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The role of bone scintigraphy in determining the etiology of heel pain

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In this study we aimed to determine the role of bone scintigraphy as an objective diagnostic method in patients with heel pain.

67 heels of 50 of 182 patients with defined features who attended the orthopedics outpatient clinic with heel pain over a 3-year period, were treated with combined methods such as nonsteroidal anti-inflammatory drugs (NSAID) and contrast baths, stretching exercises and changing of footwear habits. A one year follow-up was established. The criteria identified by Wolgin et al. were used in assessing the results of the treatment.

Subcalcaneal spur was demonstrated by radiography in 44 of the 67 heels. There were two different imaging patterns observed on three phase bone scintigraphy.

Type I imaging pattern: Focal increased activity in the heel region or normal activity on dynamic and the blood pool phases and focal increased activity at the inferior calcaneal surface in the late static phase.

Type II imaging pattern: Diffuse increased activity along the plantar fascia in the dynamic and the blood pool phase, and focal increased activity at the inferior calcaneal surface in the late static phase.

There were 34 (50.7%) type I and 18 (26.8%) type II imaging patterns on the scans. Type I and type II imaging patterns were described as osseous and fascial respectively. At the final examination, the results for pattern type I were good in 16 patients (66.7%), fair in 6 patients (25%) and poor in 2 patients (8.3%), whereas in pattern type II results were good in 12 patients (80%) and fair in 3 patients (20%). The recurrence frequency was 4.1% and 6.6%, respectively.

Subcalcaneal spur was determined in 70.5% of the patients with osseous pathology and 55.5% of the patients with fascial pathology. Based on this result, it can be ascertained that calcaneal spurs develop during the pathological process causing heel pain. Other findings supporting this claim were the differences in symptom periods of the patients with type I and type II imaging patterns and scintigraphies were normaly in 10 of 44 heels indicating subcalcaneal spurs on radiographies. These findings suggested that metabolic changes contributing to subcalcaneal spur were complete. Three phase bone scintigraphy is an objective method which can be used to diagnose heel pain, especially when determining the etiological factors and prognosis.

Key words: bone scan, heel pain, subcalcaneal spur

INTRODUCTION

Even though heel pain does not cripple it is frequently seen in orthopedic practice and is one of the foot problems given a lot of attention owing to its chronic tendency. The pain usually begins gradually and it may be sharp, continual or intermittent. On physical examination, there is usually a pain along the medial tuberosity of the calcaneus which does not spread elsewhere.[1,2]

Inflammation of the calcaneal insertion of the plantar fascia is the most frequent etiology of heel pain. The other etiological factors are: subcalcaneal spur, medial and

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lateral plantar nerve entrapment, heel fat pad atrophy and elasticity changes in the fat pad, calcaneal stress fractures, tumors of the calcaneus and surrounding soft tissues, longitudinal arc problems such as pes planus or pes cavus, problems at the insertion of the Achilles tendon and rheumatological diseases.[1–4]

Because of the complex anatomic structure of the heel region, it is usually very difficult to establish the cause of heel pain. Stress fractures, tumours and calcaneal spurs can be diagnosed by radiography. Bone scintigraphy can demonstrate functional changes on the bone before an anatomic pathology appears. Because three phase bone scintigraphy also gives information about soft tissue problems, it can be used in differential diagnosis of heel pain originating from bone or fascia.[5]

In this study, patients with heel pain were evaluated clinically, radiographically and scintigraphically and the role of bone scan in the diagnosis of heel pain has been considered.

PATIENTS AND METHODS

182 patients who attended the orthopedics outpatient clinic with heel pain between July 1996 and July 1999 were evaluated.

The examination began with a detailed patient's history. We inquired concerning occupations, sporting habits, daily activities and restrictions in activities, present and past diseases, duration of symptoms, character of the pain and predisposing factors. The most frequent predisposing factors among the 6 different types that were evaluated during the study were; walking for long periods (22 patients—44%), obesity (20 patients—40%) and standing for long periods (18 patients—36%). The other predisposing factors were type I–II pes planus (16%), tiring sporting activities (10%) and wearing high-heeled shoes (4%).

