

# Current therapeutic approaches for plantar fasciitis

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**Abstract:** Almost 1 million Americans are affected by plantar fasciitis (PF), which is the commonest cause of chronic heel pain. This condition is often managed conservatively, and many rehabilitation protocols, some with the aid of orthoses, have been adopted, with good-to-excellent clinical results. Although most cases of chronic PF can be successfully managed with a conservative approach, alternative treatments, including high-energy shock wave therapy and corticosteroid injections, are commonly accepted as second-line treatment when traditional conservative therapy fails. However, surgery is still an important mode of treatment. Recently, new minimally invasive surgical techniques that offer numerous advantages (faster recovery time, early weight-bearing, lower postoperative pain) over standard surgical approaches have been proposed, with good results and low complication rates. The purpose of this review is to report new conservative and surgical techniques for the treatment of PF. A literature search for articles about plantar fasciitis was conducted on the PubMed database in order to identify publications addressing the treatments of PF. The literature suggests that, initially, traditional conservative treatments consisting of rest, oral nonsteroidal anti-inflammatory drugs, foot orthotics, and stretching exercises can be tried for several weeks. In patients with chronic recalcitrant PF, extracorporeal shock wave therapy or corticosteroid injection can be considered. Surgery (minimally invasive techniques) should be considered only after failure of the conservative treatments.

**Keywords:** heel pain, surgery, plantar fasciosis

## Introduction

Plantar fasciitis (PF) is a common cause of heel pain seen by foot and ankle surgeons. Approximately 10%–16% of the US population suffers from PF, and approximately 75% of these patients turn to their family physician.<sup>1,2</sup> The term “plantar fasciitis” has been used for years, but this term is misleading since inflammatory cells are rarely present in biopsies from involved fascias.<sup>3</sup> Therefore, Lemont et al advocate the term “plantar fasciosis” to describe the syndrome characterized by pain along the proximal plantar fascia and its attachment in the area of the calcaneal tuberosity with impaired physical function, implying a more chronic degenerative process in comparison with acute heel pain.<sup>3</sup> In literature, the term “plantar heel pain syndrome” has been used for patients with PF. We believe this term is too generic and should be used only for plantar heel pain. In this review, we will use the term “plantar fasciitis” to refer to the presentation of patients with plantar fasciopathy and facilitate the comparison between studies reported.

The plantar fascia is formed from collagen fibers that originate from the medial tuberosity of the calcaneus and insert into the dorsal aspect of the proximal phalanges

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and the flexor tendon sheaths.<sup>4</sup> A number of studies have shown that the plantar fascia is involved in both the dynamic and static supports of the arch of the foot.<sup>5–8</sup> During weight-bearing, stretching of the longitudinal arch is prevented by tension of the plantar fascia, muscles, and ligaments, with compression of the bones forming the arch itself.<sup>8</sup> Continuity of the plantar fascia into the paratenon of the Achilles tendon has been shown in cadaver specimens, providing a positive correlation between Achilles tendon loading and plantar fascia tension.<sup>6</sup> In cadaver studies, complete release of the plantar fascia decreased the height of the medial longitudinal arch during terminal stance as well as changed the distribution of plantar foot pressure, resulting in increased pressure on the central metatarsal heads.<sup>9–11</sup>

The etiology of PF is likely multifactorial. Numerous factors, including flatfoot, advancing age, obesity, inappropriate footwear, and decrease in ankle dorsiflexion, have been associated with plantar fascia disorders.<sup>2,12,13</sup> While advancing age, which may induce plantar fascia degeneration and increased mechanical overload, is considered a risk factor for PF, the true pathogenesis remains unknown. A literature search for “articles about plantar fasciitis” was conducted on the PubMed database in order to identify publications addressing the current treatments of PF. Randomized clinical trials, case series, surveys, and narrative reviews written in English and published in peer-reviewed journals were included in this study. Although a more valid approach requires systematic search strategies, the intention of this review is to describe the current therapeutic approaches and the context in which future studies should be situated.

