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**Dr. Barua DS**  
Assistant Professor, Assam  
Medical College, Dibrugarh,  
Assam, India

**Dr. Bora D**  
PG Student, Assam Medical  
College, Dibrugarh, Assam,  
India

## Clinico-radiological study of heel pain patients with special reference to heel pad thickness: A hospital based study

**Dr. Barua DS and Dr. Bora D**

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### Abstract

**Background:** Heel pain debilitates the quality of life. Causes of this pain are many but exact diagnosis is lacking in majority. Change of architecture and mechanical properties of plantar heel pad is considered a major cause.

**Materials and method:** Prospective observational study with 194 cases of heel pain from 1<sup>st</sup> July 2006 to 1<sup>st</sup> November 2007. Acute heel pain following trauma, infection, tumour or other foot deformities were excluded. Standardised questionnaire, clinical examination and standard lateral wt. bearing & non-wt. bearing xrays view of foot projected at the calcaneum were taken to measure body weight loaded Heel Pad Thickness (LHPT) & unloaded Heel Pad Thickness (UHPT). Heel Pad Compressibility Index was measured by HPCI= (LHPT/UHPT).

**Results:** 194 cases with heel pain were included in the study. 88 cases are male, 72 cases are female patients. (Ratio male: female = 1. 2: 1). Mean UHPT=20.7mm, LHPT=12.19mm, HPCI=0.58mm. HPCI tends to increase with increase in age (> 40 yrs age group). No significant difference in UHPT, LHPT, HPCI between males and female was noted.

**Conclusion:** This is probably the first study in the North Eastern Region of India, which evaluated heel pain associated with heel pad thickness and compressibility index.

**Keywords:** Heel pain, heel pad compressibility index, loaded and unloaded heel pad thickness

### Introduction

The foot is a complex structure of 28 bones, 33 joints, 57 articulating surfaces, 112 ligaments and 20 muscles which is subjected to enormous stresses during walking and running. The human heel absorbs 110% of the body's weight during walking and 200% of the body's weight during running<sup>[1]</sup>. Plantar heel pain is a very common which is characterized by pain in the plantar heel region during activities like standing, walking and running<sup>[2, 3]</sup>.

About 10% of people during their lifetime are affected which includes both athletic and non-athletic populations<sup>[3, 4]</sup>. Quality of life is hampered<sup>[2, 3]</sup>. In 1922 Steill stated-Painful heel is seldom efficiently treated for the simple reason that the cause is not exactly diagnosed<sup>[6]</sup>. Lapidus and Guidotti in 1965 stated that the term painful heel is used in preference to any other more exact aetiological diagnosis, since the cause of this definite clinical entity still remains unknown<sup>[7]</sup>. Now even after 50 years, the cause of heel pain still remains a diagnostic dilemma.

A variety of soft tissue and osseous and systemic disorders can cause heel pain, most common ones are as follows<sup>[8]</sup>.

1. **Plantar Fascia:** Plantar Fasciitis, Rupture, Enthesopathies.
2. **Soft tissues:** Fat Pad Atrophy, Heel Bruise, Bursitis
3. **Bone:** Stress fracture of calcaneum, Paget's disease, Primary or Secondary Tumours, Infection
4. **Nerve:** Tarsal tunnel syndrome, Sciatica (S1) radiculopathy etc.

The differential diagnosis begins with a history and physical examination of the lower extremity to pinpoint the anatomic origin of heel pain. The characteristics of the different etiologies are as follows:

**Corresponding Author:**  
**Dr. Bora D**  
PG Student, Assam Medical  
College, Dibrugarh, Assam,  
India

**Plantar Fasciitis:** Gradual in onset and the pain worsens on first weight bearing in morning. After a few steps it decreases but will worsen on increased activity.

**Fat Pad Atrophy:** Occurs in elderly. The pain or tenderness is in central heel that is absent on arising in morning and is associated with atrophy of heel pad.

**Infection:** Symptoms of infection like fever and nocturnal pain are present.

**Posterior tibial nerve:** Pain is burning in nature and follows the course of posterior tibial nerve inferior to the medial malleolus and radiates into the plantar aspect of foot towards the toes. Tinel’s sign is evident.

The heel pad contains organized fibrous compartments that retain adipose tissue and is subjected to repeated load bearing. It functions as an efficient shock absorber during walking. The fibrous septa extending from the skin to the calcaneal perichondrium is organized into small chambers connecting directly with the inside of the subcutis and greater chambers situated deep in the small chamber stratum. With age there is change in compressibility due to local loss of fat with thinning of the pad or rupture of the fibrous tissue septae leading to inferior heel pain<sup>[8]</sup>. Miller WE<sup>[9]</sup>, Vinod K Panchbhavi<sup>[10]</sup> in 2006 stated that Fat pad atrophy manifests with diffuse pain under the heel, involving most of the weight-bearing surface. The pain worsens when walking on hard surfaces & wearing hard-soled footwear. Patients with fat pad atrophy do not improve with walking unlike patients of plantar fasciitis.

