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Does the slope and length of the plantar calcaneal spur affect the clinic?

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Since some of the patients with plantar calcaneal spur (PCS) do not have pain, we aimed to investigate the effect of the slope and length of the spur on this situation. The length and slope of PCS were measured by examining the radiological images of 50 patients in this prospective study. VAS, AOFAS and FFI scores of the patients were determined. Patients were divided into groups according to PCS length and slope. According to the slope of the spur, the mean AOFAS, FFI and VAS scores were, respectively; 94, 38, 1.3 in below 20 degrees; 80.1, 86.8, 4.8 in 20-30 degrees; and 70.1, 106, 6.7 in above 30 degrees. According to the length of the spur, the mean AOFAS, FFI and VAS scores were respectively; 84.9, 68.2, 3.7 in those with length 0-5 mm; 81.1, 81.7, 4.5 in those with a length of 5-10 mm; and 71.7, 102.5, 6.4 in those with a length of >10 mm. A significant correlation was found between the angle and length of the PCS with the values of VAS, AOFAS and FFI ($p<0.05$). We observed that PCSs with a slope of less than 30 degrees and shorter than 10 mm do not create a serious clinical picture. If there is severe pain and functional impairment in individuals with this characteristic spur, investigation of other possible causes of heel pain must be considered.

Keywords : Plantar calcaneal spur; plantar fasciitis; heel pain.

INTRODUCTION

Plantar heel pain (PHP) is one of the most common complaints in our clinical practice. It is known that approximately 10-15% of the population has PHP[1-3]. In these patients, limitations in activities such as standing, walking and running may occur due to pain, and a decrease in their quality of life is observed[4-6].

For a correct diagnosis in PHP, sufficient time should be allocated to the patient's anamnesis and examination. It should be questioned when the pain started, its localization, its variability during the day and how long the complaints have been going on. Determining the localization of pain is very important for diagnosis[7].

Different causes have been described in the etiology of PHP[6]. The main causes are; plantar fasciitis, plantar calcaneal spur (PCS), fat pad atrophy and inflammation, calcaneus stress fractures, and calcaneal tumors. Among them, the most common cause is plantar fasciitis. In patients with plantar fasciitis, fibrosis and subsequent ossification at the fascial attachment point in the calcaneus reulting from repetitive microtrauma is called PCS[3]. On physical examination, local tenderness on palpation where the plantar fascia attaches to the medial tubercle of the calcaneus is characteristic for the calcaneal spur [3]. For a definitive diagnosis in this patient group, it is sufficient to observe the spur formation on the calcaneal plantar surface on the roentgenogram or to see the thickening at the calcaneal attachment of the plantar fascia on the ultrasound[8-10].

PCS is seen in approximately half of patients with PHP. However, calcaneal spur can be seen in 16% of those who do not have heel pain[11-12]. So why some patients with calcaneal spur are quite unhappy; Some people have no complaints? Could factors related to the structure of the spur, other than the patient's factors, also cause this? In our literature search, we determined that there are studies investigating the relationship between plantar fasciitis and PCS, but there are very few studies investigating the effect of the morphological structure of the spur. Detailed research on this subject is very important to know the effect of the morphological structure of the spur on the patient, as it may affect the differential diagnosis of PCS and the treatment option.

With this study, we aimed to determine the relationship between the morphological structure of the spur and the level of pain and functional involvement of the patient. Our hypothesis is that large and perpendicular spurs to the plantar skin would cause more pain-function effects on the patient. If our hypothesis is confirmed, we would suggest investigating the causes of non-PCS heel pain in patients with clinically incompatible PCS structure.

