

Original Article

Plantar fasciitis treated with endoscopic partial plantar fasciotomy—One-year clinical and ultrasonographic follow-up

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ABSTRACT

Background: Endoscopic operations for plantar fasciitis generally have good clinical outcome. The aim of this study was to record the effect of endoscopic partial fasciotomy and heel spur removal and evaluate by ultrasonography whether the fascia regenerates and the heel spur reforms.

Methods: Eleven consecutive patients were evaluated before and 3, 6 and 12 months after surgery. Operations were performed endoscopically using a deep fascial approach with a medial and a lateral portal. Bony spurs were removed and the medial half of the plantar fascia was transected. All patients followed a standardized rehabilitation program.

Results: Median Foot Function Index values decreased from 119 pre-surgery to 69 and 12 ($p = 0.004$), at 3 months and 1 year post-operatively respectively. Median VAS-score for first step pain was likewise reduced from median 71 mm to 29 mm and 7 mm ($p = 0.004$), respectively. Median fascial thickness at the medial insertion was 6.0 mm (range 4.6–6.8 mm) pre-operatively. A heel spur was present in 9 cases. One year postoperatively a well-defined fascia in the area of resection was demonstrated in 8 cases. In the rest of the cases scar tissue made it impossible to clearly outline the fascia. Nine of the feet showed good medial fascial tensioning. There was no evidence of recurrence of the bony spur.

Conclusions: Endoscopic partial plantar fascia resection reduced pain symptoms and increased function significantly 3 months after operation, with additional effect achieved 12 months after surgery. Based on ultrasonography the resected fascia regenerated/healed, and a calcaneal spur did not recur.

1. Introduction

Plantar fasciitis (PF) is a frequent condition defined as pain at the medial tubercle of the calcaneus. Ten percent of the population will experience this condition in a life-time [1,2].

Operative treatment is an option in PF refractory to non-surgical treatment. The technique of endoscopic plantar fascia division was reported in 1993 with good clinical effect on 63 patients with plantar fasciitis [3]. Compared to open surgery the endoscopic operations lead to quicker improvement and higher patient satisfaction [4] as well as quicker return-to-work [5,6].

With the original endoscopic technique, the scope and instruments were introduced through low lateral and medial portals to avoid damaging the lateral plantar nerve [7–9]. The scope and instruments were working on the plantar side of the fascia. To be able to visualize and

resect the heel spur, a two-portal technique with positioning of the scope and instruments deep to the fascia and slightly anterior to the attachment of the fascia on the calcaneus was introduced [10,11].

The idea of resecting the medial part of the plantar fascia as treatment for plantar fasciitis is empirical, and it is still undetermined whether the fascia defect heals and the fascia regenerates after the procedure.

The aim of this study was to evaluate the short- and intermediate-term effect of a deep endoscopic 2-incision technique for partial fasciotomy and heel spur removal and evaluate by ultrasonography (US) if the fascia regenerates and the heel spur recurs.

2. Materials and methods

In a prospective cohort study 11 consecutive patients scheduled for

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partial plantar fasciotomy due to unilateral chronic plantar fasciitis at our department in 2015 were followed 3, 6 and 12 months' post-operatively. Patients were referred to the department from general practitioners. Prior to the study they had all gone through a supervised physiotherapeutic rehabilitation program comparable to the post-operative protocol in this study, and many had tried several other non-operative treatment modalities without effect. The duration of symptoms had been at least 6 months. Upon entering the study, they signed informed consent.

The patients were primarily evaluated by rheumatologists at our department. The diagnosis "plantar fasciitis" was based on (1) the subjective information of: pain at the anterior aspect of the heel pad with the first step in the morning, and in connection with physical activity; (2) the objective findings of an intact plantar fascia with maximal tenderness at the medial insertion point of the plantar fascia to the calcaneus; and (3) ultrasound verified hypoechoic changes at the insertion point of the fascia and a thickness of the fascia at this point of more than 4 mm, or 20% thicker than the contralateral side.

