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Ultrasound elastography in the early diagnosis of plantar fasciitis

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ABSTRACT

Background: The purpose of this study was to investigate whether ultrasound (US) elastography is useful for the early diagnosis of plantar fasciitis. **Material and methods:** We retrospectively reviewed US elastography findings of 18 feet with a clinical history and physical examination highly suggestive of plantar fasciitis but with normal findings on conventional US imaging as well as 18 asymptomatic feet. **Result:** Softening of the plantar fascia was significantly greater in the patient than in the control group [Reviewers 1 and 2: 89% (16/18) vs. 50% (9/18), $P = .027$, respectively]. **Conclusion:** US elastography is useful for the early diagnosis of plantar fasciitis.

1. Introduction

Plantar fasciitis is a frequent cause of nontraumatic heel pain, which can be reduced by treatments such as steroid injections [1,2]. The diagnostic criteria for plantar fasciitis include heel pain worsening at awakening in the morning or after a period of rest and tenderness at a medial tubercle of the calcaneus [3,4]. Although ultrasound (US) is not necessary for the diagnosis of plantar fasciitis, it may confirm a diagnosis or be utilized as imaging guidance for injection procedures. Typical US findings of plantar fasciitis include thickening of the plantar fascia, loss of normal striation, a hypoechoic area within the fascia, and perifascial fluid [4]. These morphologic changes, however, are not always observed on US in patients with plantar fasciitis [4,5]. US elastography was recently shown to be feasible in evaluating plantar fasciitis, showing softening of the plantar fascia in these patients [3]. In the cited study, most of patients showed abnormal findings consistent with plantar fasciitis on both B-mode imaging and elastography. To our knowledge, elastography has not been evaluated in patients with symptoms highly suggestive of plantar fasciitis but with normal findings on B-mode imaging. We therefore investigated whether US elastography can detect plantar fasciitis earlier than B-mode imaging.

2. Material and methods

2.1. Study population

The study was approved by our institutional review board and complied with Health Insurance Portability and Accountability Act guidelines. The board waived the requirement for informed consent for this retrospective study. Between May and December 2011, US examinations were performed on 64 symptomatic or asymptomatic feet. Longitudinal and short-axis B-mode imaging and longitudinal elastography imaging of both feet are included in the routine US protocol of our institute for patients with unilateral and bilateral heel pain. Forty-one feet satisfied the clinical diagnostic criteria of plantar fasciitis, including worsening of heel pain on awakening in the morning or after a period of rest and tenderness at a medial tubercle of the calcaneus. Twenty-one feet with findings of plantar fascia on B-mode imaging were excluded. Abnormal US findings included the presence of a hypoechoic area, loss of intrafascial striation, perifascial fluid, and plantar fascia thickness >4 mm [4]. Two feet were excluded due to posttreatment state. Finally, 18 feet of 13 patients, 5 with involvement of both feet, were included in the patient group. As controls, we analyzed 18 asymptomatic feet of 15 age- and sex-matched individuals; both feet were examined in 3 individuals. None of the subjects in either group had a history of inflammatory disease, connective tissue disease, or prior feet trauma. The subjects were divided into younger (18–50 years) and older (>50 years) groups [3].

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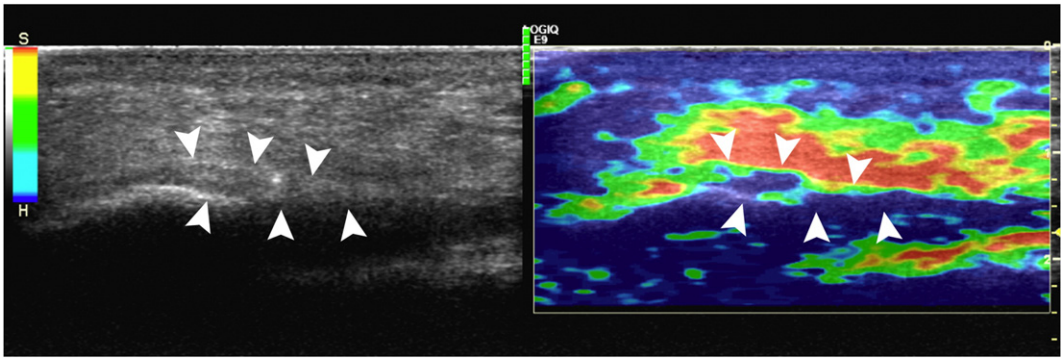

Fig. 1. A 30-year-old man in the control group. Longitudinal B-mode US image (left side of the figure) of his left heel, showing normal plantar fascia (arrowheads). US elastography (right side of the figure) obtained simultaneously showing a blue color on most areas of the plantar fascia (arrowheads), suggesting normal stiffness. Both reviewers interpreted these elastographic findings as normal.

