European Journal of Radiology 84 (2015) 458–462

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Ultrasonography as a prognostic and objective parameter in Achilles tendinopathy: A prospective observational study

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ARTICLE INFO

Article history:
Received 22 March 2014
Received in revised form 30 July 2014
Accepted 23 November 2014

Keywords:
Ultrasonography
Achilles tendinopathy
Prognostic markers
Cause of pain

ABSTRACT

Objectives: To study prospectively whether structural changes determined by ultrasound scanning (US) can be used as prognostic markers for outcome in patients with symptomatic Achilles tendinopathy (AT) and to investigate whether there exists an association between US findings and pain measured by visual analog scale (VAS) and a general assessment score (GA).
Methods: 92 consecutive patients with AT symptoms were recruited from two outpatient clinics in rheumatology. The patients underwent a conservative treatment protocol consisting of reduced activities, controlled rehabilitation including eccentric exercises of the calf muscles and if needed supplemented with corticosteroid injections. The patients were examined clinically and by US (tendon thickness, hyper- and hypoechogenicity, calcification, bursitis, calcaneusspure, tenosynovitis, gray scale and color Doppler focusing on increased flow intra- or peritendinous). The clinical and US examination were performed at entry, 1, 2, 3 and at 6 month.
Results: 42 women and 50 men were included (mean age of 47 years). They had symptoms for more than 13 months and a symptomatic Achilles tendon mean thickness of 7.4 ± 2.3 mm. Heterogeneity at the initial examination was found to be a prognostic marker for the clinical outcome. Tendon thickness, hypoechogenicity and increased flow at any time point were significantly correlated to pain at function, palpatory pain and morning pain at the same time points. A reduction in tendon thickness was statistically associated with a decrease in palpatory pain.
Conclusion: Heterogeneity is a prognostic marker in AT. Tendon thickness, hypoechogenicity and increased Doppler activity can be used as objective outcome parameters for the treatment effect of AT.

1. Introduction

Achilles tendinopathy (AT) is a very common injury in sports and a difficult condition to treat [1,2]. The exact mechanisms behind AT and the source of pain has not yet been clarified [3]. At the moment there is no consensus on the treatment regime. Eccentric exercises have proven effect on AT [4,5] as well as stretching exercises [6,7]. In these efficacy training studies on motivated patients 60–90% are cured, and we cannot expect as high cure rate in the daily clinic, in fact one clinical effectiveness study found only 10% cure rate from a home exercise program consisting of eccentric exercises [8]. Glucocorticosteroid (GCS) injection is also found to have a good short term effect on chronic AT [9], but we have found no studies that combine exercises and GCS injections. Ultrasonography (US) is increasingly used in the diagnosis of soft tissue diseases such as tendinopathy. However there is no consensus on what is defined as normal, abnormal or a pathological US. In a study by Fredberg and Bolvig on high level soccer players, asymptomatic Achilles tendons were investigated [9]. They found US changes (tendon thickness >7 mm) in 11% of the asymptomatic Achilles tendons and demonstrated that the risk of developing symptoms within 1 year was very high in the group of players with increased

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http://dx.doi.org/10.1016/j.ejrad.2014.11.028
0720-048X/

thickness on US (45%) when continuing playing soccer. This means that increased thickness probably is a precursor for developing AT. It has been suggested, that increased tendon thickness and the presence of Doppler signals are correlated with the level of discomfort and dysfunction and that reduction in symptoms is accompanied with a decrease in US changes [10]. On the other hand neovascularisation is also found in asymptomatic tendons [11]. In the present study we evaluated whether different US changes can be prognostic markers for patients with symptomatic Achilles tendinopathy undergoing a conservative treatment protocol. The hypothesis was that increased tendon thickness, increased peri- and intratendinous flow and heterogeneity (hypo-, hyperechogenicity and calcifications) at the initial examination were associated with a poor outcome at follow-up 6 months later measured by visual analog scale (VAS) and a general assessment score (GA). Furthermore we investigated whether a correlation between symptoms (VAS and GA) and US findings can be determined pointing towards objective signs of AT severity and AT improvement.

2. Materials and methods

Over an 8 month period 113 consecutive patients (52 women and 61 men) with AT from two outpatient clinics in rheumatology in Denmark were recruited for this prospective study. AT was defined as tenderness at palpation of the tendon, tenosynovium or tendon insertion impairing the daily activities of the patient. A total of 21 (18.6%) patients were excluded; 2 patients were diagnosed with a rupture of the Achilles tendon and in 5 patients erosions were found. 14 patients were excluded due to missing follow up data. There were no significant differences between the patients that completed the study and the patients that dropped out with regard to age, sex, tendon thickness, morning pain, intra or peritendinous flow, pain at function or palpatory pain. All patients were treated with the same treatment regime: Reduction in impact activities (ex running and jumping), controlled training with concentric/eccentric exercises and stretching, and if these exercises were impossible due to pain or did not lead to improvement, the treatment was supplemented with 1, up to maximum 3, GCS injections. 26% succeeded with training alone, 58% had one GCS injection, 14% had 2 injections and 2% had 3 injections. The clinical results of this treatment regime are presented in another study (E. Wetke submitted).