Ultrasonography (US) was performed by the same rheumatologist (FJ) using a Hi Vision Avius® ultrasound machine (Hitachi Medical Systems, UK) with an 18–5 MHz linear array transducer. An US technique which has been demonstrated reliable for examining the plantar fascia, the plantar fat pad and the Achilles tendon was used [12]. All feet were examined for hypo- and hyperechoic changes within the fascia, and the thickness of the central band of the plantar fascia was measured. To ensure that the central band was measured, the fascia was identified from the forefoot to the insertion on the calcaneus (Fig. 1). The Achilles tendon, the plantar fat pad, the subcalcaneal bursa, the long flexor tendons and the ankle joint were examined for concomitant pathology [12].

The study was approved by the Regional Ethical Committee (H-2-2012-151).

2.1. Surgical technique

The operation was performed endoscopically, using a deep fascial approach as described by Komatsu et al. [11]: general or regional anesthesia was used. The patient was in the supine position with the foot and ankle free of the end of the operating table. An image intensifier was used to identify the position of the medial portal in the angle between the plantar fascia and the calcaneus or the bony spur and the calcaneus. After skin incision, a blunt dissection was performed on the deep medial part of the fascia. The deep lateral portal was established inside out and using a switching stick. Working space was established using a shaver (Fig. 2), and after exposing the fascia fibrous or inflamed tissue was resected, leaving macroscopically normal tendon tissue. When a bony spur was present it was resected using a small burr. With the fascial attachment to the calcaneus exposed, the width of the fascia was determined. At the calcaneal insertion, the medial half of the plantar fascia was excised in full thickness in a ½ cm wide band using an arthroscopic punch (Fig. 3). Portals were closed with nylon sutures.

2.2. Rehabilitation

All patients were seen by a physiotherapist approximately 1 week after surgery and instructed to walk with a normal gait-pattern without crutches. Patients were instructed to use well-padded shoes and insoles (standard orthoses) with shock absorption.

Four times during the first 2 months supervised training was carried out. Training consisted of manual stretching of the plantar fascia [13], short-foot exercises, inversion of the foot against resistance, flexion of the first toe against resistance, and stretching the calf and the plantar fascia with bend knees standing with toe balls against a wall. Five weeks post-operatively heel raise standing on the forefoot on a staircase was commenced. Strength training was performed 3 times/week with at least 1 day of rest between each training session, and the stretching