## Clinical presentation

Patients with PF will complain of plantar heel pain, which is exacerbated with the first step after a period of non-weight-bearing, typically in the morning. In the early stages, patients will report that their symptoms improve after a few steps or minutes, but, in the chronic stages, pain becomes blunt and constant.<sup>14</sup>

The condition is generally self-limiting, and most of the cases spontaneously resolve regardless of the type of intervention received (including placebo). The painful symptoms usually spontaneously resolve within 10 months.<sup>14</sup> However, in approximately 10% of patients, the disease progresses to chronic pain.<sup>14</sup> Physical examination commonly reveals pain at palpation of the plantar fascia at the plantar aspect of the calcaneal tuberosity. Physical examination should, however, include the assessment of range of motion of the foot and ankle, focusing on limitation of ankle dorsiflexion, presence

of hypesthesia or dysesthesia, and assessment of the forefoot/midfoot/hindfoot alignment. Passive ankle/first-toe dorsiflexion can cause discomfort or pain in the proximal plantar fascia and it can also cause painful tightness of the Achilles tendon. A fall from a height onto the heel may cause bone fractures involving the subtalar joint, the sustentaculum tali, the plantar calcaneal tubercles, or the inferior calcaneal spur. In most cases, diffuse pain in the hindfoot is poorly localized in the heel itself.<sup>15</sup> A fracture is usually suspected with a history of trauma and focal pain at palpation. Acute plantar fascia rupture should be suspected in patients with a history of trauma and with negative radiographic and bone scan findings. Plantar swelling and ecchymosis of the heel are often present.<sup>16–18</sup>

## Differential diagnosis

The differential diagnosis of plantar heel pain includes significant disorders, such as calcaneal stress fracture, systemic arthritides, entrapment neuropathies (eg, tarsal tunnel syndrome and medial plantar nerve entrapment), calcaneal infection, plantar calcaneal bursitis, or hindfoot osteoarthritis.<sup>19</sup> Taking patient history, performing a physical examination of the foot and ankle, and ordering appropriate imaging studies, if indicated, are the first steps to making the correct diagnosis. A calcaneal stress fracture often develops from repetitive overload to the heel, and most commonly occurs when muscles become fatigued and are unable to absorb added shock. Patients experience heel pain after an increase in weight-bearing activity or change to a harder walking surface. The pain initially occurs only with activity, but often progresses to include pain at rest. Clinically, first examination may reveal swelling and stiffness associated with point tenderness at the fracture site immediately inferior and posterior to the posterior facet of the subtalar joint.<sup>19,20</sup> Magnetic resonance imaging (MRI) allows evaluation of the extent of a stress fracture, as well as assessment of the ligamentous structures and plantar surface.<sup>20,21</sup>

Paresthesia presenting as burning, tingling, or numbness with chronic unilateral pain is indicative of neurologic heel pain due to nerve entrapment. These symptoms most commonly indicate a neuropathic etiology caused by overuse, trauma, obesity, venous insufficiency, or iatrogenic injury from previous surgery.<sup>22,23</sup> Tarsal tunnel syndrome is the most commonly reported nerve entrapment due to compression of branches of the posterior tibial nerve, including the medial plantar nerve, the lateral plantar nerve, or the nerve to the abductor digiti minimi.<sup>22–25</sup> Decreased heel pad elasticity with aging and increasing body weight may cause heel pad

syndrome, which is often mistaken for PF. The syndrome is usually caused by inflammation, but damage to or atrophy of the heel pad can also elicit deep pain in the middle of the heel, which can be reproduced with firm palpation.<sup>26</sup>

## Imaging

Plain weight-bearing radiographs of the foot represent the initial imaging study. Radiologic studies generally do not add additional diagnostic information, but they can exclude alternative causes of plantar heel pain or can be used in assessment of a failed treatment. A heel spur is often detected in radiographs of the foot; however, its presence may not necessarily correlate with the patient's symptoms, since people without any symptoms can have this radiographic finding.<sup>27–30</sup> Although ultrasonography and MRI are not the current imaging modalities of choice in patients with PF, they can provide useful information.<sup>31,32</sup> Ultrasonography is an inexpensive diagnostic tool, which can be used to assess soft tissue pathology of the heel. Normal plantar fascia is hyperechoic and isoechoic with adjacent fat, with a thickness ranging from 2–4 mm.<sup>33</sup> A thickening of the fascia greater than 4 mm and areas of hypoechogenicity can be observed in patients with plantar fasciopathy, which directly correlates with heel pain.<sup>13,34,35</sup> Other signs of plantar fasciopathy include loss of definition and disorganization of the plantar fascia structure and peri-insertion edema.<sup>36</sup> Ultrasound should also be used to identify the precise localization of corticosteroid injection within the plantar fascia and may be used as an objective measure of response to treatment in PF.<sup>37–39</sup> Recently, Jeong et al reported the results of ultrasound evaluation in 125 consecutive feet with symptoms of chronic PF and concluded that distal involvement of the plantar fascia with atypical pattern (fusiform thickening of the plantar fascia distal to the insertion with normal appearance at the insertion site) is frequently observed.<sup>40</sup> Therefore, the authors suggested the use of ultrasonographic examination in cases of recalcitrant plantar heel pain that have residual pain after conservative first-line management, in order to confirm the clinical diagnosis and to classify the disease as either insertional or noninsertional plantar fasciopathy (or mixed disease).<sup>40</sup> MRI has been shown to differentiate between the various causes of heel pain, due to its ability to identify soft tissue and bony anatomy of the plantar aspect of the foot.<sup>41</sup> In patients with PF, the commonest findings are perifascial and calcaneal bone edema with high signal intensity within the plantar fascia on T2 and short-tau inversion recovery images and thickening of the plantar fascia greater than 5 mm on T1 sequences.<sup>42</sup> However, in patients with atypical chronic heel pain, osteoarthritic changes of hindfoot/midfoot joints, regional migratory osteoporosis, plantar arte-

