Sonography of Plantar Fibromatosis

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OBJECTIVE. Plantar fibromatosis is a rare benign fibroproliferative disorder of the plantar fascia that can be evaluated on sonography. Our study details the sonographic appearances of plantar fibromatosis.

MATERIALS AND METHODS. We conducted a retrospective review of the clinical presentation, sonographic appearances, and clinical progress in 14 patients (range, 35–85 years; mean age, 53.1 years;) with plantar fibromatosis. Sonography was performed using either a 13-5–MHz multidimensional or 12.5-MHz linear array transducer. The location, sonographic appearances, and size of the plantar fibromatosis nodules were noted and correlated with symptom duration and clinical outcome.

RESULTS. A total of 25 fibromatosis nodules in 19 feet were examined. On sonography, plantar fibromatosis was seen as a discrete fusiform nodular thickening of the plantar fascia, separate from the calcaneal insertion. Approximately one third (36%) of lesions were bilateral, and one quarter (26%) were multiple. All lesions were located either medially (60%) or centrally (40%) in the fascia. Most were hypoechoic (76%), were well defined (64%), and showed no acoustic enhancement (80%) or intrinsic vascularity (92%). No correlation was found between the echogenicity and size of plantar fibromatosis nodules or duration of symptoms ($p < 0.01$). One quarter of the affected feet had coexistent thickening of the plantar fascia at the calcaneal insertion with no related symptoms.

CONCLUSION. Although the sonographic appearances of plantar fibromatosis vary, the appearances are characteristic enough to allow a specific diagnosis to be made. No clear relationship was found among the sonographic appearances, duration of symptoms, or clinical outcome.

Received October 22, 2001; accepted after revision April 24, 2002.

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AJR 2002;179:1167–1172

0361–803X/02/1795–1167

Plantar fibromatosis is a rare benign condition of the plantar fascia first described by Ledderhose in 1897 [1]. It is characterized by proliferation of fibrous tissue within the plantar fascia usually in the mid- and forefoot region. Patients usually present with either pain or a lump in the sole of the foot [2].

Sonography is a useful means of confirming the presence of plantar fibromatosis [3, 4]. Although Solivetti et al. [4] described the sonographic appearances of plantar fibromatosis in six patients, the sonographic appearances of this condition have not been described in detail in the English language literature. In our study, we sought to detail the sonographic appearances of plantar fibromatosis.

Materials and Methods

Over a 3-year period, 14 patients (11 women and three men; age range, 35–85 years; average age, 53.1 years) with clinically suspected plantar fibromatosis were examined sonographically. The time between the onset of symptoms and the performance of sonography varied from 3 to 36 months (average, 12 months).

Sonographic Technique

Sonography of the sole of the foot was performed with the patient lying prone and the foot resting over the edge of the examination couch (Fig. 1). Either a 13-5–MHz multidimensional (Multi-D Array with Sonoline Elegra Advanced imaging system; Siemens, Erlangen, Germany) or a 12.5-MHz linear array (HDI 5000; ATL, Bothell, WA) transducer was used. A single operator performed all sonographic examinations. The sonographic features and vascularity of the symptomatic nodules were noted, and then the entire plantar fasciae of both feet were examined for additional asymptomatic nodules. The thickness of the plantar fascia at the calcaneal insertion was also measured (thickness ≥ 4.5 mm was considered abnormal) [5] in both feet. Because most patients were discharged

from regular follow-up care after the sonographic examination, they were contacted by telephone after an average of 10 months (range, 1–16 months) for assessment of symptoms.

Clinical Features

All patients complained of either pain or a palpable lump in the sole of the foot at presentation (Fig. 2). Eleven (89%) of 14 patients reported sole pain and 10 (71%) of 14 patients, a palpable lump in the sole. Pain was aggravated by prolonged standing or walking and relieved by rest in all patients. No patients specifically mentioned having heel pain. Symptoms affected the right foot in four (29%) of the 14 patients and the left foot in eight patients (57%). The remaining two patients (14%) had bilateral symptoms.

