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ORTHOPAEDIC SURGERY

Platelets rich plasma for treatment of chronic plantar fasciitis

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Abstract
Background Plantar fasciitis is a common cause of heel pain in adults. Many treatment options exist. Platelets rich plasma (PRP) is derived from autologous blood and contains high concentration of growth factors necessary for tissue healing. The use of PRP in the treatment of plantar fasciitis is a fairly recent and evolving concept. The purpose of our work was to study the effectiveness of PRP treatment for chronic plantar fasciitis.
Materials and methods Between February 2010 and June 2011, 25 patients with chronic plantar fasciitis with a mean age of 44 years were treated by PRP injection and included in this prospective study. All patients were assessed for the pain on Visual Analogue Scale (VAS) pre-injection and post-injection. Using ultrasound, the thickness of the plantar fascia was measured prior to the injection of PRP and at each visit of follow-up after injection. The mean follow-up was 10.3 months.
Results Using a visual analog pain scale, the average pre-injection pain in patients of was 9.1 (range 8–10). Prior to injection, 72 % of patients had severe limitation of activities, and 28 % of patients had moderate limitation of activities. Average post-injection pain decreased to 1.6. Twenty-two patients (88 %) were completely satisfied, two patients (8 %) were satisfied with reservations, and one patient (4 %) was unsatisfied with using the visual analog scale. Fifteen patients (60 %) had no functional limitations post-injection and eight patients (32 %) had minimal functional limitations. Two patients (8 %) had moderate functional limitations post-injection. Twenty PRP injections. Ultrasonography, we noted significant changes not only in thickness but also in the signal intensity of the plantar fascia after PRP injection. None of our patients experienced any complications from PRP injection at the end of follow-up period.
Conclusion Injection of PRP is safe and doesn't affect the biomechanical function of the foot. Our successful early findings with injection of PRP indicate that this may become a very commonly used modality in treating this difficult condition.

Keywords Plantar fasciitis · Platelets rich plasma · Functional limitation · Ultrasound

Introduction

The plantar fascia is a thickened fibrous aponeurosis that originates from the medial tubercle of the calcaneus and run forward to form the longitudinal foot arch. The function of plantar fascia is to provide static support of the longitudinal arch and dynamic shock absorption [1]. Plantar fasciitis is a common cause of heel pain in adults. Pain is usually caused by collagen degeneration at the origin of the plantar fascia. The cause of degeneration is repetitive microtears of the plantar fascia that overcome the body's to repair [2]. The classic sign of plantar fasciitis is that the worst pain occurs with the first few steps in the morning or at the beginning of the activity that lessens as they warm up. In more severe cases, pain will also worsen toward the end of the day [3].

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In general, plantar fasciitis is self-limiting disease. Unfortunately, the time until resolution is often 6–18 months, which can lead to frustration for patients and physicians [4]. Conservative lines of treatment, including non-steroidal anti-inflammatory drugs, heel pads or orthotics, physical therapy, stretching exercises, corticosteroid injections, and extracorporeal shockwave therapy, regarded as the mainstay of treatment and provide substantial relief to about 80 % of patients [5].

A new frontier in the treatment of orthopedic injuries is the growing science of orthobiologics or the science of injectables to promote healing through the use of the patient's own biological tissues. For 20 years, PRP has been utilized in a number of medical fields including orthopedics, sports medicine, neurosurgery, urology, and maxillofacial surgery. Platelets rich plasma is promoted as an ideal autologous biological blood-derived product, which can be exogenously applied to various tissues where it releases high concentrations of platelet derived growth factors that enhance wound healing, bone healing and tendon healing [6].

Although numerous studies have been documented success in the healing of tissues, most of the literature to date has been small pilot studies and anecdotal studies. The purpose of this prospective study is to clinically evaluate the efficacy of treatment for plantar fasciitis using platelets rich plasma injection into the origin of the plantar fascia.