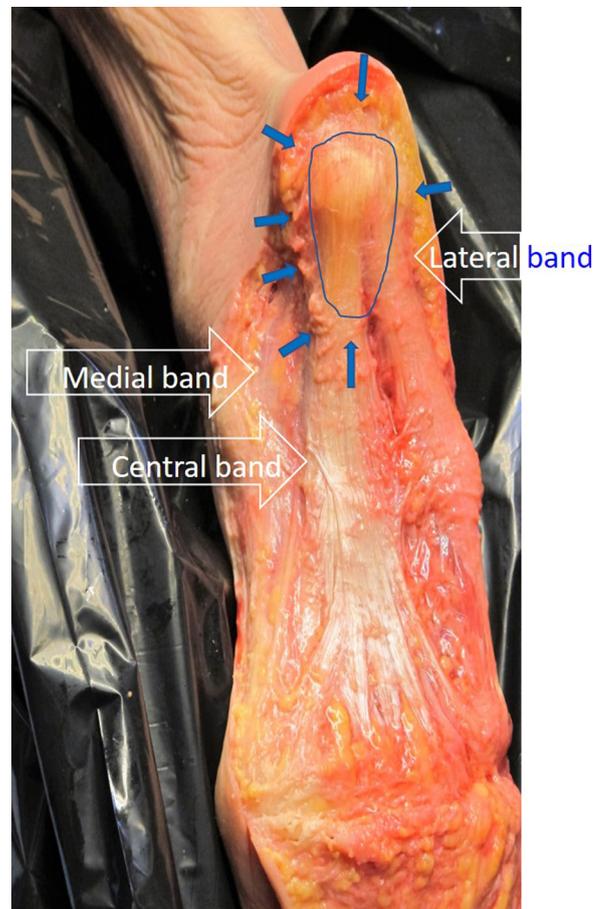


Fig. 1. Anatomy of the normal plantar fascia in an anatomical specimen. Blue circle: subcalcaneal bursa. Closed arrows: fibrous septae to the fat pad. Open arrows: thin medial band, thick central and lateral band. The dissection was conducted on a deceased adult who, under Danish legislation (Health Law no. 546, § 188), had bequeathed her body to science and education at the Department of Cellular and Molecular Medicine at the University of Copenhagen. The dissection was approved by the head of the Body Donation Program at the Department of Cellular and Molecular Medicine. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

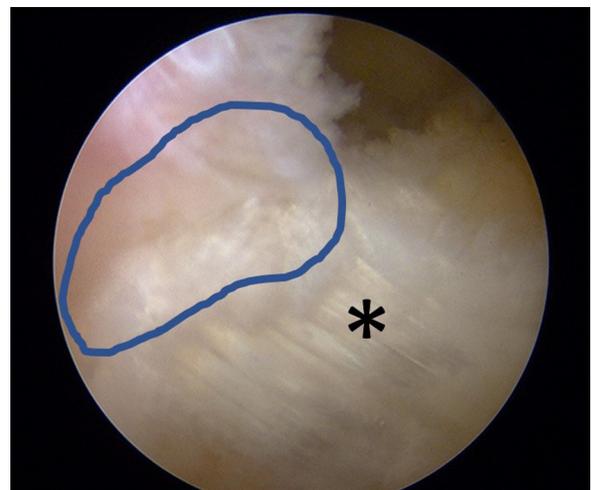


Fig. 2. Intraoperative photo: plantar fascia (*) and heel spur (blue area). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)



Fig. 3. Intraoperative photo: bony spur plus medial part of the central band of the plantar fascia resected.

exercises were done daily. All concentric and eccentric strength exercises were performed slowly (3–4 s in each direction) and progressed by adjusting the elastic bands used for the exercises. The heel raises were progressed by slowly applying more weight on the affected foot, and ultimately doing the exercise unilaterally.

2.3. Evaluation

The patients were evaluated before surgery and 3, 6, and 12 months after surgery by a rheumatologist who was not involved in the operations or the rehabilitation.

The primary outcome was patient assessment using the Foot Function Index (FFI). The FFI is a self-report questionnaire consisting of 23 items in three domains: foot pain (9 items), function (9 items) and disability (5 items). The total score ranges 0–230 points, and it has been validated for plantar fasciitis with a minimal clinical important difference of 7 points [14].

Secondary outcomes were VAS-score for the first steps out of bed in the morning, and VAS-score for average pain during everyday living. According to Landorf et al. [15] a change of 9 mm in pain score is clinically relevant for patients with plantar fasciitis.

Patients were asked, if they would opt for the same operation again and/or recommend the operation to other patients based on their own experience.

US was performed preoperatively for measurement of plantar fascia thickness and the presence of a heel spur and 1 year postoperatively for the visualization of plantar fascia healing and potential heel spur recurrence.

2.4. Statistics

Due to the small number of patients, results were presented and compared using non-parametrical statistics. Wilcoxon's test was used to compare VAS and FFI data.

3. Results

The median patient age was 50 years (range 25–57). There were 5 women and 6 men. Median BMI of 29 (range 21–35).

Symptoms had been present for median 24 months (range 6–60) before operation.

Foot Function Index (FFI) values decreased from median 119 preoperatively to median 69 three months post-operatively ($p = 0.03$), and median 12 one year post-operatively ($p = 0.004$) (Fig. 4). Reduction in FFI for each of the three domains is shown in Fig. 5.