All patients lived a sedentary lifestyle (either mild exercise or none). All wore standard flat footwear, and none had a history of trauma. General health was largely unremarkable: hypertension was present in two patients, tennis elbow in one patient, diabetes in one patient, and osteoarthropathy in four patients. No patients had clinical evidence of an associated fibroproliferative disorders such as Dupuytren's fascia or Peyronie's disease.

Results

Sonographic Features

A total of 25 fibromatosis nodules in 19 feet were found. The distribution, sonographic features, and size of these nodules are shown in Table 1. On sonography, plantar fibromatosis appeared as a discrete fusiform nodular thickening of the plantar fascia that was separate from the calcaneal insertion in all patients (Figs. 3 and 4). No internal calcification, heterogeneity, or cystic component was seen. Posterior acoustic enhancement with hypoechoic rather than isoechoic lesions was seen but was not related to lesion size (Figs. 3, 5, and 6). Intrinsic vascularity was a feature of two lesions (Fig. 7). No correlation was found between the echogenicity, definition, or size of plantar fibromatosis nodules and the duration of symptoms ($p < 0.01$). In three of the five patients with bilateral plantar fibromatosis, the nodules on one side were asymptomatic. Asymptomatic nodules tended to be smaller than symptomatic nodules.

Coexistent Thickening of the Plantar Fascia Calcaneal Insertion

The average thickness of the plantar fascia at the calcaneal insertion in the more symptomatic foot in each patient was 3.6 mm (range, 2.2–4.8 mm). The average thickness of the plantar fascia at the calcaneal insertion in the nonsymptomatic or less symptomatic foot in each patient was 4.0 mm (range, 2.3–5.6 mm). Seven (25%) of the 28 feet examined had abnormal thickening of the plantar fascia at the calcaneal insertion (Figs. 8 and 9). In three patients (43%), the more symptomatic foot was involved, whereas in four patients (57%), the nonsymptomatic or less symptomatic foot was affected.

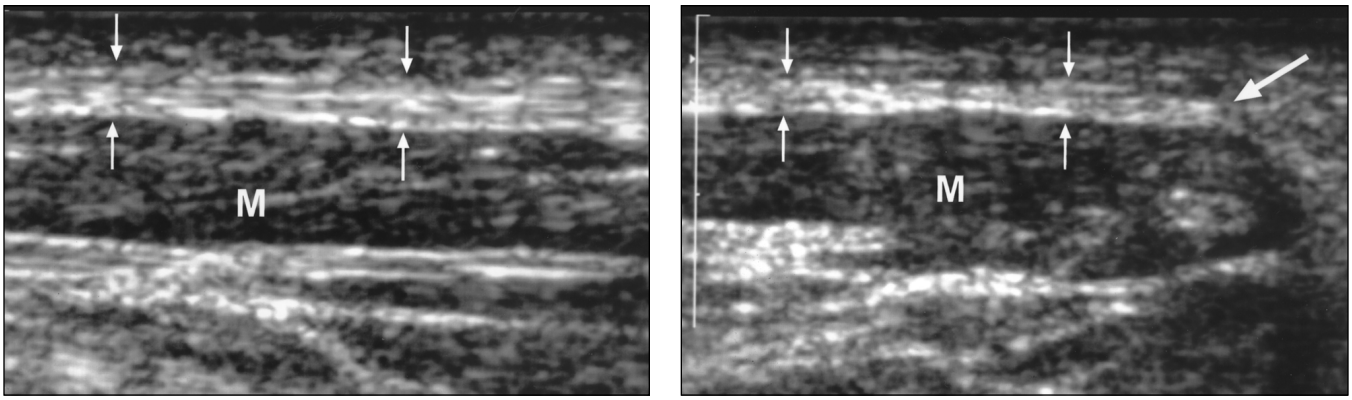

Fig. 1.—28-year-old woman with normal plantar fascia in midfoot.
A, On longitudinal sonogram of sole in region of midfoot, normal plantar fascia appears as sharply defined echogenic band (*arrows*) 1–2 mm thick. Flexor digitorum brevis muscle (M) is attached to section of deep surface of fascia.
B, Transverse sonogram of sole shows normal plantar fascia (*small arrows*) in midfoot region and medial free edge (*large arrow*) of plantar fascia. M = flexor digitorum brevis muscle.