Materials and methods

This study was being done between Feb. 2010 and June 2011, 25 patients with chronic plantar fasciitis (14 females and 11 males) with chronic plantar fasciitis.

Inclusion criteria

- Patients aged >18 years, with chronic plantar fasciitis after failure of conservative treatment for at least 6 months.
- Patients should be able to understand the informed consent, and the VAS pain in the morning higher than 5.

Exclusion criteria

- Patients who received local steroid injection within 6 months, physical therapy within 6 weeks, or non-steroidal anti-inflammatory within 1 week.
- Active bilateral plantar fasciitis,
- Previous surgery for plantar fasciitis,
- Vascular insufficiency or neuropathy related to heel pain,
- Diabetics, or other painful or function limited disorders of the foot and ankle.
- Pregnancy,
- History of severe anemia (hemoglobin less than 5),
- Significant cardiovascular, renal or hepatic disease,

Ultrasound measurement of the medial, central and lateral bands of the plantar fascia was done prior to injection of PRP in the affected foot and for the asymptomatic foot for comparison and to serve as a control.

Platelets rich plasma preparation

Blood is drawn from the patient (about 50 ml) into a 60-ml syringe that contained 5 ml sodium citrate. Then the blood was centrifuged for approximately 15 min (3,000 rounds per minute) using desk top centrifuge. The blood is then separated into platelets poor plasma and platelets rich plasma. The platelets poor plasma is then extracted and discarded. After one more shaking procedure, the platelet rich plasma is withdrawn. The resulting platelets concentrate contains approximately a 6–8 times concentration of platelets compared to baseline whole blood. The total time from blood draw to injection in the patients is about 30–35 min.

Injection technique

The procedure is done on an out-patient basis and under completes aseptic condition. Then, 5 cc platelets concentrate is injected using a 22 needle into the most tender area of plantar fascia using a peppering technique (a single skin portal and 4 or 5 penetrations to fascia). The patient is then observed for 15–20 min and then discharged.

Post-injection protocol

The use of NSAID or any type of foot orthoses is prohibited. Because there may be discomfort experienced by the patient at the site of the injection for up to 48 h, patients are encouraged to ice the injection site, elevate the limb, and modify activities. Immediately after injection, the patients are kept in sitting position without moving the foot for 15 min. Patients are discharged to home with instruction to limit their activities for 48 h and use acetaminophen for pain control. After 2 days, patients are sent to the physiotherapist to start stretching exercises for 2 weeks and strengthening exercises for additional 2 weeks. At 4 weeks post-injection, the patients are allowed to start normal recreational activities.

Using the VAS, patients were evaluated for pre-procedure pain, pain at each post-injection visit. All patients in the study completed a questionnaire pre-injection, 2 weeks post-injection, 3 months, 6 months and at 1 year follow up visits. This questionnaire includes the following; pain level using VAS when getting out of bed, at rest, and after activ-

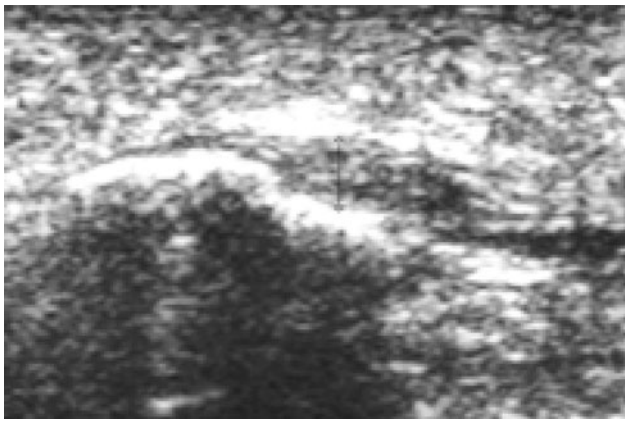

Fig. 1 Sagittal sonogram of the heel region for 42-year-old woman, showing hypoechogenic changes and thickening of the plantar fascia measuring 7.5 mm (*arrows*)