2.1. Clinical examination

The patients' symptoms were followed over 6 months, with a total of 5 visits (entry, 1, 2, 3 and 6 months). The patients were evaluated clinically and with US at each visit. Pain was measured on a 100 mm VAS. Symptoms were evaluated as pain at function consisting of 20 times one foot heel raises (VAS function), palpatory pain by pinging the tendon gently between two fingers (VAS palpation) and morning pain (VAS morning). General assessment was evaluated as relative to symptoms at the first consultation on the following scale: 0 = no more symptoms, 1 = much better, 2 = slightly better, 3 = no changes, 4 = slightly worse, 5 = much worse. Ultrasound scanning (US) was performed at all visits before exercises by one of the investigators, who were experienced in US (Siemens G-50 with a linear transducer VF 13–5 (5–13 Hz)). US was performed with the patient prone with the feet hanging free over the edge of the bench and tendon relaxed. The tendon was scanned longitudinally and transversally. The tendon maximal thickness was measured. The two investigators had beforehand agreed upon how to evaluate tenosynovitis on gray scale (thickening of hyper/hypo echoic paratenon with poorly defined boarders), tendinosis (hyper/hypoechoic areas within the tendon), bursitis (clearly visible bursa over 2 mm in size), insertional tendinopati (echo changes at the insertion and 5 mm above), calcifications within the tendon (hyperechogenicity with echo shadow underneath), calcaneal spur (an elevation of the calcaneal compacta as a spur at the distal insertion of the tendon). Color-Doppler was used to measure the presence of flow within the tendon or peritendon. We used the factory setting with pulse repetition frequency on 780 Hz. At an asymptomatic area of the gastrocnemius part of the tendon the Doppler was calibrated to zero-pixels. Peritendinous flow and intratendinous flow was registered as clearly visible color-Doppler signal just as visible arteries with pulsation within the paratenon and tendon were registered. Tenosynovitis could therefore be diagnosed as either on gray scale and/or with color Doppler.

2.2. Data analysis

Statistical analyses were performed using STATA version 13.1. Statistical significance was set at $p < 0.05$. Completed patients and dropouts were compared according to central baseline measurements using Fischer exact tests for dichotomous variables, *t*-test for continuous variables, and Wilcoxon rank-sum test for ordinal data. Descriptive statistics (means and standard deviations as relative frequencies (%)) were obtained on completed patients.

Association between tendon thickness, increased peri- and intratendinous flow and heterogeneity at the initial examination and outcome (measured by VAS) at 6 months follow up were tested using Wilcoxon rank-sum test for dichotomous variables and by correlation for continuous variables. Association between decrease in tendon thickness and decrease in VAS measures between baseline and 6 months follow-up were analysed by linear regression.

Due to non normally distributed data, the VAS scores were divided into 4 clinically meaningful categories, VAS 0 = no more pain, VAS 1–25 = low pain, VAS 26–50 = acceptable pain during rehabilitation, VAS 51–100 = unacceptable pain. Univariate ordinal logistic regression was used to assess associations between US findings and pain measured by visual analog scale (VAS) and a general assessment score (GA). The analyses were run for the total number of observations ($n = 460$). To correct inference for the dependence among observations from a single subject, the analyses were performed as a cluster analysis. Hence, each patient was treated as a cluster. The Brandt test [12] was used to test the proportional odds constraint that the regression coefficients for the comparison of the 4 VAS categories were similar. If this test was statistically significant at the 5% level, a generalized ordered logistic regression [13] was estimated instead. This output is a series of binary logistic regressions. First, it is category 1 vs. categories 2, 3, and 4; then categories 1 and 2 vs. 3 and 4; and then categories 1, 2, and 3 vs. 4.

3. Results

92 patients completed the study, 42 women and 50 men with a mean age of 46.9 (SD 15.7) years, symptoms for 13.2 (SD 15.5) months and a symptomatic and asymptomatic Achilles tendon mean maximal thickness of 7.4 (SD 2.3)mm and 5.5 mm (SD 1.1), respectively. The US findings at entry are shown in Table 1. Eight (9%) symptomatic tendons were found with no US changes and 23 (30.7%) asymptomatic tendons were found with US abnormalities. Patients with or without heterogeneity at entry were compared with regard to results at 6 month follow up. We found significant differences in VAS palpation ($p = 0.04$) and borderline significance