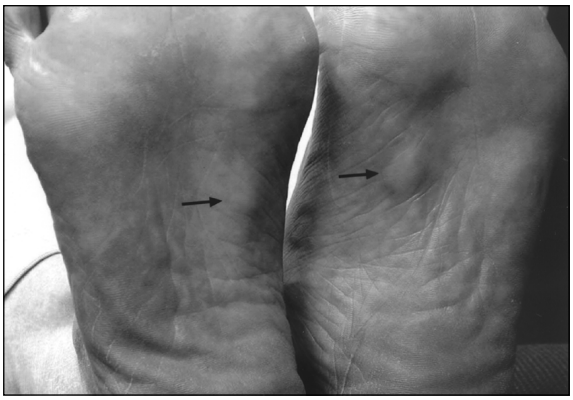

Fig. 2.—Photograph of feet of 52-year-old man with bilateral plantar fibromatosis shows two discrete nodules (*arrows*), one larger than other, at proximal forefoot of each sole.

Clinical Progress

Four (29%) of the 14 patients were treated with palpation-guided intralesional steroid injection. One of these patients remained asymptomatic for more than 1 year after the injection. The other three patients obtained symptomatic relief for only 2–6 months, but although the symptoms returned, there was continuing improvement. Follow-up sonography performed in two of the patients showed a decrease in size of the fibromatosis nodules (Fig. 10). All 10 (72%) of the 14 patients who were treated conservatively also experienced a reduction in symptoms to varying degrees. The palpable sole nodules persisted in all patients. No patient underwent surgery.

The final diagnosis was established by clinical and imaging findings, clinical follow-up, and follow-up by telephone conducted an average of 10 months after the patient's discharge from routine follow-up.

TABLE 1 Features of Plantar Fibromatosis Nodules in 14 Patients

Characteristics of Fibromatosis Nodules	Findings	
Distribution of Nodules	No.	%
Involvement (n = 14 patients)		
Unilateral	9	64
Bilateral	5	36
Multiplicity (n = 19 affected feet)		
Single site	14	74
Multiple sites	5	26
Location in sole of foot (n = 25 fibromatosis nodules)		
Medial	15	60
Central	10	40
Lateral	0	0
Sonographic Appearance of 25 Nodules	No.	%
Echogenicity (relative to echogenicity of plantar fascia)		
Hypoechoic	19	76
Isoechoic	6	24
Hyperechoic	0	0
Fascial margin		
Well-defined	16	64
Ill-defined	9	36
Nonfascial margin		
Well-defined	25	100
Ill-defined	0	0
Acoustic enhancement		
Present	7	20
Not present	18	80
Intrinsic vascularity		
Present	2	8
Not present	23	92
Nodule Dimensions	Average	Range
Length (mm)	12.9	4.0–17.0
Width (mm)	10.4	4.0–21.8
Depth (mm)	4.4	2.4–10.0

Discussion

The plantar fascia, or aponeurosis, is a thin band of fascia that extends from the inferior margin of the calcaneus to the plantar plates of the metatarsophalangeal joints and the bases of the proximal phalanges [5]. Plantar fibromatosis is a benign fibroblastic proliferative disorder of the plantar fascia that usually manifests as a firm subdermal mass [2]. Our study verifies the recognized clinical features of plantar fibromatosis. Most lesions are solitary and unilateral; however, multiple lesions and bilateral occurrence also are common. Typically, symptoms are present for several months, although some lesions are asymptomatic [2]. Plantar fibromatosis usually affects the central and medial portions of the plantar arch. Rare sites of occurrence not represented in this study group are the medial aspect of the calcaneum [6] or the fascial slips to the digits [7].

The cause of plantar fibromatosis is not known [2, 8]. A genetic predisposition and alteration in the collagen profile of the plantar fascia have been proposed as causative factors [2, 8]. The findings of our study and others indicate that trauma does not appear to have a predisposing role [2, 8]. An association is thought to exist between plantar fibromatosis and other fibroproliferative disorders, such as keloids, Peyronie's disease, and Dupuytren's disease of the palms and knuckle pads [2, 8, 9]. We found no such association among our patients, but the appearance of palmar fibromatosis may be delayed for 5–10 years after the occurrence of plantar fibromatosis [9]. Immunohistochemical and ultrastructural studies have shown similarities in the fibroblasts and myofibroblasts found in the soles and palms of patients with plantar fibromatosis and Dupuytren's disease, respectively [10]. These findings suggest that the two diseases are different expressions of the same disorder [10], although contracture is not usually a feature of plantar fibromatosis [11].