Patients with the following were excluded: tumors of the foot bones, past surgical intervention for ankle or foot bones, type III pes planus and pes cavus, post-traumatic or congenital foot deformity, diagnosed rheumatological diseases, Achilles tendinitis and bursitis, Haglund syndrome, tarsal tunnel syndrome, sciatalgia, those who had treatment for heel pain before, daily activity unaffected because of heel pain and those who had no radiographical or scintigraphical pathology. Finally, 67 heels of 50 patients, 38 female and 12 male, were included in the study. 15 of the patients were actively working, 12 were retired and 23 were housewives. The mean age was 46.32 years (23–73 years). The mean age of females was 45.73 (24–68 years) and of males was 48.16 (23–73 years). The study involved 17 right heels, 16 left heels and 17 bilaterally.

At physical examination firstly the height and weight of the patient was noted, then the body-mass index (weight [kg]/height^2 (m^2]) was calculated with the help of these scores. Patients with an index value higher than 27 were classed as obese.[6] Then maximum tenderness points of the heels were determined. Examinations of the patients who were having NSAID treatment for any reason were performed 2 weeks after their treatments had stopped.

Table 1 Wolgin's classification scale

Good	No symptoms
Fair	Continued symptoms but no activity restriction either at work or in sport
Poor	Continued symptoms limiting activity

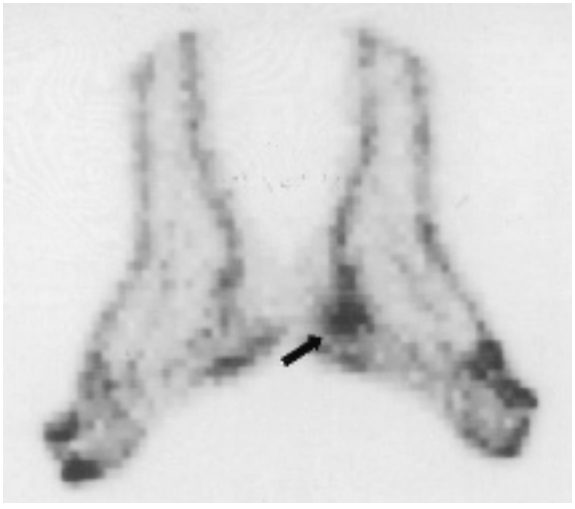
By taking loaded and unloaded antero-posterior and lateral radiographs of all the patients, pathologies of the bones and lengths of subcalcaneal spurs were ascertained. Subcalcaneal spurs were classified as small (1–2 mm), medium (3–5 mm) and large (6+ mm).[7] After radiographical evaluation, three-phase bone scintigraphy of all the patients was performed. Scanning was done by dorsiflexing the ankles after holding the soles together. With a high-sensitivity collimator, 1 second dynamic images were obtained for 1 minute after intravenous injection of 740 MBq Tc-99m MDP, followed by a blood-pool phase image for 2 minutes. Late static images were obtained 3–4 hours after injection for 400,000 counts or 10 minutes, with a high-resolution, parallel-hole collimator.

After all these evaluations, the patients were classified in groups of diagnoses, subcalcaneal spur, plantar fasciitis and subcalcaneal pain syndromes. Whatever the diagnoses, all patients were prescribed NSAID (Nimesulid 100 mg/day) for 2 weeks, contrast bathing three times a day, 20 minutes per session, and in addition stretching exercises for the Achilles tendon and plantar fascia were performed. All the patients were made to wear low-heeled, wide-toed and soft-soled shoes. The patients were told to take care to perform contrast bathing with 3 minutes of cold and 1 minute of hot water and always to start and finish with cold. Stretching exercises were performed 3 times a day as described by Brotzman.[8]