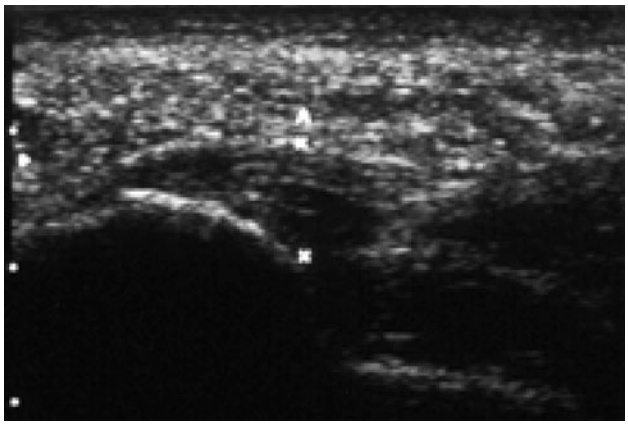

Fig. 2 Sagittal heel sonogram for a 36-year-old man showing thickened hypoechoic plantar fascia measuring 8.2 mm with loss of edge sharpness

ity; effect of the procedure on patient condition; and patient satisfaction. Statistical analysis, using the Student *t* test was applied for each parameter. A *P* value of less than 0.05 was considered to be significant. All patients had a radiograph made of the heel before the treatment, immediately post-injection, and at the 6 months follow up evaluation for detection of any structural changes of the hind foot or arch changes. Also, ultrasound measurement was taken for the medial, central and lateral bands of the plantar fascia at each post-injection visit to assess plantar fascia thickness and signal intensity.

Technique of sonography (Figs. 1, 2, 3, 4)

Sonographic examinations were performed with a 7.5 MHz linear transducer on both symptomatic and non symptomatic heels. The patient lay prone with their feet hanging free over the end of the examination couch and their ankles dorsiflexed to 90°. Care to keep the beam perpendicular to the plantar fascia to avoid anisotropy. Sagittal imaging of the plantar fascia is performed, and its thickness is measured at a standard reference point where the plantar fascia crosses the anterior aspect of the inferior border of the calcaneus. Plantar fascia thickness greater than 4 mm is considered abnormal [7].

Results (Tables 1, 2) (Figs. 5, 6)

The mean follow up was 10.3 months (range 9–13 months). Using the VAS, the average pre-injection pain was 9.1 (range 8–10). According to patient's questionnaire; 72 % of patients (18 patients) had severe limitation of activities, and 28 % of patients (7 patients) had moderate limitation of activities pre-injection. Post-injection, using the same scale the pain decreased to average of 1.6 (range 0–6)

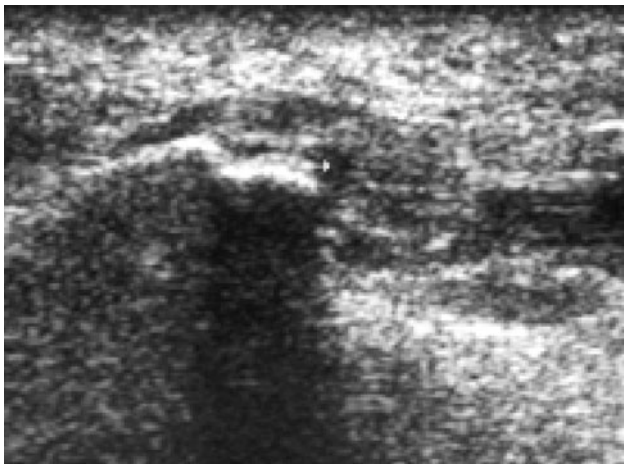

Fig. 3 Sagittal sonogram for a 44-year-old woman showing thickening, hypoechogenicity, and fluid collection in the paratenon (*arrow*)