rio venous malformation, and calcaneal stress fracture can be detected with MRI.<sup>43</sup> The high cost of this exam should be taken into account, hence MRI is indicated only in patients with recalcitrant atypical heel pain. Other examinations, such as computerized tomography scanning, technetium-99m bone scan, nerve conduction velocity, and electromyography test, are indicated for those patients with a high index of suspicion for the other causes of heel pain.

## Therapy

### Nonoperative treatment

Conservative therapies remain the preferred approach to treating PF, successfully managing 85%–90% of cases (Table 1).<sup>44,45</sup> A 2010 clinical practice guideline from the American College of Foot and Ankle Surgeons recommends conservative treatments, such as nonsteroidal anti-inflammatory drugs (NSAIDs), specific plantar fascia stretching, and orthotics for the initial management of plantar heel pain.<sup>46</sup> Patients should be informed that it may take 6–12 months for symptoms to resolve. Patient-directed treatments to improve heel pain consist of rest, activity modification, ice, and acetaminophen or NSAIDs. A randomized placebo-controlled prospective study of NSAIDs to treat chronic PF showed short-term improvement in pain relief and disability when combined with other conservative treatments.<sup>47</sup> However, there are few studies to support the benefits of these treatments used alone.

The use of foot orthoses (prefabricated or custom-made) is considered the commonest approach in patients with PF.<sup>48</sup> Orthoses theoretically unload the plantar fascia, reducing foot pronation. Because of the moderate expense, it is suggested that they should not be prescribed routinely to all patients but should be used instead in cases of abnormal foot posture (eg, flat feet). Lee et al performed a meta-analysis examining the effects of foot orthoses on self-reported pain and function in patients with PF and found that foot orthoses can decrease rear foot pain and improve foot function.<sup>49</sup> A Cochrane Review found that custom foot orthotics may not help to reduce foot pain any more than prefabricated foot orthotics, but, when custom foot orthotics are used with an anterior night splint, patients may show higher pain relief.<sup>50</sup> It is a generally held consensus that one or more of these options should be started prior to initiating any invasive treatments (level II evidence; Table 1). A recent paper reported good results with either full-length silicone insoles for patients with PF or an ultrasound-guided corticosteroid injection.<sup>51</sup> Plantar fascia-specific stretching exercise has shown good results in the treatment of chronic PF.<sup>14,52–54</sup> This approach for treatment of PF is simple and

**Table I** Evidence for management of plantar fasciitis

Grade of recommendation	Level of evidence	Treatment	Comments
A	I	PFSS	Strong evidence: several multicenter RCTs have shown good results based on an effective, inexpensive, and straightforward treatment. <sup>14,52-54</sup>
		ESWT	Strong evidence: multiple meta-analyses of RCTs showed that ESWT decreases pain and improves function. <sup>59-63</sup>
B	II–III	Orthotics	Moderate evidence: use of silicone insoles or custom foot orthotics. Systematic reviews but RCT evidence lacking. <sup>48-51</sup>
		NSAIDs	Moderate evidence: short-term improvement in pain relief and disability. Systematic reviews but RCT evidence lacking. <sup>46,47</sup>
		Corticosteroid injections	Moderate evidence: acceptable first-line treatment. Observational or controlled trials with several limitations. <sup>65-71</sup>
		Radiotherapy	Moderate evidence: therapeutic alternative for painful heel spur. Retrospective studies and RCTs. <sup>88,90,91,94</sup>
		PRP injections	Weak evidence: PRP has been shown to be safe and effective in reducing pain scores and improving function. Case series based on clinical experience and expertise. <sup>9,78,79</sup>
C	IV	Plantar fasciotomy or gastrocnemius recession	Weak evidence: second-line treatment for chronic plantar fasciitis. Retrospective studies and case series with several limitations. <sup>46,97,98,101-104,111,113</sup>