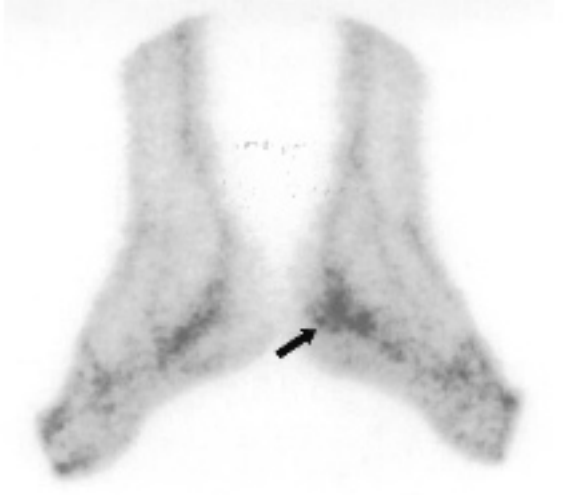
After 2 weeks, the patients were evaluated again. The NSAID treatment of those whose pain had been relieved was stopped, but contrast baths and stretching exercises continued. For those whose pain had not been relieved, NSAID treatment was extended for another 2 weeks. At the end of the fourth week, these patients' NSAID treatment was stopped but contrast baths and stretching exercises for all patients continued. Control examinations were made at the end of the 1st, 3rd, 6th and 12th months. With these control examinations we aimed at identifying the time for pain relief and to determine recurrence. The results of the treatment were classified according to the criteria defined by Wolgin et al. as "Good", "Fair" and "Poor"[2] (Table 1).

RESULTS

Pain was detected in 8 different locations. Amongst them, the medial side of the calcaneus (in 24 patients—48%),



A



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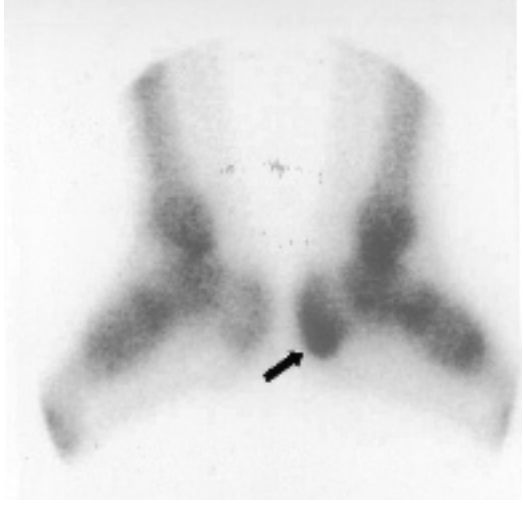

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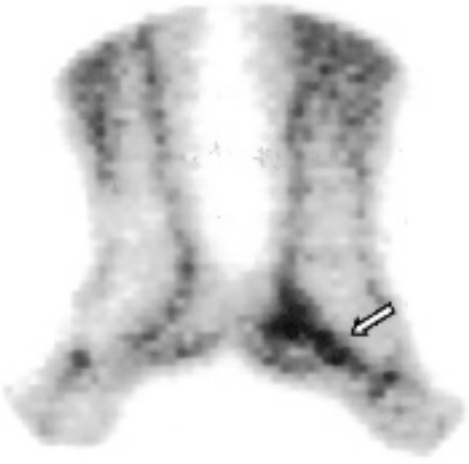
Fig. 1 Type I imaging pattern in patient with left calcaneal spur. Dynamic (A) and blood pool (B) images revealing increased activity in left heel region (*arrow*). Late static (C) image showing increased activity localized to inferior calcaneal surface (*arrow*).



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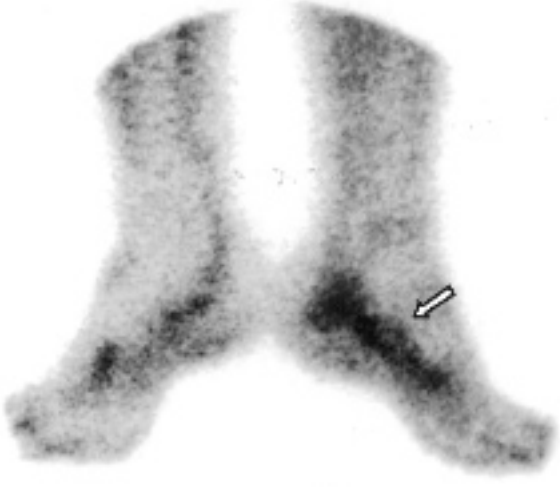

