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Original Article

Ultrasonographic evaluation at 6-month follow-up of plantar fasciitis after extracorporeal shock wave therapy

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Abstract *Introduction* The aim of this study was to investigate the effect of extracorporeal shock wave therapy (ESWT) on the ultrasonographic appearance of chronically painful, proximal plantar fasciitis.

Materials and methods Twenty-two patients with a unilateral proximal plantar fasciitis were prospectively enrolled after unsuccessful conservative treatment lasting 6 months. The contralateral plantar fascia was used as the control. ESWT (3×3000 shock waves/session of 0.2 mJ/mm^2) was performed at weekly intervals. The thickness of the plantar fascia was measured ultrasonographically about 2 cm distal of the medial calcaneal tuberosity. Pain estimation on a visual analogue scale (VAS) and the comfortable walking time were recorded. No local anaesthesia was applied. Follow-up was done at 6, 12 and 24 weeks.

Results Before ESWT, the plantar fasciitis side was ultrasonographically significantly thicker than the control side ($p<0.05$), whereas 6 months after ESWT, the thickness of the fascia was no longer significantly different. The decrease in thickness of the plantar fasciitis side was significant ($p<0.05$). Pain during activities of daily living decreased by 79% according to the VAS, and the

comfortable walking time increased, both significantly ($p<0.01$). In patients with little pain (VAS<30), the thickness of the plantar fasciitis side was significantly less ($p<0.01$) compared with patients who still suffered more pain (VAS>30).

Conclusion After ESWT, the thickness of the plantar fascia in patients with plantar fasciitis decreased, pain and walking time improved (all significantly).

Keywords Plantar fasciitis · Extracorporeal shock wave therapy · Ultrasonography

Introduction

Plantar fasciitis is a common clinical problem. Patients present with pain on the plantar side of the foot, often near the medial side of the calcaneal tuberosity. The exact aetiology is unknown. Association with obesity, middle age, pes planus, pes cavus or tight Achilles tendon has been described. A heel spur is not considered pathognomonic of the disorder, although it is often detected [8, 20, 21].

Apart from the clinical examination, ultrasonographic evaluation and magnetic resonance imaging (MRI) can provide further information to confirm the diagnosis of plantar fasciitis. MRI studies found a significantly increased plantar fascia thickness in patients with plantar fasciitis (mean 6.7 and 7.4 mm) compared with a healthy control group (mean 3.2 and 3.3 mm) [2, 31]. Ultrasonographic studies presented similar significant differences, with a mean thickness of the plantar fasciitis side ranging between 5.2 and 5.7 mm, and a mean thickness of an asymptomatic plantar fascia between 2.6 and 3.8 mm [5, 13, 34, 35].

The therapy of choice is conservative. It is effective in approximately 90% of patients [8]. Non-steroidal anti-inflammatory drugs, local steroid injections, heel cups, orthotics and/or shoe modifications, electrotherapy and physiotherapy with stretching exercises are used [7, 17, 30, 37]. In the remaining 10% of patients, surgical intervention is recommended [6, 28].

The use of extracorporeal shock wave therapy (ESWT) as a further non-surgical method in orthopaedics and traumatology began more than 10 years ago. Since then, ESWT has been used to treat various insertional tendopathies and delayed unions and non-unions of fractures [9, 10, 14, 15, 16, 22, 23, 24, 25, 26, 27, 29].

The aim of this study was to investigate the effect of ESWT on the ultrasonographic appearance of chronically painful, proximal plantar fasciitis.

Patients and methods

Between January 1999 and August 1999, 22 patients with an unilateral proximal plantar fasciitis were prospectively enrolled in a clinical study after unsuccessful conservative treatment lasting at least 6 months. The contralateral plantar fascia was used as the control.

Previously applied treatment consisted of non-steroidal anti-inflammatory drugs (NSAIDs), local steroid injections, heel cups or orthotics, and electrotherapy (iontophoresis with diclofenac). A heel spur was present in all patients on the symptomatic side. Exclusion criteria were neurological disorders, local infections, local tumours, coagulation disorders and pregnancy.