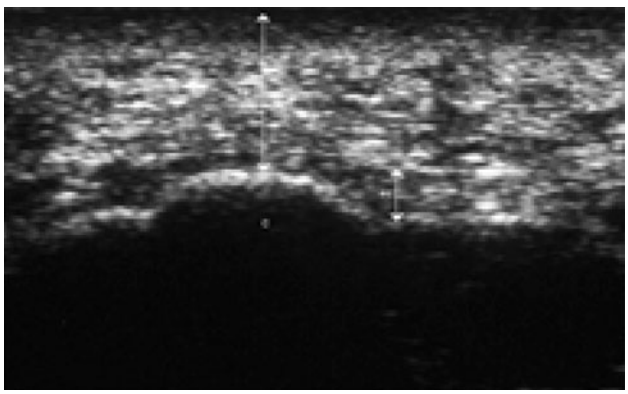

Fig. 4 Longitudinal sonogram for a 41-year-old woman, plantar aspect of the foot, showing the normal internal longitudinal fibrillar pattern within the plantar fascia (*arrows*)

($P < 0.001$). Fifteen patients (60 %) had no functional limitations post-injection, and eight patients (32 %) had minimal functional limitations. Only two patients (8 %) had

Table 1 Results of the whole study

	Before injection (mm)	2 weeks post-injection (mm)	6 weeks post-injection (mm)	3 months post-injection (mm)
Average thickness of medial band	7.1	5.7	5.2	4.8
Average thickness of central band	6.6	6.1	5.8	5.4
Average thickness of lateral band	4.6	4.6	4.6	4.6

Table 2 Average thickness of plantar fascia

	Pre-operative	Post-operative at late follow up
Average VAS	9.1	2.1
No limitation of activity	–	15 (60 %)
Minimal limitation of activity	–	8 (32 %)
Moderate limitation of activity	7 (28 %)	2 (8 %)
Severe limitation of activity	18 (72 %)	–
Average thickness of medial band (mm)	7.1	5.1
Average thickness of central band (mm)	6.6	5.4
Average thickness of lateral band (mm)	4.6	4.6

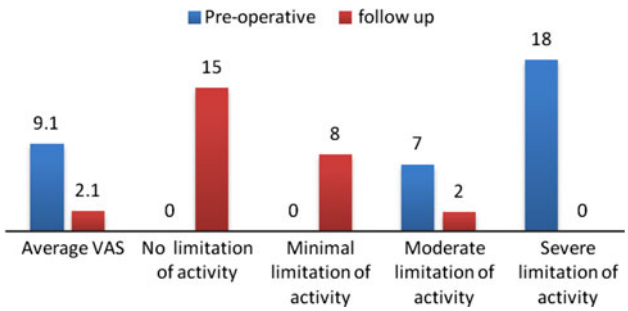

Fig. 5 Results of the whole study

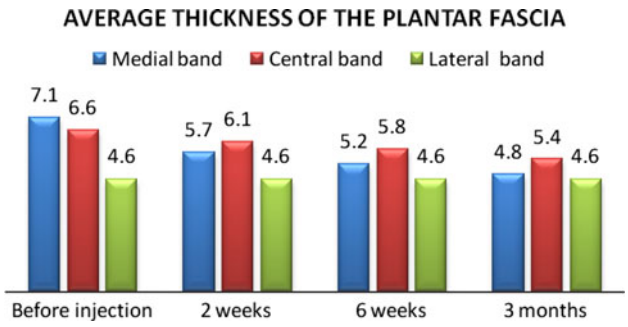

Fig. 6 Average thickness of plantar fascia by ultrasound

moderate functional limitation post-operatively. Twenty-two patients (88 %) were completely satisfied, two patients (8 %) were satisfied with reservations, and one patient (4 %) was unsatisfied with the end result of PRP injection.