MATERIALS AND METHODS

The length and slope of PCS were measured by examining the radiological images of 50 patients in this prospective study. Visual Analog Scale (VAS), American Orthopedic Foot and Ankle Society (AOFAS) ve Foot Function Index-Turkish version (FFI) scores of the patients were determined. Patients were divided into groups according to PCS length and slope. Radiographs are often the first step in imaging patients with PHP[13]. Isolated PCS was detected in the lateral radiography of the feet taken from patients who applied to the Recep Tayyip Erdoğan University Orthopedics and Traumatology outpatient clinic between October 2020-2021 and met the inclusion criteria and were evaluated prospectively. Those under the age of 35 and over the age of 55, those with a body mass index of less than 30 or more than 35, those with a lower extremity trauma in the last 6 months, those with a history of surgery or infection in the foot-ankle, those with a history of overuse, diabetic Patients, those with a history of rheumatological disease, and those who received treatment for calcaneal spur in the last 6 months were not included in the study. The length of the plantar calcaneal spurs was measured manually using the picture archiving and communication system in our hospital, by examining the radiological images of 50 patients who met the inclusion criteria. Visual Analog Scale (VAS), American Orthopedic Foot and Ankle Society (AOFAS) and Foot Function Index-Turkish version (FFI)[14] scores were determined for each patient.

To determine the PCS length, the distance from the calcaneal origin of the spur to its distal end was measured. The patients were divided into 3 groups according to the length of PCS: Less than 5mm, 5-10mm, and 10mm or more. While calculating the slope of the spur, the angle between the PCS axis and the calcaneus was measured as previously described in the literature by Zhang et al.[15]. For this measurement, the first line was parallel to the anterior articular surface of the calcaneus and the second line was parallel to the axis of the PCS (Figure 1). The patients were again divided into 3 groups according to the slope of PCS: Those with angulation less than 20 degrees were classified as type A, those with angulation between 20 and 30 degrees were classified as type B, and those with angulation more than 30 degrees were classified as type C. While planning the degrees in this classification; They were grouped according to whether the spur extends superior to the plantar fascia, inside the fascia, or inferior to the fascia.

The fact that our study is prospective, the spurs are evaluated separately in terms of both length and inclination, and the effects on the spur only are very valuable in terms of research, by excluding factors such as patient's age, body mass index, trauma, arthrosis, and treatment for spurs while investigating the effects of the spur.

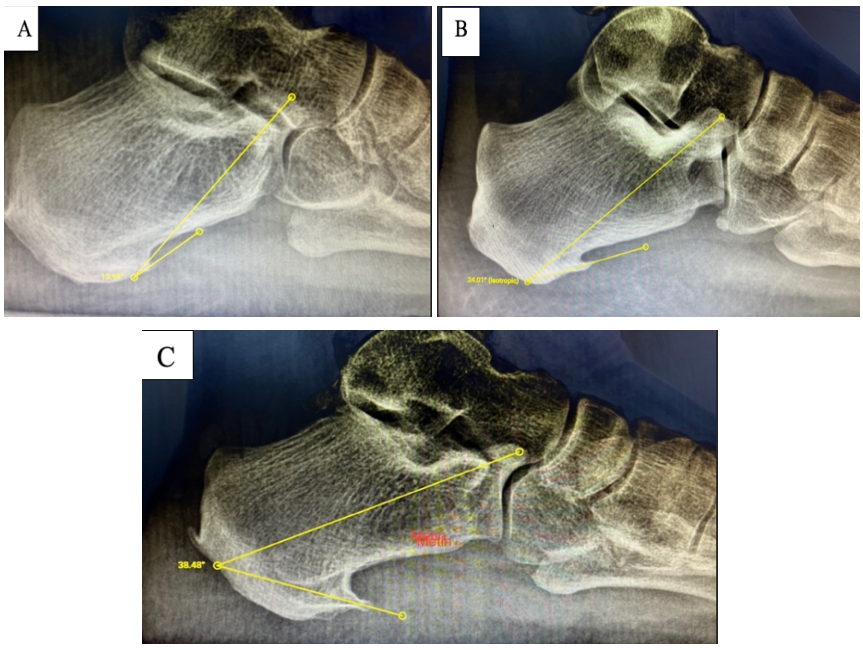

Fig. 1 — Sample lateral radiography images of the plantar calcaneal spurs taken by stepping; a) angulation of 13 degrees (type A), b) angulation of 24 degrees (type B), c) angulation of 38 degrees (type C).