The median VAS-score for pain when taking the first steps in the

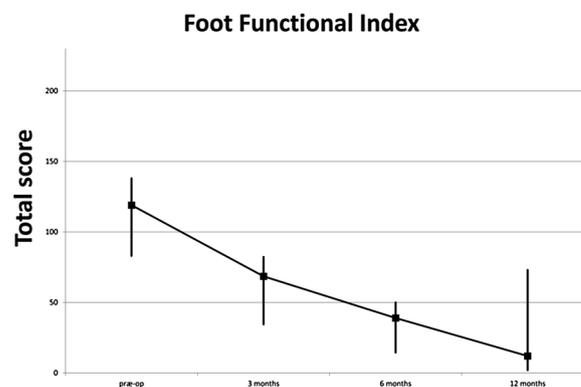


Fig. 4. Foot Functional Index (FFI). Maximal possible disability score 230. Median and quartiles are reported. Statistically significant reduction from preoperatively to 3 months post-operatively: $p = 0.03$, and from preoperatively to 1 year postoperatively: $p = 0.004$.

morning was reduced from 71 mm pre-operatively to 29 mm three months post-operatively ($p = 0.003$), and 7 mm one year post-operatively ($p = 0.004$) (Fig. 6).

Median VAS-score for pain during activity fell from 56 mm preoperatively to 34 mm three months post-operatively ($p < 0.001$), and 8 mm one year post-operatively ($p < 0.001$) (Fig. 6).

When comparing the VAS-scores for pain when taking the first steps in the morning before surgery and 1 year after surgery for all the patients, one patient had unchanged morning step pain and one patient experienced worse pain than pre-operatively. The same pattern was seen when comparing pre- and 1 year post-operative values for VAS-scores during ADL functions and for FFI.

One year after surgery no patient reported scar tissue pain or neuropathic pain. One patient with total pain relief at 12 months presented with a marked reduction of medial arch height. The patient had not noticed any loss of function. One patient complained of heel pad pain and one patient of forefoot pain. There were no post-operative infections.

One year after the operation 10 of 11 patients would opt for the operation again and would recommend operation to a patient with similar problems.

Before surgery, the median fascial thickness at the medial fascial insertion on the calcaneus as measured by US was 6.0 mm (range 4.6–6.8 mm). A heel spur was present in 9 of the 11 cases.

One year after surgery a well-defined fascia in the area of resection was demonstrated by US in 8 of the 11 cases. The median fascia thickness in these cases was 3.5 mm. In the rest of the cases scar tissue made it impossible to clearly outline the fascia. Nine of the feet showed good fascial tensioning when dorsiflexing the toes. One of the two cases where tension in the fascia could not be demonstrated was the case mentioned earlier with reduction of the medial arch height. The other case did not show any change in arch configuration.

There was no evidence on US of recurrence of the bony spur 1 year postoperatively.

4. Discussion

In the present cohort study, significant and clinically relevant improvement was found in foot/ankle disability as measured by FFI-score, VAS-score for the first steps out of bed in the morning, and VAS-score for average pain during everyday living 3 months and 1 year after surgery. These results are consistent with other published results for endoscopic partial fascial release [3,5–11,16–23,25]. All though different outcome measures were used, good to excellent results are reported in 80–97% of the cases. In the present study, the FFI was chosen as a patient reported outcome measure as it is a validated score for plantar fasciitis with a minimal clinical relevant difference of 7 points