Prior to injection, the bands of the plantar fascia near the origin at the calcaneal tubercle appeared thicker and more hypoechoic as compared to the asymptomatic side. The average thickness of the symptomatic medial band prior to injection was 7.1 mm as compared to the average thickness of the asymptomatic medial band, which was 4.9 mm. The average thickness of the symptomatic central band prior to injection was 6.6 versus 4.3 mm for the asymptomatic side. The average thickness of the symptomatic lateral band prior to injection was 4.6 versus 3.7 mm for the asymptomatic side. The post-injection measurement was obtained at 2 weeks, 6 weeks, and 3 months and revealed significant changes not only in the thickness but also in the signal intensity of the fascial bands. At 2 weeks post-injection the medial band showed an average reduction in thickness of 1.4 mm. By 6 weeks, the average reduction in thickness was 1.9 mm. At 3 months, it was 2.3 mm. At the end of 3 months, the average thickness of the symptomatic medial and central bands was 4.8 and 5.4 mm respectively ($P < 0.001$).

None of our patients experienced any complications from PRP injection at the end of follow-up period. No post-injection foot deformities or changes in the arches were noted. Between 6 weeks and 3 months, 6 of the 25 patients (24 %) took oral non-steroidal anti-inflammatory drugs. But between 3 and 6 months only one patient (4 %) took oral NSAIDs. The average period before return to work or daily activities was 2 weeks. The patients were allowed to start normal recreational activities after 4 weeks.

Discussion

Plantar fasciitis is the most common condition treated by podiatric foot and ankle specialist. However, the true etiology of plantar fasciitis is still unknown and has been attributed to many different etiological factors. Also there are many available treatment methods, but when conservative treatment results in a non-satisfactory outcome, the patient is often interested in treatment options other than surgery [8].

Steroid injection is a popular method of treating the plantar fasciitis but seems to be useful in the short term and only to a small extent [9]. Treatment with steroids has a high frequency of relapse and recurrence, probably because intra fascial injection may lead to permanent adverse changes within the structure of the fascia and because

patients tend to overuse the foot after injection as a result of direct pain relief [10].

Since the early 1990s, extracorporeal shock wave therapy (ESWT) has been used for treatment of chronic plantar fasciitis. Results have been mixed and depending on the cited study, success rates have ranged from 48 to 77 %. The underlying working mechanism of ESWT on plantar fascia is not completely understood. Both an analgesic effect and a stimulating effect on tissue regeneration have been suggested as possible working mechanism. Drawbacks to this type of treatment include contra-indications in neuropathic patients, destruction of muscle tissue, development of compartment syndromes and cost concerns [11].

Researchers have documented that PRP has four to six times the normal level of growth factors, which results in fibrocytes migration and induction of neurovascular growth [8]. Most importantly, in a recent study of Peerbooms et al. [12] a positive effect of injection of PRP in the common extensor origin for lateral epicondylitis was seen. It demonstrates that a single injection of PRP improves pain and function more than corticosteroid injection. These improvements were sustained over time with no reported complications. One of the greatest benefits to this treatment is that the patient uses his or her own blood for the procedures. This eliminates all kinds of potential problems including disease transmission and tissue rejection.

The use of autologous PRP is not a new treatment. The healing cascade, which is the physiological response to any injury or surgical intervention, is well documented and relies on proteins that are delivered to the healing site by platelets and white blood cells in addition to those proteins that are present in the plasma [13]. Successful tissue healing and regeneration requires a scaffold or matrix, undifferentiated cells and signal proteins and adhesion molecules (growth factors). It is well known that platelets affect mitogenic activity of cells like osteoblast, chondroblast or tenoblast [14].

Injection of PRP into the affected tissues addresses the healing stages necessary to reverse the degenerative process which are going on in the base of plantar fascia [15]. The individual cytokines present in the platelet α granules have been shown to enhance fibroblast migration and proliferation, up-regulate vascularization, and increase collagen deposition. The cytokines present in platelet α granules have been shown to affect the healing stages necessary to reverse a chronic plantar fasciitis. Transforming growth factor $\beta 1$ is shown to significantly increase type I collagen production by tendon sheath fibroblast. Additionally, many of these cytokines have been thought to work in a dose dependent manner [9].