In our study, one quarter of the affected feet examined had abnormal thickening of the plantar fascia at the calcaneal insertion with no accompanying heel pain. An association between plantar fibromatosis and subclinical plantar fasciitis may exist, but an alternate and more likely explanation is that the plantar fascia insertion thickens in response to altered weight-bearing in patients with plantar fibromatosis. Gibbon and Long [5] showed that the plantar fascia insertion does significantly thicken in patients with coexistent but unrelated conditions of the foot and ankle, such as Achilles tendon disease, and they considered altered weight-bearing to be a likely cause.

In patients presenting with a plantar foot lump or pain, several possible diagnoses could be considered, but in most instances, the clinical features of plantar fibromatosis are characteristic enough to allow a firm diagnosis [2]. In our study, the final diagnosis was established via clinical and imaging findings and clinical follow-up. Imaging can confirm the diagnosis, exclude similar conditions affecting the sole, and delineate the extent of fibro-

matosis. The differential diagnosis includes several benign and malignant soft-tissue tumors [2], which can be separated into those arising from the plantar fascia (plantar fasciitis and chronic fascial rupture) and those arising from other nonfascial soft-tissue tumors of the foot (e.g., a ganglion, inclusion cyst, foreign body granuloma, nerve sheath tumor, or synovial sarcoma). In cases of plantar fibromatosis, sonographic visualization of continuity between the lesion and the plantar fascia is the single most useful sign in allowing one to confidently diagnose the lesion as being of fascial origin and thus to exclude the possibility of a neuroma or other extrafascial soft-tissue tumors.

The two main differential diagnoses of plantar fibromatosis are plantar fasciitis and a

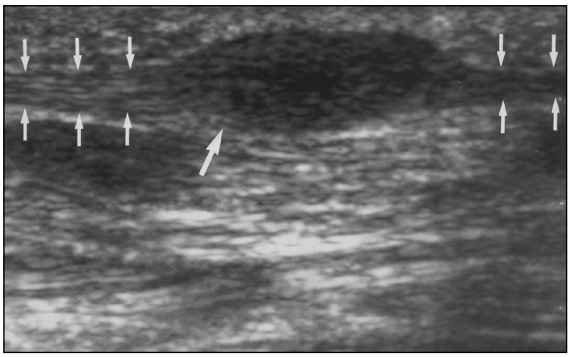

Fig. 3.—Longitudinal sonogram of midfoot of 32-year-old woman shows well-defined fusiform hypoechoic nodule (*large arrow*) arising within plantar fascia (*small arrows*). Lesion shows moderate acoustic enhancement.

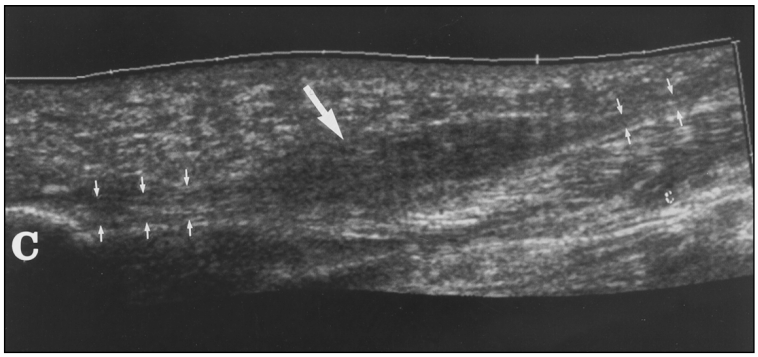

Fig. 4.—Longitudinal extended-field-of-view sonogram in 43-year-old woman reveals ill-defined fusiform hypoechoic fibromatosis nodule (*large arrow*) in midfoot, separate from unthickened calcaneal (C) insertion of plantar fascia. Small arrows indicate plantar fascia.