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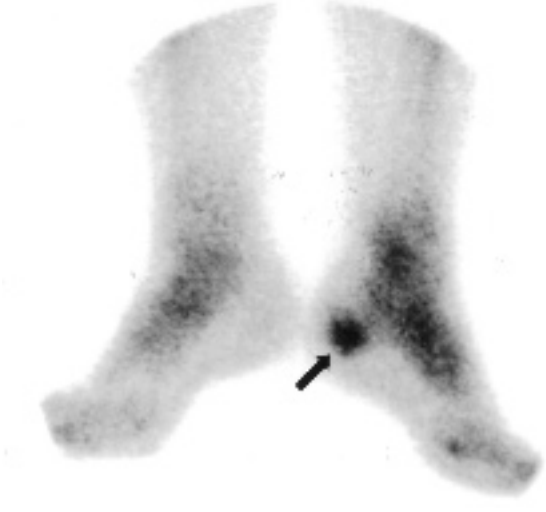

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Fig. 2 Type II imaging pattern in patient with left plantar fasciitis. Dynamic (A) and the blood pool (B) images showing diffuse increased activity along the left plantar fascia (*open arrow*). Late static (C) image revealing focal increased activity at the inferior calcaneal surface (*arrow*) in the left heel.

Table 2 Detail of study results

No	Age	Sex	Involvement side	Body-mass index	Duration of symptoms (months)	Predisposing factors	Localization of pain	Radiological evaluation		Scintigraphical evaluation		Healing time (months)	Recurrence	Results
								Spur	Length of spur (mm)	Pattern type I	Pattern type II			
1	40	F	Left	28.33	7	1	1-7	+	2		+	7		Fair
2	50	F	Left	24.04	2	5	1-3-7	–			+	4		Good
3	47	F	Bilateral	29.68	4	1-2	2-6	+	3-3	+		–		Poor
4	45	F	Left	25.30	12	6	5	–		+		4		Good
5	40	F	Right	30.76	120	1	7	+	2	+		7		Fair
6	46	F	Left	28.51	12	1	7-8	–				7		Good
7	40	F	Right	24.91	5	2	1-3	+	3		+	6		Good
8	46	F	Bilateral	27.50	6	1-3	7-8	+	2-2	+		–		Poor
9	23	M	Bilateral	18.12	2	4	5	–		+		1		Good
10	41	F	Bilateral	27.50	24	1	1-3	+	3-2	+		8		Fair
11	46	F	Bilateral	227.27	120	1-5	1	+	4-4	+		8		Fair
12	40	F	Left	24.11	12	2-5	1-6-7	+	2		+	6		Good
13	48	M	Right	24.65	3	–	4	–				3		Good
14	67	F	Bilateral	32.83	24	1-5	1-4	+	1-1			8	+	Fair
15	33	F	Right	17.89	3	2-6	1-6	–		+		3		Good
16	50	F	Left	27.84	120	1	6	+	2			6		Fair
17	68	F	Bilateral	28.57	12	1	3	+	3-4		+	6	+	Fair
18	40	M	Left	22.51	23	2-3	1-6-7	+	2		+	5		Fair
19	52	F	Left	29.78	12	1	3	+	5	+		7		Fair
20	32	M	Right	22.78	6	4	3	+	3	+		3		Good
21	33	F	Left	21.40	4	2-6	1	+	4	+		5		Good
22	51	F	Left	28.47	25	1-2	1	+	6	+		7		Good
23	47	F	Bilateral	39.11	4	1-2	7	+	1-2			7	+	Fair
24	49	F	Right	20.21	1	2-3	7	–				3		Good
25	70	M	Bilateral	28.20	12	1-3	1-7	+	3-3	+		8		Fair
26	34	F	Right	21.64	12	2-3-5	7	–				4		Good
27	50	M	Left	25.94	27	2-3-5	3	+	2		+	5		Good
28	73	M	Left	19.37	10	2	7-8	+	2		+	8		Good
29	46	F	Right	32.73	2	1-3	1-8	+	1		+	7		Good
30	51	M	Right	22.33	4	3	1-8	+	1		+	5		Good
31	51	M	Bilateral	26.66	24	2-3-4	8	+	1-1			8		Good
32	56	M	Right	23.30	4	3-4	3-8	–			+	7		Good
33	44	F	Left	34.37	48	1-3	8	+	1			7		Good
34	65	F	Right	29.16	2	1-3	1-8	–		+		7		Good
35	44	F	Right	38.75	24	1-2	3-8	+	6	+		8		Good
36	23	M	Right	19.08	4	3	4-6	–		+		1		Good
37	48	F	Right	21.09	5	6	2	–		+		2		Good
38	42	F	Right	25.78	8	3-5	1-8	–				5		Good
39	24	F	Left	20.21	3	2-3	1	–			+	3		Good
40	48	F	Right	20.21	20	–	4-6	–		+		6		Good
41	42	F	Bilateral	20.42	26	3	1	+	1-2	+		5		Good
42	56	F	Right	29.09	48	1-2	1-8	+	3	+		8	+	Fair
43	33	F	Bilateral	19.08	3	2-3	5	–		+		4		Good
44	33	F	Bilateral	18.64	4	3-4	1-4	+	2-2	+		5		Good
45	48	F	Bilateral	29.29	12	1-2-3	1-8	+	2-2			–		Poor
46	61	M	Bilateral	21.45	17	3	4-8	–			+	7		Good
47	37	F	Left	20.20	13	3	4-6-7	–			+	5		Good
48	68	F	Bilateral	25.57	14	–	1-5	–			+	8		Good
49	54	F	Bilateral	22.42	21	5	1-3	+	2-3	+		6		Good
50	41	F	Left	21.05	11	3	1-4-6	+	1	+		4		Good

