypothesis is based on the theory that equinus (ankle dorsiflexion less than 10°) during gait causes abnormal compensatory pronation of the subtalar joint, which in turn increases stress on the plantar fascia.

No association was identified between calf endurance and chronic plantar heel pain. The Standing Heel Rise test scores reported for the group A and group B were substantially lower than those reported in the literature, however, this was to be expected. In this study, standing heel rise test was not significant.

The identified association between the 100 point scoring system and chronic plantar heel pain for pain and function of the foot. Group A and group B was compared to identified the association between chronic plantar heel pain and function of the foot. The significant difference was found between groups. 100 point scoring system was much more significant.

Conclusion

Results of this study showed that body mass index are affecting by the chronic plantar heel pain much more than normal pronated foot posture individuals. In our study, chronic plantar heel pain is affected much more in group A. Pain and function is also affected much more in the group A than group B on the basis of 100 Point scoring system. Decreased dorsiflexion range of motion and decreased calf endurance do not play the role in chronic plantar heel pain.

The study therefore concludes the Null hypothesis that not affect the chronic plantar heel pain so reject the null hypothesis and accept the alternate hypothesis that obese pronated foot posture individuals may affect the chronic plantar heel pain much more than normal pronated foot posture individuals.

*Limitations of study: t*he procedure used for the patient was little hectic for the chronic plantar heel pain patient and patient might felt discomfort; small sample size, number of subjects included were less, only 80 patients were included; the FPI protocol involves a degree of subjectivity due to its observational nature and a change in examiner may have influenced the results.

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