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ORIGINAL STUDY

Platelet-Rich-Plasma injection seems to be effective in treatment of plantar fasciitis : a case series

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Plantar fasciitis is the most common cause of heel pain. Diverse non-operative treatment options are available. The purpose of this study was to determine if a single platelet-rich-plasma injection at the origin of the plantar fascia in patients with plantar fasciitis gives a functional improvement. Patients with plantar fasciitis and failed conservative treatment were included in this retrospective study. Included patients were sent four questionnaires after platelet-rich-plasma injection. Primary outcome is functional improvement, determined by foot function index in which lower scores correlates with a better foot function. A total of 61 feet in 58 patients were included. The median foot function index before treatment was 69.4 and after treatment 31.8, which is a significant decrease. In 80.3% of the patients the foot function index decreased. Therefore platelet-rich-plasma injection seems to be effective in treatment of patients with plantar fasciitis when conservative treatment failed.

Keywords : platelet-rich-plasma ; plantar fasciitis ; tendon disorder ; plantar fascia.

INTRODUCTION

Plantar fasciitis is the most common cause of heel pain (*3*). Although the name suggests an inflammation of the plantar fascia, during the chronic phase, no inflammatory cells are found (*17*). Therefore plantar fasciitis is thought to be a degenerative process, caused by repetitive micro trauma at the point of insertion, comparable with lateral epicondylitis of the elbow (*10*). Plantar fasciitis affects mostly middle aged or older patients, slightly more women than men (*25*). Risk factors are obesity, running and prolonged standing (*29,33*).

Patients with plantar fasciitis typically presents with 'first step pain' which tends to decrease by activity and worse with heavy use (*23*). At the end of the day the pain increase in severe cases (*18*). Palpation of the medial calcaneal tubercle, the origin of the plantar fascia, is painful in plantar fasciitis (*5,23*). The role of imaging is controversial for diagnosing plantar fasciitis (*21*). Ultrasound examination can contribute to confirm this clinical diagnosis, additional imaging techniques as radiograph and MRI can be used to exclude other diagnoses when necessary (*7,21*). Sometimes a bone spur at the calcaneal bone is found on lateral radiograph of the foot. It is

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important to realise the bone spur originates from the flexor digitorum brevis muscle, not from the plantar fascia (*23*).

In general the prognosis of plantar fasciitis is benign and self-limiting, in 80-90% of patients the symptoms resolve within ten months (*15*). Various types of conservative treatment are available for treatment of plantar fasciitis : adapting life style, rest, stretching, weight loss, massage, night splints, shoe inserts, non-steroidal anti-inflammatory drugs, extracorporeal shock wave therapy, casting and taping (*7,32,36*). Although 80-90% of patients with plantar fasciitis respond to conservative treatment, high quality evidence of efficacy for any of the conservative treatment are lacking (*9,23,25*). Surgical treatment is very rare and seldom performed and is not advised to do before 12 months of conservative treatment (*5,25*).

The use of corticosteroid injections are popular and have a good short term effect in treatment of plantar fasciitis (*8,9,20,22*). However, long term results are disappointing and multiple corticosteroid injections may cause severe adverse events such as plantar fascia ruptures, structural tendon changes and fat pad atrophy (*1,7*).

Currently, for treatment of plantar fasciitis, Platelet-Rich-Plasma (PRP) injections are used although this remains an evolving concept. The use of PRP injections has increased in recent years, especially for chronic non-healing tendon injuries and muscle pathology (*11,30*). PRP is derived from autologous blood and contains high amounts of platelets and various growth factors, which are thought to initiate the body's natural healing response (*11*). The concentration of platelets in PRP is four to five times higher, compared to normal blood. It is presumed that PRP enhances the recruitment, proliferation and differentiation of cells which are involved in tissue regeneration (*11*). Good results are described for PRP injection in treatment of other enthesopathies such as lateral epicondylitis (*12,26*).