Although PRP is a hot topic now in the field of orthopedic medicine, the large controlled, double-blind scientific studies to validate its effectiveness are needed. Unfortunately, to date, the literature is full of pilot studies with small sample for treatment of plantar fasciitis (single person stories). These types of studies are not sufficient to validate a new scientific treatment methodology on scientific evidence, and we cannot use it for comparison with our study [6, 8–10, 13].

Sonography has proved to be an excellent imaging technique for the assessment of plantar aponeurosis. The plantar aponeurosis is shown sonographically as a homogeneous hyperechogenic band with internal linear interfaces on longitudinal sections in normal heel. Sonographic findings of PF were assessed as thickening of the plantar fascia, reduced echogenicity of the plantar fascia, and loss of the fascia edge sharpness. Sonography is noninvasive, less expensive, readily available, easier, and faster than other imaging modalities in the diagnosis of PF and can also be performed at the bedside [7, 16].

In our study we did not use local anesthetic which could lead to bias, as an injection with local anesthetic alone led to improvement in plantar fasciitis. Also we noted little changes in the lateral band thickness because these patients demonstrated the typical type of plantar fascial pain, which is located more medially at the medial calcaneal tubercle.

Contra-indications to the use of PRP include coagulopathies, concurrent anticoagulant therapy, active infection, tumor, and pregnancy. Theoretically several systemic complications may be associated with the use of PRP, as a result of systemic increase in growth factors, the injection of PRP could initiate cancer like effect but no studies to date found any data to support this concern. In our study, no complications were reported [8].

At the end of follow up period, 22 patients (88 %) had complete resolution of pain and satisfied with results which is comparable to the results from the lateral epicondylitis study and superior to the results from other procedures for treatment of chronic plantar fasciitis likes steroids injection or ESWT. Also, this technique cannot impair the biomechanical function of the foot, unlike other invasive procedures that transect or resects part of the plantar fascia. In our study, only one patient was dissatisfied and has moderate limitation of function. Interestingly, all patients in our study had improvement that was noted on diagnostic ultrasound.

Kane et al. [17] in comparative study between ultrasound-guided steroids injection with palpation-guided steroid injection in the management of idiopathic plantar fasciitis stated that, ultrasonography was positive in 24/28 symptomatic heels (positive predictive value 0.86) and in 2/18 asymptomatic heels (negative predictive value 0.89) in diagnosis of PF. The mean thickness of the plantar fascia at the anterior calcaneal border in all symptomatic heels was 5.7 ± 0.3 mm as compared with 3.8 ± 0.2 mm in all asymptomatic heels. They concluded that, following

palpation-guided injection, the VAS score decreased from 59.7 to 18.2 and the overall response rate (50 % reduction in symptoms as assessed by VAS) was 80 % (8/10) following palpation-guided steroid injection. The mean plantar fascia thickness at the anterior border of the calcaneus decreased from 5.7 mm pre-operatively to 4.65 mm post-operatively. There was no evidence of fascial rupture at follow-up ultrasound examination.

In the current study, our results were comparable or better as regard the average reduction of the thickness of the plantar fascia, and average improvement of VAS in addition to absence of complication of local injection of corticosteroids [18].

Conclusion

We believe that, the injection of PRP for treatment of chronic plantar fasciitis may cause a reparative effect leading to a resolution of symptoms. Our successful early findings with the injecting PRP indicate this may become a very commonly used modality in treatment of chronic plantar fasciitis. Certainly, the injection of PRP is safe, economic, cannot impair the biomechanical function of the foot, and none of our patients experienced any complications. We have been utilizing this procedure for about 2 years, so we consider it a technique of plantar fasciorrhaphy.

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