In this prospective observational study, we have tried to find out correlation of heel-pad thickness & compressibility index in heel pain patients and also some other factors such as age, sex, site of distribution in the heel pain.

**Materials and Methods**

194 patients attending the Outpatient Department of Orthopaedic Surgery, Assam Medical College and Hospital, Dibrugarh with the chief complains of heel pain were included in the study. This prospective observational study was conducted from 1st July 2006 to 31st November 2007, a duration of seventeen months. All cases presenting with painful heel during this period were included. Acute heel pain due to trauma or acute infection were excluded. Also, any other pathological condition of the heel such as tumours were excluded. Foot deformities such as cavus foot, heel valgus and flat foot were excluded.

**Assessment of demographic and clinical characteristics**

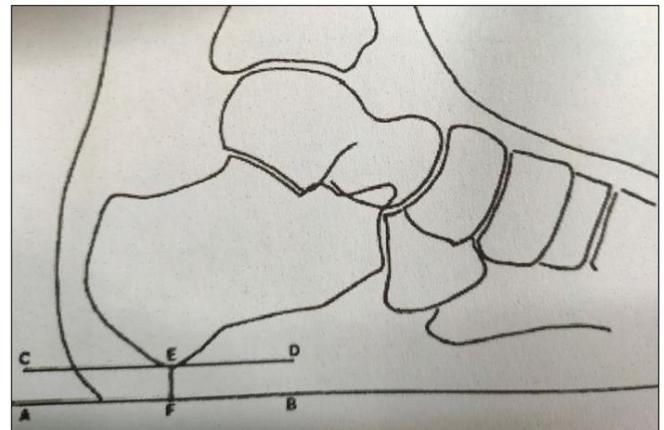
Age was recorded in whole years depending on the participant’s age on the day of their first visit. The patient’s history, clinical examination was systematically recorded which gave a clue to those patients who required investigations.

**Heel Pain**

A standardised self-reported heel pain questionnaire was used to capture information regarding the duration, onset, characteristic and factors related to the pain symptoms. The questionnaire excluded other associated systemic and local causes such as trauma and infection. Clinical examination was done to reinforce the findings of the questionnaire and to rule out any other pathologies and foot deformity.

**Heel pad measurement**

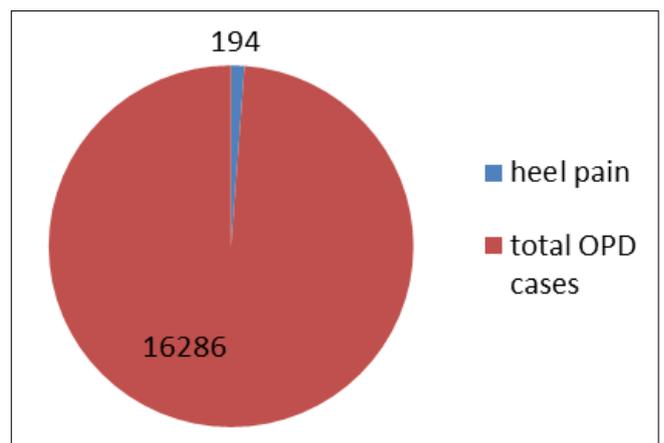
Heel pad measurement was done by a standard lateral view of foot projected at the calcaneum. Wt. Bearing & non-wt. bearing x-rays were taken. Shortest distance between the plantar surface of calcaneum and external skin contour was measured both in wt bearing & non wt bearing Xrays which were the Loaded Heel Pad Thickness (LHPT) & Unloaded Heel Pad Thickness (UHPT). Heel Pad Compressibility Index was measured by HPCI= (LHPT/UHPT). HPCI approaching 1.00 means loss of elasticity of heel pad.



**Fig 1:** Distance between EF is the heel pad thickness.

**Results**

A total of 16,480 patients attended the Orthopaedics OPD of AMCH during the mentioned period, out of which 194 cases with heel pain were included in the study comprising an incidence of about 1.18% (Figure 1). 34 were due to trauma and were excluded. 160 patients complained of pain on the plantar aspect of heel. 88 cases are male patients, 72 cases are female patients. (Ratio male: female=1.2: 1). Mean UHPT-20.7 mm, LHPT-12.19 mm, HPCI-0.59 mm. HPCI tends to increase with increase in age (> 40 yrs age group). No significant difference in UHPT, LHPT, HPCI between males and female noted. (Table 1)