FFI for pain, function, and activity

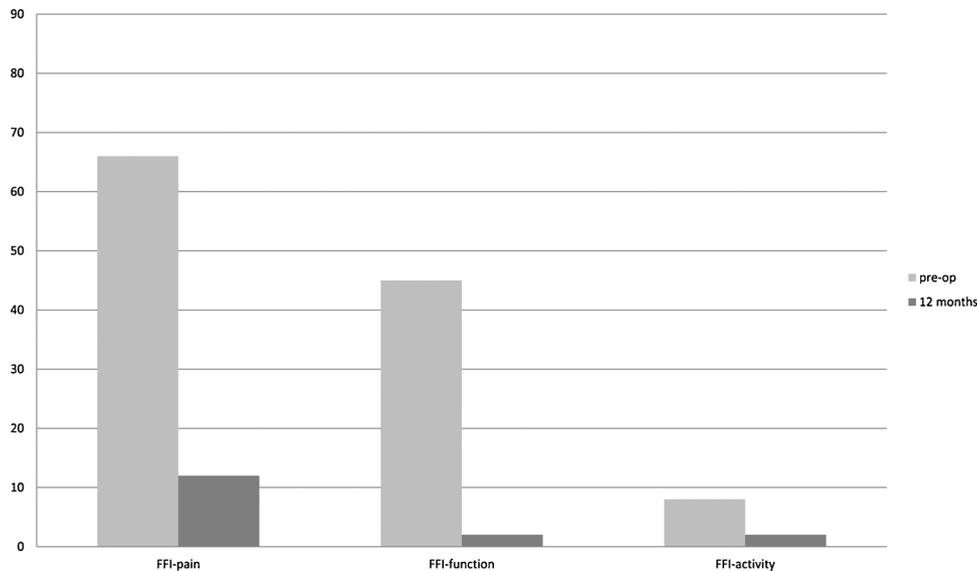


Fig. 5. Results for the three domains of the Foot Functional Index (FFI) pre- and 1 year postoperatively. Medians are shown. Points are shown along the y-axis. The differences from pre- to 1 year postoperatively are statistically significant ($p < 0.004$).

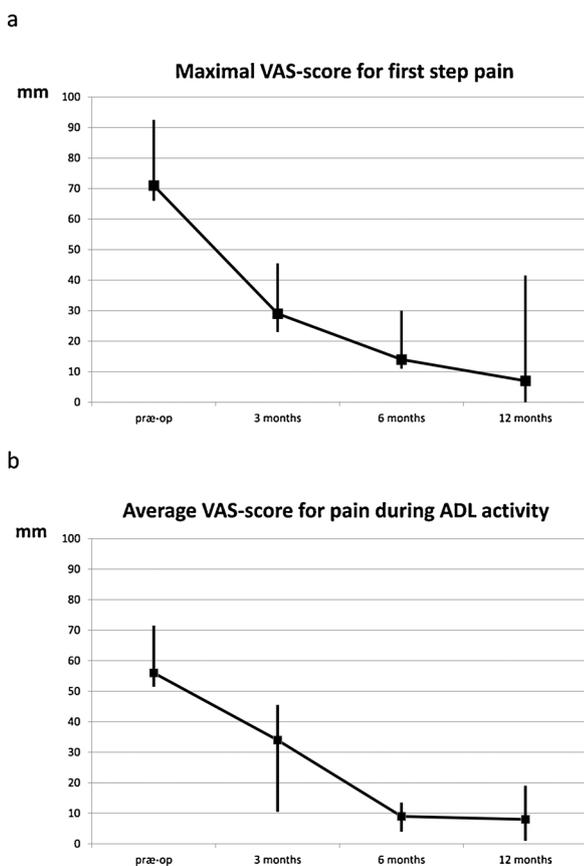


Fig. 6. Maximal VAS-score for first step pain (a) and average VAS-score for pain during ADL activity (b). Median and quartiles are reported. Statistically significant reduction from pre-operatively to 3 months post-operatively ($p = 0.003$), and from preoperatively to 1 year postoperatively ($p < 0.001$).

[14]. VAS-scores have also been validated for plantar fasciitis patients, and changes above 9 mm is found clinically relevant [15]. The median improvement in this study was far beyond these minimal relevant differences and all but one patient improved clinically relevant at 3

months and further at 12 months.

In the present study, a deep fascial approach for fascial endoscopic surgery was used [11]. This made it possible to remove calcaneal spurs and it facilitated decortication of the calcaneal bone adjacent to the fascia, which enabled a good visualization of the fascia before partial resection. Whether resection of the calcaneal spur improves results of surgical treatment is debated. It is suggested that the calcaneal spur is not the cause of heel pain, as it is found in asymptomatic persons [24], albeit a heel spur increases the risk of developing plantar fasciitis [26]. Spurs are frequently found in patients with heel pain [27,28], and an anatomic study of the painful plantar fascia has shown an abundance of small vessels and nerve endings in the connective tissue between the calcaneal spur and the plantar fascia [29], indicating that pain could be elicited from the compression of the fascia against the heel spur. Superior clinical results of heel spur resection compared to fasciotomy alone have been reported in two studies [17,30], while in one case series calcaneal spur resection did not result in superior outcome [31]. In this study 9 of 11 patients presented with a heel spur.