Ethical approval was obtained from the ethical committee of Recep Tayyip Erdoğan University Faculty of Medicine, with the decision number 2020/196 dated 17/09/2020.

The data set was preprocessed (outlier, missing observation, normal distribution assumption). The descriptive statistics of the normally distributed continuous variables are given as X±SD, the non-normally distributed continuous variables are given as median and min-max values, and the categorical variables (qualitative) are given as percentages and ratios. Comparisons were made between the normally distributed continuous variables and the groups using parametric methods. Comparisons were made between non-normally distributed continuous variables and groups according to appropriate nonparametric methods. Chi-square tests were applied to categorical variables (qualitative). The relationship between continuous variables was evaluated according to Pearson correlation coefficient in those with normal distribution and Spearman's rank correlation coefficient in non-normally distributed variables. Statistical significance was accepted as $p < 0.05$.

RESULTS

Of the 50 patients who met the inclusion criteria, the right side was affected in 27 (54%) and the left side in 23 (46%). While 44 of the patients (88%) were female, 6 of them were male (12%). Their mean age was 49.2 (35-55), and their mean body mass index was 32.4 (30-35). When the patients were grouped according to their activity levels, 58% were active (at least 2 days of regular exercise or standing for at least 8 hours a week), 40% were at moderate activity level, and 2% were sedentary. The onset of the complaints ranged from 1 month to 36 months, with an average of 8.8 months. When the time period in which pain complaint is seen more is questioned; 32% of the patients stated that their complaints increased after rest, 26% in the morning, 18% during the whole day, and 10% at night. There was no pain in the plantar heel region in 7 patients (14%) (figure 2).

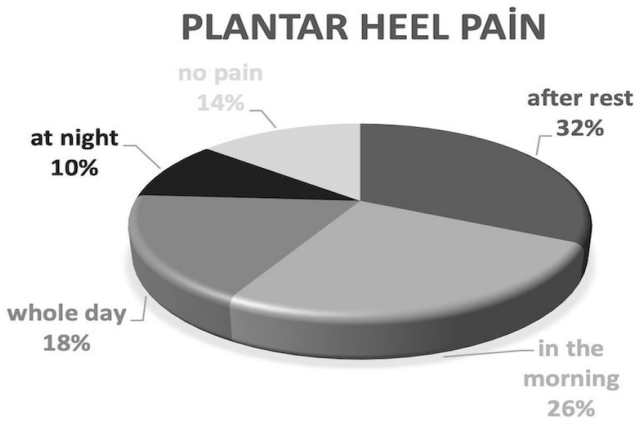

Fig. 2 — Most common time periods for plantar heel pain.

The diagnosis of PCS was made incidentally in these patients (Table I). The mean PCS length was 8.2 mm (2.9-15.5 mm), while the mean PCS angle was 27.1 degrees (13-41.4 degrees).

The mean VAS value of the patients was 4.9 (0-8), the mean AOFAS value was 78.8 (43-100), and the mean total FFI was 83.7 (0-142).

When the PCS of the patients are evaluated according to their structure; Eight (16%) were type A, 24 (48%) were type B, and 18 (36%) were type C. When evaluated according to their lengths; those with less than 5 mm were 12 (24%), those between 5-10 mm were 24 (48%), and those with more than 10 mm were 14 (28%).

When evaluated according to the slope of the spur, the mean AOFAS, FFI and VAS scores were, respectively; 94, 38, 1.3 in type A; 80.1, 86.8, 4.8 in type B; and 70.1, 106, 6.7 in type C. There was a significant correlation between PCS angle and VAS, AOFAS and FFI values ($p<0.05$).

When evaluated according to the length of the spur, the mean AOFAS, FFI and VAS scores were, respectively, 84.9, 68.2, 3.7 in those with PCS length of 0-5 mm; 81.1, 81.7, 4.5 in those with 5-10 mm;

Table I. — Mean AOFAS values by PCS slope and length.

AOFAS	<5 mm	5-10 mm	≥10 mm
Type A	94.6 (n=4)	94.7 (n=3)	97 (n=1)
Type B	80.1 (n=7)	83.4 (n=14)	74 (n=3)
Type C	80 (n=1)	70.8 (n=7)	68.6 (n=10)

Table II. — Mean VAS values according to PCS slope and length.