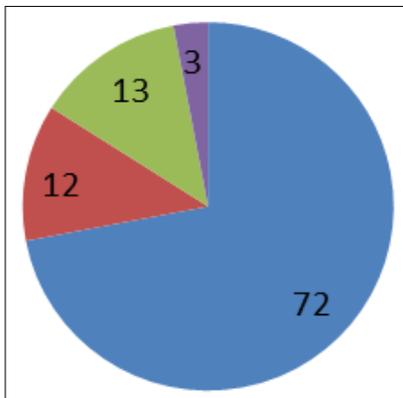


**Fig 2:** Blue: cases with heel pain, Red: Total OPD cases

**Table 1:** The Sex of Age group Male Female

Mean values	Sex		Age group	
	Male	Female	20-39yrs	>40years
UHPT	21.25mm	20.12mm	20.9mm	21.2mm
LHPT	12.35mm	12.0mm	12.06mm	12.67mm
HPCI	0.59	0.59	0.57	0.61

There were no cases in the age group of 0 - 19 years. The youngest patient in the study was aged 20 years and the oldest was 79 years old. Maximum patients belonged to fourth decade. The site of heel pain was most commonly found in the medial aspect of heel (72%) followed by pain in the sole (13%) and pain in the post part of the heel (12%). Diffuse heel pain involving medial, lateral, posterior and sole of the heel comprises 3% of heel pain.



**Fig 3:** Blue: medial side pain, Red: Post part pain, Green: Sole pain, Purple: Diffuse pain.



**Fig 4:** Unloaded heel pad. Loaded heel pad.

## Discussion

Histologically, the heel pad is made of dense strands of fibrous chambers. The pad encloses closely packed fat cells and is divided into a superficial microchamber layer and deep macrochamber layer. Microchamber layer contains small fat chambers and macrochamber layer contains big fat chambers [8, 11]. The macrochamber layer is softer and the microchamber layer is stiffer. The total heel pad stiffness falls between the values of these two layers. But the macrochamber layer is much thicker and hence the stiffness of the heel pad is close to that of the macrochamber layer. The microchamber layer contains predominantly elastic fibers, whereas the macrochamber layer contains equal amounts of collagen and elastic fibers. Hence, the mechanical properties of these two layers differ too [12, 13].

Overuse, cumulative microtrauma or acute traumatic injury may damage the architecture of the heel pad decreasing its ability to cushion and protect and making the foot vulnerable to mechanically related complications such as heel pad syndrome, plantar fasciitis and calcaneal stress fracture [14, 15]. It is believed that change in the architecture and mechanical properties of the heel pad is one of the basic causes of plantar heel pain [17, 18].

Stiffness (or elastic modulus), one kind of soft tissue mechanical property, is crucial to the function and health status of the heel pad [17]. The heel pad must have adequate

elasticity (ability to deform under loading) to achieve and maintain the protection and cushioning effect on the heel. The present study found that plantar heel pain was accompanied by loss of elasticity of the heel pad. Stiffening of the heel pad may reduce the cushioning ability of the heel pad, resulting in higher impact forces and pressures during locomotion that may lead to a higher risk of further injury.

Several studies have been reported on its measurement *in vivo* using various techniques, including radiologic measurements [24, 25], indentation systems [19] and ultrasound-based mechanical devices [18].

Barret *et al.* stated that the skin is thicker on the sole of the foot than anywhere else; a honeycomb pattern of fibroelastic sepate anchored to one another, the calcaneus, and the skin encloses the subcutaneous fat globules [16]. This structure cushions heel strike and allows the skin to resist forces upto twice body weight in long distance running. The thickness of adipose tissue decreases after the age of 40, with loss of shock absorbency. A small percentage of the population has an adventitious subcalcaneal bursae, which may become inflamed and causes heel pain.

Vinod K Panchbhavi in eMedicine in 2006 stated that fat pad atrophy in elderly patients and in persons who have received multiple steroid injections manifests with pain under the heel is more diffuse, involving most of the weight-bearing surface [10].

Amis *et al.* in 1988 found a significant increase in the thickness of the heel pad in the affected foot of 170 patients with unilateral heel pain [22]. Somachi P in 1994 studied the heel pad thickness (loaded and unloaded) in a group of patients and normal subjects and found out that the Heel Pad thickness and HPCI is comparatively greater in patients than in normal subjects [23]. After comparison we found out that the UHPT, LHPT, HPCI is greater in patients with age >40 years than <40 years.

In a survey by heelspur.com in 1997, they stated that the incidence of heel pain was 1% in the 1st decade, 10% in 2nd decade, 30% in 3rd decade, 40% in 4th decade, 15% in 5th decade and 4% above the age of 59 years. Similar pattern could be appreciated in our study. The average age of the patients suffering from heel pain in our study is 39 years, which is comparable with the survey results of heelspur.com (2000), where they have found the average age of onset as 41 years [20]. V Marwah in 1983 found 67.5% of his patients complaining of pain in the medial aspect of the heel, which was similar to our results of 72% heel pain in the same region but this was mostly due to plantar fasciitis. 13% cases had sole pain which was due to fat pad atrophy [21].

## Conclusion

This is probably the first study in the North Eastern Region of India, which evaluated heel pain and heel pad thickness. A comparative study including the work pattern, foot structure and type of foot wear used by patients with a longer follow-up is required to find out whether loss of heel pad elasticity might have a significant impact on heel pain.

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