2.2. US imaging

B-mode US imaging and US elastography were performed using the Logiq E9 US system (GE Ultrasound, Milwaukee, WI, USA) by two musculoskeletal radiologists (BLIND and BLIND) with 3 and 11 years of experience, respectively, in musculoskeletal imaging and more than 12 months of experience each in US elastography. Each subject was examined lying prone with 90° of knee flexion in the neutral ankle position. US elastography was performed by applying gentle compression with a linear array transducer (6–15 MHz, GE Ultrasound, Milwaukee, WI, USA), with the force applied to each lesion adjusted according to the quality factor bar and curve displayed on the screen. Elastography was displayed as a color-coded image within a rectangular region of interest (ROI), superimposed over the B-mode US image obtained simultaneously. The color represented the relative stiffness of the tissues within the ROI and ranged from red (soft) to blue (hard) in a continuous spectrum.

US images were evaluated retrospectively by the two radiologists, who were blinded to the findings of the other radiologist and to the clinical findings. In a longitudinal view, the thickness of the plantar fascia was measured from the anterior edge of the inferior calcaneal border vertically to the inferior border of the plantar fascia [3]. The stiffness of each plantar fascia was assessed as hard (blue area comprising >50% of the plantar fascia) or soft (blue area <50% of the plantar fascia) (Figs. 1 and 2).

2.3. Statistical analysis

Interobserver agreement in measurement of plantar fascial thickness and elastography findings was calculated using the kappa value and intraclass correlation coefficient (ICC). ICC values of <.40, .40–.75, and >.75 indicated *poor*, *fair to good*, and *excellent* agreement, respectively [6]. Kappa values were interpreted as indicating *poor* (0), *slight* (0.01–0.20), *fair* (0.21–0.40), *moderate* (0.41–0.60), *substantial* (0.61–0.80), or *almost perfect* (0.81–1.00) agreement [7]. All statistical analyses were performed using commercial software (SPSS, version 18, SPSS, Chicago, IL, USA). A P value of <.05 was regarded as statistically significant.

3. Results

There were 7 right and 11 left feet in the patient group and 9 right and 9 left feet in the control group. The mean age of patients (45±11 years) and controls (46±14 years) did not differ significantly. Mean duration of pain in the patient group was 3.9±2.1 months. On B-mode US examination, the thickness of the plantar fascia did not differ significantly in patient (Reviewers 1 and 2, 2.9±0.7 mm each) and control (Reviewer 1, 2.6±0.6 mm; Reviewer 2, 2.5±0.6 mm) feet (Table 1). However, on US elastography, softening of the plantar fascia differed significantly between the patient [Reviewers 1 and 2, 89% (16/18)] and control [Reviewers 1 and 2, 50% (9/18)] groups (P= .027). Interobserver agreement was excellent (ICC=.942) for measurements of thickness, and substantial (=.738) for elastographic findings (Table 2).

When we divided the all study subjects and controls into younger (age 18–50 years) and older (age >50 years) individuals, we found that 21 feet (10 right and 11 left feet) were in the younger group and 15 (6 right and 9 left feet) in the older group. The thickness of the plantar fascia was significantly greater in the older than in the younger group for Reviewers 1 (3.0±0.6 mm vs. 2.6±0.7 mm, P= .049) and 2 (2.5±0.7 mm vs. 3.0±0.6 mm, P= .046). In contrast, the softening of the plantar fascia did not differ significantly between

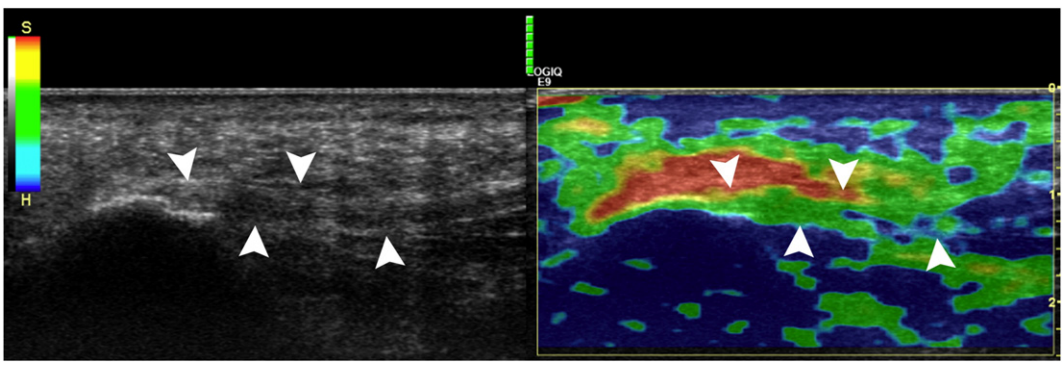

Fig. 2. Clinically suggested plantar fasciitis in a 50-year-old woman with left heel pain. This patient was presented with a 6-month history of tenderness at the medial aspect of the calcaneus and pain while resting and was clinically diagnosed with plantar fasciitis. Longitudinal B-mode US image (left side of the figure) of her left heel, showing a normal plantar fascia (arrowheads). US elastography (right side of the figure) of her left heel showing a green color on most areas of the plantar fascia (arrowheads). Both reviewers interpreted these elastographic findings as indicating softening of the plantar fascia.