VAS	<5 mm	5-10 mm	≥10 mm
Type A	1.8	0.7	1
Type B	4.6	4	7
Type C	5	7	6.8

Table III. — Average FFI values by PKS slope and length.

FFI	<5 mm	5-10 mm	≥10 mm
Type A	38.8	42	23
Type B	83.6	76.6	114
Type C	78	109.2	107

and 71.7, 102.5, 6.4 in those with >10 mm (Table II,III). There was a significant correlation between the length of PCS and VAS, AOFAS and FFI values ($p<0.05$).

DISCUSSION

TPHP is pain or tenderness of the heel that is limited to the sole of the foot. It significantly affects patients' daily activities such as walking and standing, and their quality of life[15,16]. The pain may begin in the middle of the heel, or often in the medial tubercle of the calcaneum[13], and extend longitudinally through the plantar fascia to the medial arch of the foot[17]. In our study, localized tenderness just medial to the midline of the heel was observed with palpation in all symptomatic patients. Heel pain in patients with PCS is typically more intense in the morning and after rest, and increases with standing[16,17]. In parallel with the literature, the pain of the patients in our study mostly occurred after rest (32%) and in the morning (26%). Again, in our study, we observed that the complaints of patients who spent more time standing during the day became chronic. There was a significant correlation between the duration of standing and the duration of symptoms ($p<0.05$).

There are physiological and pathological factors that cause PHP. Advanced age, increased body mass index, foot structure in pronation, and arthritic changes are associated with an increased incidence of PCS[3,18,19]. For this reason, PHP is a candidate to be more of a problem in the future with the increase in the average life expectancy and the increase in degenerative bone structure and obesity in the aging population. Since the incidence of PCS and PTHP increases with aging[20], we included only patients between the ages of 35-55 in our study. As Rano et al.[19] stated in their study, since obesity also increases the incidence of PCS and negatively affects PHP, we selected all patients from the same body mass index range. For the same reason, patients with pathological conditions such as arthritis, infection, rheumatological disease and abnormal foot structure were also excluded from the study.

Although it is known that plantar fasciitis is the most common cause of PCS, it is not seen in all patients with plantar fasciitis[8]. Vyce et al. also showed in their study that not all patients with PCS have pain. They found 11-16% painless PCS in the young and middle-aged groups[21]. PCS was detected incidentally in 7 (14%) of the patients in our study.

Although studies showing the relationship between PCS and plantar fasciitis are common, the number of studies showing the effect of the change in the morphological structure of the spur is sparse. Regarding the morphological structure of the spur, Duvries described 3 types of PCS in 1957. It was classified as large and asymptomatic in type 1, large and symptomatic in type 2, and small and irregular in type 3[11]. Ahmad et al. defined 3 types of PCS. Those with a horizontal structure were classified as type 1, those with a vertical structure as type 2, and those with a hooked structure as type 3[22]. Zhou et al. described 2 types: The spur extending superiorly to the plantar fascia insertion in type A and the spur extending into the plantar fascia insertion in type B[23]. Zhang et al., on the other hand, described spurs that form an angle of less than 30 degrees between the line drawn parallel to the calcaneal central axis and the line drawn parallel to the PCS axis as type 1, spurs forming an angle between 30-60 degrees as type 2, and spurs forming an angle of more than 60 degrees as type 3[15]. The classification that we used and described in our study was inspired by the classification of Zhou[23] and Zhang[15]. PCS was examined in 3 groups as those extending superior to the plantar fascia insertion (type A with angulation between 0-20 degrees), those extending inside (type B between 20-30 degrees), and those extending to the inferior (over 30 degrees type C).