**Notes:** The three-category system of quality of evidence was chosen: “strong” (Grade A), “moderate” (Grade B), and “weak” (Grade C). The strongest evidence comes from multicenter RCTs or meta-analyses of RCTs. The moderate strength category is populated by systematic reviews, retrospective studies or controlled trials with important limitations and by exceptionally strong observational studies. Case series and on occasion retrospective studies with multiple serious limitations, will fill the weak quality evidence category.

**Abbreviations:** ESWT, extracorporeal shock wave therapy; NSAIDs, nonsteroidal anti-inflammatory drugs; PFSS, plantar fascia-specific stretching; PRP, platelet-rich plasma; RCT, randomized controlled trial.

inexpensive; however, recommendations for the optimal duration and frequency of stretching exercises have not been unanimously established (Figure 1). The results, obtained from good experimental studies,<sup>14,52-54</sup> suggest this treatment protocol for the treatment of chronic proximal PF. In a 2011 study, adding myofascial trigger-point manual therapy to a plantar fascia-specific stretching exercise routine improved self-reported pain and function when compared to stretching alone.<sup>55</sup> However, due to the absence of a true control/sham/placebo group and long-term follow-up, the trigger-point release techniques cannot be considered effective in the treatment of heel pain.

Patients with severe pain when arising from bed in the morning can achieve benefits from the use of a night splint, which can provide a stretch lasting for many hours. Poor compliance should be taken into account, especially for patients with a low quality of nighttime bed rest.

Extracorporeal shock wave therapy (ESWT) has been used to treat different orthopedic disorders, including PF, shoulder calcific tendinitis, lateral epicondylitis, and Achilles tendinopathy.<sup>56-60</sup> Shock waves used to treat PF are hypothesized to improve pain relief by promoting extracellular responses that cause neovascularization and angiogenesis leading to tissue repair and regeneration.<sup>61</sup> Theoretically, patients with plantar fasciopathy with degeneration and calcific change

(ie, calcaneal spur) may be successfully treated with a “stimulating” approach, such as ESWT. Rompe et al have previously reviewed the results of using focused shock wave therapy to treat chronic PF in a meta-analysis.<sup>62</sup> Despite the heterogeneity between the studies included in their work (method of shock wave generation, amount of shock wave energy delivered, use of anesthesia, and outcome measure), the authors concluded that ESWT should be considered for the treatment of plantar fasciopathy when more common, accepted, and proven noninvasive treatments have failed. A 2012 review article concluded that most research shows that ESWT decreases pain and improves function in 34%–88% of patients with chronic PF.<sup>60</sup> Dizon et al, in a more recent meta-analysis, combined the results of eleven studies on the effects of ESWT on PF and reported a decrease of pain and improved function in patients with chronic PF.<sup>63</sup> Therefore, ESWT should be recommended as a remedial measure after failure of traditional conservative treatment and before surgical intervention. Recently, one study reported comparable results between high-energy ESWT and endoscopic plantar fasciotomy at short-term follow-up (1 year).<sup>64</sup> However, larger randomized controlled studies are still needed to compare the curative effect of ESWT with surgery in the treatment of recalcitrant PF.

Corticosteroid injections have been used to treat multiple orthopedic diseases, including acute and chronic tendon





**Figure 1** Plantar fascia specific stretching.

pathologies.<sup>65,66</sup> A single dexamethasone injection has been proven to reduce pain and improve function in patients with plantar fasciopathy.<sup>66–68</sup> Additionally, the American College of Foot and Ankle Surgeons considers corticosteroid injections an acceptable first-line treatment for PF.<sup>46</sup> Complications such as plantar fascia calcification, post-injection pain, fat pad atrophy, and plantar fascia ruptures should be taken into account.<sup>69–71</sup>