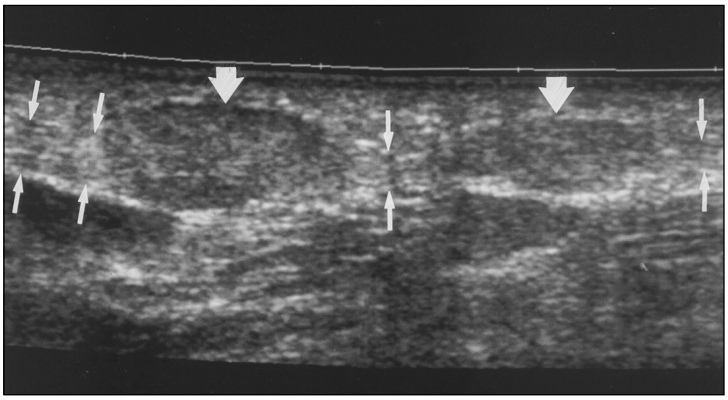

Fig. 5.—Longitudinal extended-field-of-view sonogram of sole of foot in 47-year-old man shows two discrete fibromatosis nodules located adjacent to each other. Both nodules (*thick arrows*) are slightly hypoechoic to plantar fascia (*thin arrows*). Larger of two nodules shows posterior enhancement, whereas smaller nodule does not.

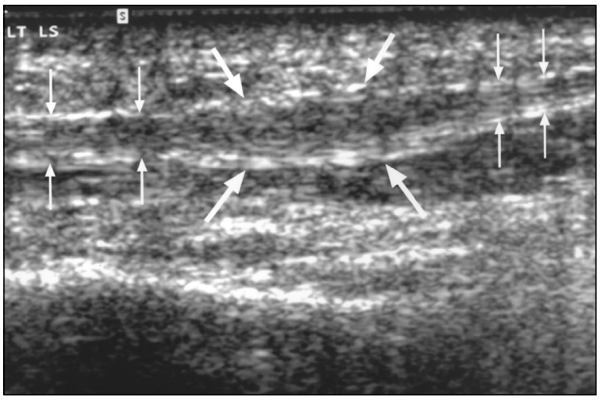

Fig. 6.—Longitudinal sonogram of sole of foot in 68-year-old woman reveals midfoot nodule (*large arrows*) isoechoic to plantar fascia (*small arrows*).

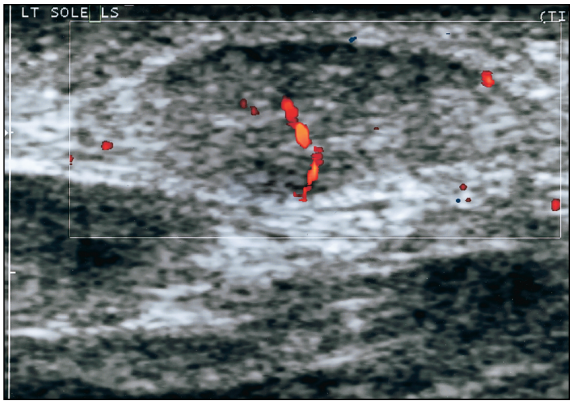

Fig. 7.— Longitudinal color Doppler sonogram of sole of foot in 49-year-old woman shows mild intrinsic vascularity of plantar fibromatosis nodule.

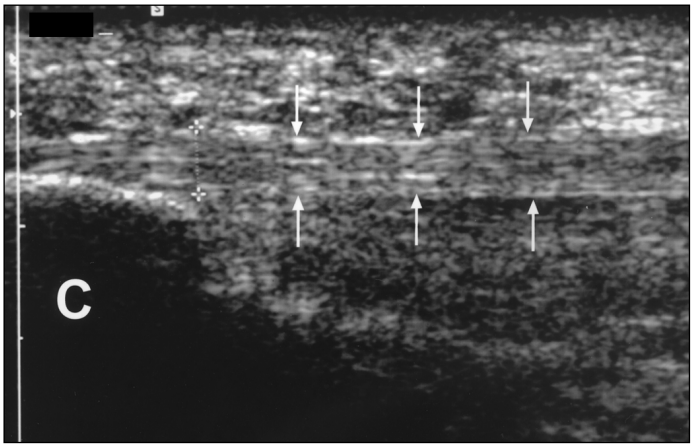

Fig. 8.—Longitudinal sonogram of sole of foot in 49-year-old woman shows normal insertion of plantar fascia (*arrows*) into calcaneus (C). At leading edge of calcaneus, plantar fascia measured 3 mm deep, which is normal thickness. Plantar fibromatosis nodule was more distal along plantar fascia.