When we evaluate the spurs only according to their length, the mean aofas, ffi and vas scores are respectively; 5mm. in those shorter than: 84.9, 68.2, 3.7. 5-10mm. in length: 81.1, 81.7, 4.5. Longer than 10mm: calculated as 71.7, 102.5, 6.4. When we evaluate the spurs only according to their slope, the mean aofas, ffi and vas scores in type A patients are 94, 38, 1.3, respectively. While it was 80.1, 86.8, 4.8 in type Bs, it was 70.1, 106, 6.7 in type Cs.

When we look at the AOFAS value, it is seen that the increase in length in type A (0-20 degrees) does not cause a significant clinical effect. In Type B (20-30 degrees), it is seen that there is a negative effect of lengths over 10 mm, while in type C (over 30 degrees), we determined that there is a negative effect from values above 5 mm. According to the VAS value, while no significant increase was observed in pain with an increase in length in type A, it was observed that the complaint of pain increased when it was over 10 mm in type B and over 5 mm in type C. When we look at the FFI values, functional involvement was seen in lengths above 10 mm in types A and B, and in lengths above 5 mm in type C.

Our study also supports that PCS with an inclination of more than 30 degrees is more likely to cause clinical adverse effects in line with the study of Zhang et al.[15].

However, we support the view that pain intensity is independent of PCS length only in type A. We observed a significant increase in pain over 10 mm in type B and 5 mm in type C.

Patients can be informed in line with these data according to PCS length and slope. It should be kept in mind that advanced imaging methods for differential diagnosis can be applied to elucidate the source of the symptom in patients with a high clinical involvement in Type A PCS of any length or PCS with any slope shorter than 5 mm.

Since PHP is a multifactorial condition involving many tissues, PCS is often seen together with surrounding soft tissue pathologies[6]. It is not always possible to make this distinction by looking at the nature and level of pain with heel palpation. While radiographic imaging can reveal only the presence and structural features (length and slope) of PCS, it cannot clearly reveal soft tissue pathologies.

Our hypothesis was that small (less than 5mm) spurs that do not extend distal to the plantar fascia insertion would not have a serious clinical effect. We thought that larger and steeper spurs would cause more dysfunction and pain in patients. This situation necessitates the use of advanced imaging methods in patients with clinical features that are more exaggerated than the structure of the spur. An imaging method that has increased in popularity in recent years is weight bearing computed tomography (WBCT), which can present a 3-dimensional image taken under weight. WBCT is a reliable and precise modality for the measurement and analysis of body position in the foot and ankle and associated deformities[24]. Especially valuable in sequence disorders such as malaligment in the foot structure[24,25], this imaging method offers a better quality image compared to 2-dimensional conventional tomographs[26], emits less radiation, and can provide images in a short time[27]. Also, we think that in the future, these images can be used more frequently before computer-assisted surgical treatment applications.

CONCLUSION

As a result, our hypothesis was largely confirmed that longer and higher inclined spurs would irritate the plantar fascia more and make patients more symptomatic. The main morphological feature in the etiology of symptoms is not the length but the slope of the spur. However, since there was a significant positive ($p<0.001$) correlation between the length and slope of the PCS, the length and slope of the spur should be evaluted together. We can expect fewer symptoms for PCS, with lengths of <10 mm, with angulations of less than 20 degrees (Type A) and 20-30 degrees (type B). In this group of patients with severe pain and functional impairment, other possible causes of heel pain (such as plantar fasciitis, heel fat pad anomalies, compression of the inferior calcaneal nerve, fracture of the spine, concomitant inflammation, plantar fascia ruptures, calcaneal stress fractures, S1 radiculopathy, fat pad atrophy and tumoral lesions) are likely. We recommend resorting to advanced imaging modalities such as electrophysiologic studies, exploratory ultrasonography, magnetic resonance imaging or WBCT. Further studies are needed to compare the results of these advanced imaging methods, in which the etiology of plantar heel pain in small and lower inclined heel spurs is investigated.

Authors Contributions: All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Rıfat Şahin. The first draft of the manuscript was written by Rıfat Şahin and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Availability of data and materials: In this study, permission to examine the images and datas were obtained ethically.

Ethical Approval: This study approval was granted by the Ethics Committee of the University Recep Tayyip Erdogan, Turkey (September 17, 2020/No. 2020-196).

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