Several studies investigated the effects of PRP injections in treatment of plantar fasciitis (*2,14,16, 19,28,31*). Ragab *et al* showed effects on plantar fascia thickness, improvement in pain and good satisfaction after PRP injection (*28*). Martinelli *et al* and Kumar *et al* described a significant decrease of pain after PRP injection (*14,19*). Recently in a study of Shetty *et al* a significant improvement in pain and function after three months of PRP injection was found (*31*). Three studies compared corticosteroid injection with PRP injection for treatment of plantar fasciitis. Lee *et al* as well as Monto showed PRP injection is better in the long term and corticosteroid injection had more effect in the short term (*16,22*). Akşahin *et al* showed no significant difference observed between corticosteroid and PRP injection (*2*).

Until now, to our best knowledge, no study determined the functional outcome after PRP injections in plantar fasciitis. As described before, plantar fasciitis probably has the same pathophysiology as lateral epicondylitis, therefore we presume PRP injections can be used in treatment of plantar fasciitis. The aim of this study is to determine if a PRP injection at the origin of the plantar fascia in patients with plantar fasciitis gives a functional improvement.

MATERIALS AND METHODS

We retrospectively identified all patients who attended our institution which were diagnosed with plantar fasciitis and were treated with a PRP injection between May 2010 and July 2012. Patients with plantar fasciitis who had failed conservative treatment after a minimum period of 12 weeks were included. We accepted the following conservative treatment before PRP injection : insole, stretching, night splint, physiotherapy, pain medication, extracorporeal shock wave therapy and steroid injection. The conservative treatment was not monitored by one of the orthopaedic surgeons, since all patients underwent conservative treatment before consulting our institution.

Patients were excluded with an atypical form of plantar fasciitis in which patients presented no first step pain and the maximally tender point was not located at the medial calcaneal tubercle. Additionally patients with severe diabetes mellitus, vascular disease and patients who underwent surgery at the fascia before were excluded. The patient must have central heel pain, patients with pain located over the abductor halluces were excluded.

Approximately 54 ml whole blood is collected from the median cubital vein of the patient with a 60 ml syringe which contains six ml sodium citrate. This is injected into a Biomet (Warsaw, Indiana, USA) Gravitational Platelet Separation system (GPS) kit. The GPS kit is then placed

in a centrifuge. After spinning for 15 minutes at 3200 rounds per minute, the blood is separated in three layers. Then it is possible to extract six ml PRP from the GPS kit. Finally the pH has to increase to a physiologic level. Buffering the acid anticoagulant is done with 8.4% sodium bicarbonate solution which is added to the platelet concentrate, with a ratio of 0.05 cc sodium bicarbonate to 1cc platelet concentrate.

Before injection, the skin is made aseptic. The injection place is defined by palpating the most tender point at the insertion point of the plantar fascia. One injection is done through a medial approach by a peppering technique (single skin entry and multiple penetrations to the fascia). The patient is lying supine with the ankle in neutral position. Because the procedure is very painful this takes place under complete anaesthesia. No local anaesthesia was used since this could change the pH, which can influence the PRP effectiveness (*11*). After injection the patient was observed for a short time by the anaesthesiologist. After the wound is treated with a bandage dressing, the patient is discharged. All orthopaedic surgeons who performed PRP injection treatment in our institution followed the same protocol. The patients learned stretching exercises from a physiotherapist after PRP injection. The patients are allowed to bear full weight and can start performing stretching exercises after two weeks. Patients were advised to avoid sport activities such as running and jumping for the first four to six weeks after treatment.

After treatment we sent all included patients a digital or paper questionnaire. The questionnaire consisted of two Dutch translated versions of Foot Function Index (FFI), treatment satisfaction questions and the Short-Form Health Survey (SF-12). All questionnaires were completed after treatment.

The FFI questionnaire includes two subscales : pain and disability (*6*). All 17 questions must be answered by a VAS-scale between 0 and 10. Therefore the total FFI is between 0% which means no complaints, and 100% which means the worst outcome. Patients completed two FFI questionnaires, one regarding their function before and one regarding their function after treatment. Both questionnaires were completed after treatment.