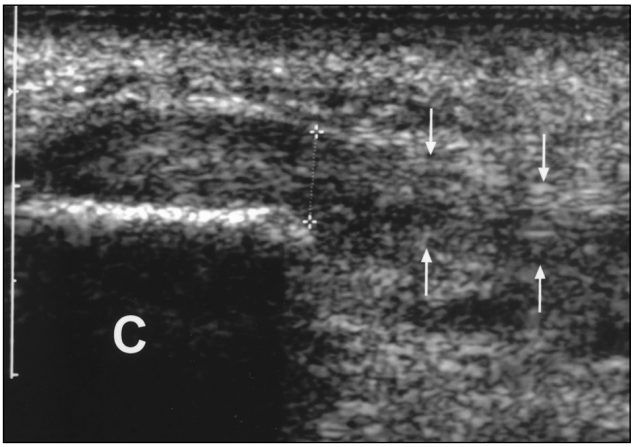

Fig. 9.—Longitudinal sonogram of sole of foot in 71-year-old woman reveals thickened insertion of plantar fascia (*arrows*) into calcaneus (C). At leading edge of calcaneus, plantar fascia was found to be abnormally thickened, measuring 4.8 mm in depth. Plantar fibromatosis nodule was more distal along plantar fascia. Identical appearances are found in patients with clinically manifest plantar fasciitis.

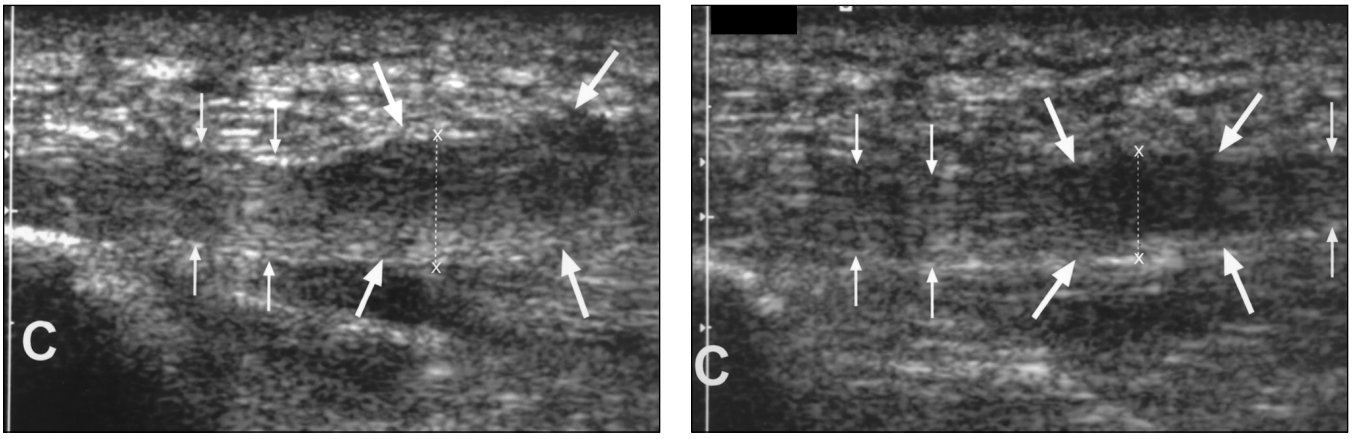

Fig. 10.—53-year-old woman with plantar fibromatosis treated by steroid injection.
A, Longitudinal sonogram of sole of foot displays localized nodular thickening (*large arrows*) of plantar fascia (*small arrows*) in midfoot region anterior to calcaneus (C). Thickness of nodule is 5.9 mm.
B, Follow-up sonogram obtained 17 months later (and 14 months after steroid injection) shows nodule to be smaller. Thickness of nodule measured 4.4 mm. Patient's symptoms had largely resolved. C = calcaneus.