Drilling (infonation) of the calcaneus is suggested as part of the endoscopic procedure with the aim of reducing the intraosseous pressure in the bone, as increased pressure is thought to be painful [19]. With the present technique, the calcaneus is decorticated in the area where the heel spur is resected adjacent to the plantar fascia, and this may have the same effect on intraosseous pressure as drilling. However, to our knowledge no comparative study of the effect of calcaneal drilling has been reported.

In this study 50% of the width of the medial part of the central fascia band was resected. Whilst release of more than 50% of the width increases the risk of lateral column pain [32], the amount of resection necessary to obtain clinical effect is unknown. It may also be that partial fascial resection is not necessary at all and that debridement of the fascia (\pm heel spur removal) would suffice [33]. Partial fascial release may cause plantar fascial weakness and result in medial arch collapse and increased pressure under the midfoot, especially the 2nd metatarsal head area [20]. A medial column deficiency was present in one patient in the present study and forefoot pain reported by another. That these two cases from our group of 11 patients reflect the complication rate of surgery is not supported by literature, as complications are sparsely reported.

Based on ultrasonography, there was congruency of the resected

part of the plantar fascia 1 year after surgery, and in the 8 cases, where the layers were clearly visible, the fascia thickness was within the normal range. Dorsiflexion of the ankle and toes resulted in a visible tensioning of the resected part of the fascia in 9 of 11 of our cases. This suggests that resection of a part of the fascia does not influence the load sharing function of the plantar fascia. Furthermore, there was no sign of recurrence of the heel spur one year after resection. This is in accordance with a study of 30 patients in whom the spur did not re-occur on radiographs during the mean follow-up period of 24 months [34].

It seems that endoscopic operations lead to faster improvement and quicker return-to-work compared to open surgery [5,6,21], but the effect of endoscopic surgery compared to other minimal invasive treatment modalities for plantar fasciitis is poorly documented. In a randomized study comparing radiofrequency microtenotomy with endoscopic fasciotomy there was no difference of clinical improvement between the two groups [35].

In the present study heel pain and functional disability was significantly reduced as early as 3 months after operation, while further improvement was recorded after 1 year. This recovery time is in line with earlier reported results [11] but substantially longer than the 29 days, that has been reported by Tomczak and Haverstock [6].

This study is limited by the small number of patients included, and the conclusions cannot therefore be generalized. The study also lacks a control group where patients were conservatively treated using the rehabilitation protocol of this study. All patients had tried a similar training protocol prior to surgery, but their results in this study could still be influenced by the increased focus on them and their foot problems.

5. Conclusion

Endoscopic partial plantar fascia release using a deep fascial approach was effective for relieving plantar fasciitis pain symptoms in the majority of subjects in this study. There was a reduction of symptoms as early as 3 months after operation, but 12 months after surgery improvements are substantial. Based on ultrasonography the resected fascia seemed to regenerate and regain a load sharing function in the majority of cases, and the calcaneal spur does not recur during the first year after surgery.

Brief summary

What is already known:

- Plantar fasciitis is a frequent condition and ten percent of the population will experience this condition in a life-time.
- Operative treatment is an option in plantar fasciitis refractory to non-surgical treatment.
- Compared to open surgery, partial endoscopic fasciotomy leads to quicker improvement and quicker return-to-work.

What this study adds:

- Based on ultrasonography the resected part of the fascia seems to regenerate and regain a load sharing function.
- The calcaneal spur does not recur during the first year after surgery.
- Reduction of symptoms is significant after 3 months but substantial additional effect is seen up to 12 months after surgery.

Conflicts of interest

None.

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