Predisposing factors: 1. Obesity 2. Standing for a long time 3. Walking for a long time 4. Tiring sport activities 5. Type I-II pes planus 6. Wearing high heeled shoes

Localization of pain: 1. Medial side of calcaneus 2. Lateral side of calcaneus 3. Middle of calcaneus 4. Insertion of the Achilles tendon 5. Diffusely on the sole 6. Edge of sole 7. Midpoint of plantar fascia 8. Calcaneal insertion of plantar fascia

the calcaneal insertion of the plantar fascia (in 14 patients —28%) and the midpoint of the plantar fascia (in 13 patients—26%) were the most frequently seen. The other pain sensitivity points were the middle of the sole (24%), the side of the sole (18%), the insertion of the Achilles tendon (16%), diffusely over the sole (8%) and the lateral side of the calcaneus (2%).

Subcalcaneal spurs were found radiographically in 44 heels of 31 patients. 27 (61.4%) of the spurs were small, 15 (34.1%) were medium and 2 (4.5%) were large. 28 spurs were found in patients in the 41–60 age group. The average symptom period was 25 months (4–120 months) in patients with subcalcaneal spur and 7.2 months (1–20 months) in patients without.

Two different imaging patterns were observed on scintigraphic examination of the patients;

I. Focal increased activity in the heel region or normal activity on dynamic and blood pool phases and focal increased activity at the inferior calcaneal surface in the late static phase. This indicated an osseous pathology (Type I imaging pattern, subcalcaneal spur) (Fig. 1). Type I imaging pattern was seen in 34 of the 67 heels (50.7%—24 patients).

II. The dynamic and the blood pool images demonstrated diffuse increased activity along the plantar fascia whereas the late static phase revealed focal increased activity in the inferior calcaneal surface in 18 of the 67 heels (26.8%—1 patients). This indicated a fascial pathology (Type II imaging pattern, plantar fasciitis) (Fig. 2).

On the other hand, 15 heels of the 11 patients had normal scintigraphic imaging.

The mean age of the patients with imaging pattern type I was 43.5 years (23–70 years) and with imaging pattern type II was 49.6 years (24–73 years), and 11 patients (45.8%) with pattern type I and 3 patients (20%) with pattern type II were obese. The average duration of symptoms in patients with type I and type II patterns was 21.5 months (2–120 months) and 10.3 months (2–23 months), respectively.

The most tender point was the medial side of the calcaneus for patients with type I and type II patterns; next, in decreasing order of frequency, were middle of the calcaneus and insertion of the Achilles tendon in patients with pattern type I and middle of the plantar fascia and calcaneal insertion of the plantar fascia in patients with pattern type II. It was determined that pain which increased with walking was the most common pain pattern in patients with type I and type II imaging patterns.