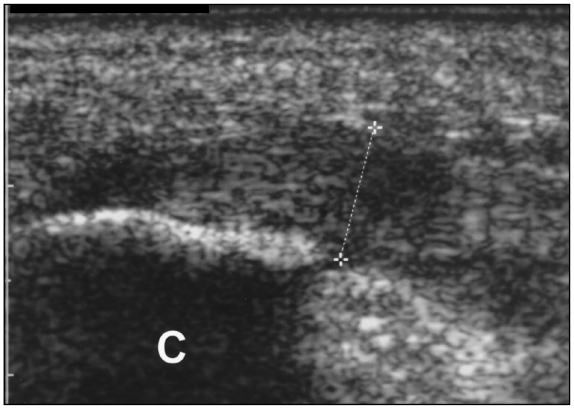

Fig. 11.—57-year-old women with chronic heel pain. Longitudinal sonogram of sole reveals thickened insertion of plantar fascia into calcaneus (C). Plantar fascia at leading edge of calcaneus was found to be abnormally thickened, measuring 7.3 mm deep. Appearances in this clinical context are consistent with plantar fasciitis. Remainder of plantar fascia was unremarkable.

chronic rupture of the plantar fascia. Plantar fasciitis is seen sonographically as a thickening and hypoechogenicity of the plantar fascia at or near the calcaneal insertion, especially medially, and is often associated with a calcaneal spur [5] (Fig. 11). In contrast, plantar fibromatosis occurs in the plantar fascia, separate from the calcaneum. Differentiation of plantar fibromatosis from a chronic partial rupture of the plantar fascia may be more difficult. Both may give rise to a fusiform plantar fascial mass separated from the calcaneal insertion [12]. Helpful distinguishing features of a chronic rupture are an absence of a history of acute or repetitive trauma and, on sonography, the absence of a visible tear or perifascial edema or fluid, none of which are sonographic features of plantar fibromatosis.

On MR imaging, plantar fibromatosis appears as a well-defined nodule that is contiguous with the plantar fascia and has low signal intensity on T1-weighted sequences and low to intermediate signal intensity on T2-weighted sequences [12]. MR imaging is excellent at showing the deep extension found in advanced, aggressive forms of plantar fibromatosis, but the availability and low cost of sonography make it the imaging technique of choice for most patients [3, 4].

Plantar fibromatosis is thought to have three distinct phases: a proliferative phase with nodular fibroblastic proliferation, an active phase with collagen synthesis and deposition, and a mature phase with reduced fibroblastic activity and collagen maturation [8, 10]. Because none of the patients in our study underwent surgery, no correlation between the sonographic features and the histologic features was possible. Although the lesions in this study varied in size, definition, and echogenicity, no relationship between any of these features and the chronicity of symptoms was found. The finding that some nodules are subclinical suggests that chronic symptoms may not necessarily correlate with histologic immaturity. Intrinsic vascularity was a feature of only two nodules in our study and did not prove useful in characterizing the maturity of the nodule. Symptoms improved over time in all patients, so a relationship between the sonographic appearances of plantar fibromatosis and subsequent clinical progress was not established.

As shown in our study, the natural history of plantar fibromatosis is that most nodules become less symptomatic over time. Most patients were treated conservatively. A steroid injection seemed to provide partial relief in patients who received this treatment. Surgery—local excision, wide local excision, or a complete plantar fasciectomy—may be indicated in a patient with nodules that become extremely painful or aggressive [11]. Surgery is associated with a high rate of recurrence, a feature possibly related to the relative abundance of type III collagen in the plantar fascia [2]. Recurrence is particularly common in nodules with infiltration into the skin or deep tissues. These particular features should be assessed on sonography.

In conclusion, the sonographic appearances of plantar fibromatosis vary but are still characteristic enough to allow a specific diagnosis to be made. No relationship among the sonographic appearances of the nodules, the duration of symptoms, or the clinical outcome was found.

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