Steroid injection immediately after endoscopic surgery has been suggested to decrease postoperative fibrosis.<sup>71,72</sup> Recently, promising clinical results have been reported with the use of platelet-rich plasma (PRP) injections for treating chronic muscle and tendon injuries.<sup>73–76</sup> The rationale for using PRP is to promote cellular chemotaxis, matrix synthesis, and proliferation through higher than physiologic doses of reparative growth factors.<sup>77</sup> PRP has been shown to be safe and effective in reducing pain scores and improving function in chronic PF.<sup>9,78</sup> It can be argued that steroid injections, which decrease the inflammatory state of the tissue, are more successful in PF than in plantar fasciopathy. In a recent paper, Akşahin et al compared the use of PRP injection with methylprednisolone injection, and both treatments were effective and successful in treating recalcitrant PF with no complications.<sup>79</sup> Therefore, future randomized controlled trials are warranted to confirm or refute these findings. New conservative treatments have been

proposed in recent years, including a micronized dehydrated human amniotic/chorionic membrane injection or botulinum toxin type A injection, with satisfactory results, but more studies are needed to include such protocols in the first-line approach for recalcitrant PF.<sup>80–85</sup>

Cast immobilization for 4–6 weeks or use of a short-leg walking boot to immobilize or offload the foot during activity has been proposed for recalcitrant PF, but the lack of prospective randomized studies precludes specific recommendations.<sup>86,87</sup>

A further modality for the treatment of painful PF is radiotherapy.<sup>88–92</sup> Radiotherapy in nonmalignant disease is effective because the anti-inflammatory activity is mediated by a mechanism of downregulation of leukocyte adhesion and nitric oxide synthase activity in stimulated macrophages.<sup>93</sup> In a retrospective study, Miszczyk et al reported lack of pain in 157 of 327 (48%) patients without a dose–response relationship.<sup>88</sup> In a more recent multicenter randomized controlled trial on the effect of radiation therapy on PF, Niewald et al demonstrated that radiation therapy with 6.0 Gy doses applied in six fractions of 1.0 Gy twice weekly (standard dose) was highly significantly superior to low-dose radiation therapy (0.6 Gy applied in six fractions of 0.1 Gy twice weekly).<sup>94</sup> Considering the lack of adverse effects, the simplicity of treatment, and the safe modality, radiotherapy seems to be an effective treatment for PF.

## Surgical treatment

Surgery should be considered only for patients who have not responded adequately after 6–12 months of conservative therapy.<sup>95</sup> Surgery typically includes open plantar fasciotomy, resection of the heel spur (when present), and release of the abductor hallucis fascia.<sup>96,97</sup> Complications of open surgery include residual pain (approximately 25% of patients will still experience heel pain); flatfoot deformity due to over-release of the plantar fascia; medial calcaneal nerve damage; and plantar tender scar.<sup>95</sup> Several studies have investigated open plantar fasciotomy through a variety of approaches.<sup>98–100</sup> Endoscopic plantar fascia fasciotomy, performed through a small skin incision, has been proven to achieve better results in comparison to traditional open surgery, and current practice suggests a minimally invasive approach to plantar fasciotomy versus extensive open surgical exposures.<sup>46,101–103</sup> The use of endoscopic approaches in performing these procedures allows more rapid recovery and return to activity after surgery, with a low rate of complications (wound infection, residual pain). Patients undergoing surgery should expect

a return to normal activity in approximately 2–3 months; however, patients should be informed about the possibility of complications such as residual pain.<sup>12,104</sup> Further surgical approaches to relieving heel pain, which include radio-frequency ablation of the plantar fascia, radiofrequency nerve ablation, and cryosurgery, have shown good clinical results.<sup>105–109</sup> Further studies to compare these new minimally invasive techniques with more traditional surgical approaches are warranted. Some authors suggest assessing the tightness of the Achilles tendon, since increased tension on the Achilles tendon is coupled with increased strain on the plantar fascia.<sup>110–112</sup>

Monteagudo et al, in a retrospective study, compared the results of open plantar fasciotomy with open gastrocnemius recession in the treatment of chronic PF.<sup>113</sup> The authors concluded that proximal medial gastrocnemius release provides better clinical results than open fasciotomy with less incidence of complications and a higher satisfaction rate of the patients.<sup>113</sup>

## Summary

PF is a common cause of chronic heel pain. In subjects at risk for PF, stretching exercises, weight loss, and changes in footwear may be effective preventive measures. Usually, first-line conservative treatment (including rest, NSAIDs, plantar fascia-specific stretching exercises, and orthoses) can successfully manage most cases of PF. Surgery (minimally invasive techniques) should be considered only after failure of the conservative treatments.

## Disclosure

The authors report no conflicts of interest in this work.

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