Subcalcaneal spurs were determined on radiographies in 24 heels (70.5%) with pattern type I and in 10 heels (55.5%) with pattern type II. There were also differences between the length of the subcalcaneal spurs. The average length of subcalcaneal spurs in patients with pattern type I was greater than in patients with pattern type II (2.95 mm/2.2 mm).

The average period for release from pain was 5.6 months (1–8 months). This period was 5.3 months (1–8 months) in patients with pattern type I and 5.8 months (3–8 months) in patients with pattern type II.

At the final examination, which was done according to the criteria of Wolgin et al., results were good in 16 patients (66.7%), fair in 6 patients (25%) and poor in 2 patients (8.3%) with pattern type I, whereas they were good in 12 patients (80%) and fair in 3 patients (20%) with pattern type II.

There was recurrence in 4 patients (8%); in 1 patient with pattern type I (4.1%), in 1 patient with pattern type II (6.6%) and in 2 patients whose scintigraphy was normal (18.2%).

Although all patients with pattern type II recovered, 2 patients (1 patient with pattern type I and 1 patient who was normal on scintigraphy) were still symptomatic for a year.

Detailed results are shown in Table 2.

DISCUSSION

Heel pain is quite a common problem and may be experienced at any time of life in both genders. There is still some argument about its diagnosis and treatment. Patients usually go to the doctor only when the problem is chronic, because progress of heel pain is slow and does not seriously affect daily activities at the beginning. Neither doctor nor patient takes heel pain seriously and it is treated with simple measures. This leads to the problem becoming chronic, and moreover the patient often does not follow the prescribed treatment. Finally, unnecessary surgical treatment is carried out on patients who have not undergone the very important conservative treatment for a minimum of 6–12 months.[7]

It is difficult to identify the cause of heel pain because the heel region has a complex anatomy and any of the structures in this localization can bring about heel pain. Effective treatment is possible only if a precise diagnosis is reached; it is therefore very useful for both doctor and patient to determine the exact cause of heel pain.

There are many causes of chronic heel pain, ranging from bony abnormalities such as calcaneal stress fractures, subcalcaneal spurs and tumors of the calcaneus to conditions which are primarily soft tissue injuries, namely Achilles tendonitis, entrapment of medial and lateral plantar nerves and changing of heel pad length and elasticity.[3,6,7,9] Therefore, at the minimum antero-posterior and lateral x-rays must be taken in both loaded and unloaded positions[9,10] but radiography is not very useful in diagnosing the cause of heel pain because the radiographical anatomy of the heel is very complex and some etiological factors can be seen even in the normal population.[11] On the other hand, bone scintigraphy can give us some information concerning bone and soft tissue pathologies. Functional changes in the bone can be detected by scintigraphy before any anatomic pathology is

seen. Because the three phase bone scan gives information concerning soft tissue, it can also be used in differential diagnosis of heel pain originating in fascia and bone.[5] There have been some experiments showing the role of bone scintigraphy in the diagnosis of heel pain. The common conclusion of these studies was that bone scan was recommended to be performed only if radiographies were normal.[12–15] In our study, pain and tenderness were frequently localized on the medial side of the calcaneus in patients with both type I and type II patterns. The other common pain localizations were the middle of the calcaneus in patients with pattern type I and middle of the plantar fascia in patients with pattern type II. In addition, the average length of the subcalcaneal spur was 2.95 mm in patients with pattern type I and 2.2 mm in patients with pattern type II. We realized that pattern type I was specific for bone pathology, especially for subcalcaneal spur, and pattern type II was specific for fascial pathology, especially for plantar fasciitis. Even though 10 of the 34 heels (29.4%) did not show subcalcaneal spur on radiographies in patients with pattern type I, 10 of the 18 heels (55.5%) showed subcalcaneal spurs on radiographies in patients with pattern type II, which is why the results of radiography and scintigraphy must be evaluated together in the diagnosis of heel pain. Similar results were also reported by Intenzo et al.[5]