After enrollment, treatment of the unilateral plantar fasciitis consisted of three sessions of ESWT (3000 shock waves/session of 0.2 mJ/mm^2) at weekly intervals. No local anaesthesia was applied. The ESWT was performed with the Piezoson 300 (Richard Wolf, Knittlingen, Germany), a piezo-electric system with inline ultrasound detection (Fig. 1).

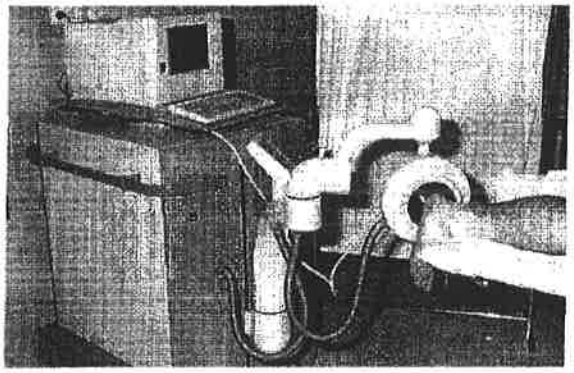

Fig. 1. Position of the patient for extracorporeal shock wave therapy (ESWT) at the medial aspect of the calcaneal tuberosity with the application tube in place

At the 12-week follow-up 2 patients were lost, and another 4 patients at the 24-week follow-up. At the time of enrollment, the group consisted of 5 men and 17 women, with an average age of 51.6 years (range 24–79 years). The duration of symptoms was 8.8 months (range 6–12 months), the length of the spur (symptomatic side) on a lateral X-ray measured 3.4 mm (range 1–11 mm). The body mass index averaged 30.2 kg/m^2 (range 22–36.5 kg/m^2), and the European shoe size was 40.4 (range 36–45).

A clinical investigation including ultrasonography was carried out before ESWT and at follow-up appointments (6, 12, 24 weeks after completion of ESWT). The thickness of the plantar fascia was measured about 2 cm distal of the medial calcaneal tuberosity (Fig. 2). Pain estimation on a

visual analogue scale (VAS) [12] ranging from no pain (0) to maximal pain (100) regarding different situations (rest, activities of daily living and one-leg stance) was assessed, and the comfortable walking time recorded. Statistical analysis was done with the non-parametrical Wilcoxon test for paired samples and the non-parametrical U-test (Mann-Whitney) for unpaired samples.

Fig. 2. Ultrasonographic longitudinal appearance (linear scanner) of the plantar fascia. Asymptomatic left side with 4.2 mm thickness (+) and symptomatic right side with 5.3 mm thickness (x)

Results

Before ESWT, the mean thickness of the plantar fascia was significantly ($p<0.05$; U-test) greater on the symptomatic side (5.2±1.5 mm) than on the asymptomatic (control) side (4.3±1.1 mm). With the numbers available, we found no significant differences in the thickness of the plantar fascia between the symptomatic and the control side at the 6, 12 and 24 week follow-ups. Six months after ESWT, the decrease in thickness of the plantar fasciitis (5.2±1.5 to 4.4±1.0 mm) was significant ($p<0.05$; Wilcoxon test). With the numbers available, we detected no significant change of thickness on the control side (Table 1).

[Table 1. will appear here. See end of document.]

Six months after ESWT, pain estimation by the patients on the VAS had improved significantly ($p<0.01$; Wilcoxon test) in all test situations. At rest the pain declined by 82%. During activities of daily living and during single-leg stance, the pain decreased by 79%. The comfortable walking time increased significantly ($p<0.01$; Wilcoxon test) 6 months after ESWT (Table 2).

[Table 2. will appear here. See end of document.]

Those patients with little pain (VAS<30; n=13) during everyday life 6 months after ESWT showed significantly (p<0.01; U-test) thinner plantar fascias on the symptomatic side compared with patients with more pain persisting (n=3) (4.1±0.6 to 5.8±1.1 mm).

With the numbers available, no influence of the length of spur, body mass index or shoe size on the thickness of the plantar fascia could be detected, both on the symptomatic and asymptomatic side.