A combination of radiography and scintigraphy is useful for doctors not only in the diagnosis of the disease but also in follow-up of the patients. In our study, the average duration of symptoms before treatment was 21.5 months in patients with pattern type I and 10.3 months in patients with pattern type II. At the end of the treatment the percentage of good and fair results was 100% in patients with pattern type II, whereas in patients with pattern type I the success rate was 91.7%. Based on these results we can say that the prognosis of plantar fasciitis is better and this is quite important in terms of giving the patient information and reassurance. On the other hand, we can not explain with either our study results nor data from the literature why the average recovery period of patients with plantar fasciitis is longer than in patients with subcalcaneal spur.

Subcalcaneal spur and plantar fasciitis very often cause heel pain. Intrinsic muscles and plantar fascia originate in the medial calcaneal tuberosity. Repeated trauma creates traction stress at the point of origin and finally leads to an inflammatory process at the plantar fascia. Necrosis of collagen, angiofibroblastic hyperplasia, chondroid metaplasia and calcification of the matrix were found in biopsy specimens taken from the origin of the plantar fascia in patients with chronic heel pain. Similar changes were ascertained in the flexor brevis muscle lying under the plantar fascia attached to the point in which the subcalcaneal spur originates.[1] In our study, at the scintigraphic evaluation of patients with type II pattern, it was concluded that the uptake seen through plantar fascia in dynamic and blood pool images is related to hyperemia occurring due to inflammation of the plantar fascia. On the other hand, in patients with a type I pattern, due to angiofibroblastic hyperplasia and calcification of the matrix occurring at the calcaneal origin of the plantar fascia, because of chronicity of cases, uptake was localized at the inferior calcaneal surface. But on bone scintigraphy, in spite of late static images revealing increased activity at the inferior calcaneal surface in patients with both type I and type II patterns, radiography did not show a subcalcaneal spur in 29.5% of the patients with pattern type I and 44.5% of the patients with pattern type II. When we both evaluated and combined the basic information and our study results, we affirm that plantar fasciitis occurs first due to inflammation and that subcalcaneal spur appears subsequently as a reaction.

Although bone scintigraphy is able to show the functional change in the bone before any anatomic change has appeared, in our study scintigraphies were normal in 10 of the 44 heels (22.7%) indicating subcalcaneal spurs on radiographies. The average duration of symptoms was 21.5 months in patients with pattern type I, 10.3 months in patients with pattern type II and 38.6 months in scintigraphically normal patients. In addition, the percentage of good results in this group was 33.6% and was lower than in patients with type I and type II patterns. The ratio was 66.7% in patients with pattern type I and 80% in patients with pattern type II. There was recurrence in 4.1% of the patients with pattern type I, in 6.6% of the patients with pattern type II and in 18.2% of the patients scintigraphically normal. We realized from the all these results that metabolic changes contributing to subcalcaneal spur were completed and going back would be very difficult. These results support our hypothesis that firstly plantar fasciitis occurs due to inflammation and as a consequence subcalcaneal spur appears, and why the prognosis for patients with type II pattern was better than for type I.

CONCLUSION

Heel pain is a quite common problem in orthopedic practice and its diagnosis and treatment are still being discussed. Many patients are frequently treated for subcalcaneal spur after radiographical examination, but in fact heel pain is multifactorial. Therefore, patients with heel pain must be evaluated by detailed physical examination, radiographies and bone scintigraphy. On bone scintigraphy, if dynamic and blood pool images reveal normal or incresed activity in the heel region and the late static phase reveals focal increased activity at the inferior calcaneal surface, the etiological factor is of osseous origin. If the dynamic and blood pool images demonstrate diffuse activity along the plantar fascia and a late static image reveals focal increased activity at the inferior calcaneal surface, the etiological factor is of fascial origin. Inferior

calcaneal uptake in the late static phase is seen in both imaging patterns. Therefore dynamic and blood pool images are necessary to differentiate types I and II. These imaging patterns are very useful in diagnosis, in determining the prognosis and for effective treatment.

We also concluded that subcalcaneal spur is not a primary lesion and appears as secondary to the pathological process causing heel pain, also that thereafter it can cause heel pain by itself.

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