Discussion

Several authors discussed the appearance of plantar fasciitis as investigated with ultrasonography or MRI [2, 5, 13, 31, 34, 35]. In all of these studies, the thickness of the plantar fascia was significantly greater on the symptomatic side compared with the asymptomatic side. Taking the standard deviations into account, our results matched the results found in the literature.

To our knowledge, the ultrasonographic appearance of the plantar fascia after ESWT has not yet been described. We found a significant decrease in the thickness of symptomatic plantar fascias after ESWT. Kane et al. [13] described the same finding in symptomatic plantar fascias following a corticoid injection. The thickness of the plantar fascia seems to be related to the response to treatment.

This could be underlined by our finding regarding the pain estimation after ESWT. Pain during activities of daily living decreased by 79% on the VAS, and the comfortable walking time increased, both significantly. Moreover, those patients with little pain (VAS<30) 6 months after ESWT showed significantly thinner plantar fascias on the symptomatic side than those patients with more pain persisting.

In the literature, success rates regarding the pain estimation after ESWT in patients with plantar fasciitis varied from 70% after 5 months in the study of Hammer et al. [9] to 48% described by Rompe et al. [25] and 83% by Hammer et al. [10] after 6 months. Success rates of 58% after 12 months [15] and 77.4% after 24 months [24] have been reported. Our result of pain reduction corresponded with that in earlier studies.

However, apart from other positive results of ESWT for plantar fasciitis [1, 3, 19, 27, 32, 36], in the recent literature there are studies that quoted limited or no use of ESWT. Buchbinder et al. [4] detected no significant effect against placebo after 6 and 12 weeks. Melegati et al.[18] reported a negative effect of previous steroid injections on the result of ESWT. Helbig et al. [11] stated

that results after ESWT of patients with plantar fasciitis were better if the symptoms were more chronic. To compare all these results, a meta-analysis is necessary due to different study protocols.

With the numbers available, we could not detect any influence of different morphological factors such as the length of a heel spur, body mass index or shoe size on the thickness of the plantar fascia or the outcome after ESWT treatment.

The definite mechanism of ESWT remains unclear. The concept of shock waves in orthopaedic disorders is that they stimulate or reactivate healing processes in tendons, surrounding tissue and bone probably through microdisruption of avascular or minimally vascular tissues to encourage revascularisation, release of local growth factors, and the recruitment of appropriate stem cells conducive to more normal tissue healing [33].

In summary, we found the chronically painful, proximal plantar fascia to be ultrasonographically thicker than the pain-free control side. After ESWT, the decrease in thickness of the symptomatic plantar fascia as well as the improvement of pain and walking time were significant. Six months after ESWT, patients with little pain (VAS<30) had significantly thinner plantar fascias than patients with more pain persisting. The thickness of the plantar fascia seems to be related to the response to treatment.

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Table 1. Thickness of the plantar fascia (ultrasonographic measurement) on the symptomatic and asymptomatic side before and after extracorporeal shock wave therapy (ESWT)

	t=0	*t*=6 weeks	*t*=12 weeks	*t*=24 weeks
	n=22	*n*=22	*n*=20	*n*=16
Plantar, fasciitis±SD (mm)	5.2±1.5	4.5±1.4	4.7±1.4	4.4±1.0
Pain-free, control±SD, side (mm)	4.3±1.1	4.2±1.2	4.5±1.5	4.0±0.7

Table 2. Pain on the visual analogue scale (VAS) and comfortable walking time (h) before and after ESWT

		t=0	*t*=6 weeks	*t*=12 weeks	*t*=24 weeks
		n=22	*n*=22	*n*=20	*n*=16
VAS±SD	Rest	42.5±27.3	34.6±34.7	7.5±20.0	7.5±18.8
	Daily activities	78.2±18.0	30.0±35.8	25.5±31.1	16.3±30.9
	Single-leg stance	79.6±17.0	34.8±36.0	28.5±36.2	16.6±30.9
Walking time±SD (h)		0.1±0.3	6.7±7.9	7.5±7.9	9.8±7.5