The SF-12 is a short version of the SF-36 and contains twelve questions (*35*). The SF-12 provides two outcomes : Physical Component Summery (PCS) and Mental Component Summery (MCS).

Primary outcome of this study is to determine if functional improvement can be achieved with PRP injection. Secondary outcome is to determine treatment satisfaction of PRP injection.

Statistical analysis was performed with the SPSS statistics, version 21 (IBM SPSS, Armonk, NY, USA). Data were analysed for type of distribution by the Shapiro-Wilk test. Since the FFI outcome was not normally distributed, the Wilcoxon signed rank test was used. P-value lower than 0.05 was considered statistically significant.

RESULTS

Between May 2010 and July 2012, 75 feet of 70 patients were treated with a PRP injection for plantar fasciitis in our clinic. Four patients did not want to participate in this study, due to lack of interest. Eight patients were lost to follow-up. A total of 61 feet of 58 patients were included (Table I). Mean age was 48.7 years old (SD ± 10.3). The group consisted of 45 (73.8%) women. Body Mass Index (BMI) of the patients was between 20 and 40, with a mean of 29.1 (SD ± 4.5). Mean follow-up was 16.2 months, range five to 31 months. The left side was treated in 35 feet (57.3%).

Primary outcome

Median FFI before PRP injection was 69.4 (interquartile range 25.9). After treatment the median FFI was 31.8 (interquartile range 42.3) this is a significant reduction of FFI, p-value < 0.001 (Table II). Values are noted with interquartile range, since FFI outcome was not normally distributed, therefore no standard deviation could be determined. The post-treatment FFI decreased in 80.3% of the patients. Lower FFI value's correlate with an improvement of foot function. The mean time for patients to notice improvement of the treatment was 9.4 weeks. When the post-treatment FFI is compared with

Table I. — Characteristics of the total study population

	Feet (n = 61)
Gender, woman (%)	45 (73.8%)
Age, years	48.7 (± 10.3)
Side, right (%)	26 (42.6%)
Follow-up, months	16.2 (± 5.94)
BMI, kg/m^2	29.1 (± 4.5)

All values are presented as mean (± standard deviation), or reported otherwise.

Table II. — Foot Function Index (FFI) score

FFI	Outcome
pre-treatment	69.4 (25.9)
post-treatment	31.8 (42.3)†

All values are presented as median (interquartile range).
† $p < 0.001$ between the two groups.

pre-treatment, the mean difference is a decrease of 29.5% for all patients, this also includes patients with FFI increased after treatment. In only those patients with a reduction of their FFI, a mean reduction of 44.1% was detected. BMI and FFI showed no correlation. Furthermore no correlation is found between pre- or post-treatment FFI and SF-12 outcome.

Secondary outcome

The overall treatment satisfaction is good, 67.2% of the patients were satisfied. Although 32.8% of the patients were unsatisfied (Table III). The reason for not being satisfied was persistent pain after treatment. Patients who were unsatisfied after treatment showed besides less or no improvement in the FFI. The SF-12 physical component had a mean score of 42.9 (SD ± 11.7). The mental component scored 51.2 (SD ± 6.8) points (Table IV).

DISCUSSION

The aim of this study was to determine if a single PRP injection at the origin of the plantar fascia in patients with plantar fasciitis gives a functional improvement, determined by the FFI. In this present study 80.3% of patients, after treatment with a PRP injection, showed a lower FFI compared to FFI before the injection. Lower FFI correlates with better foot function. The pre-treatment FFI was median 69.4 (interquartile range 25.9) and after treatment a median score of 31.8 (interquartile range 42.3) was found. Patients rated in 67.2% the treatment outcome as satisfied, good or even excellent (Table III). We proposed to give a realistic view what patients can expect of treatment with PRP, nevertheless patients reported persistent pain as a reason to be dissatisfied. We could not find any correlation between the patient characteristics : BMI, SF-12 and age for poor FFI outcome. So we presume these factors have no influence on functional outcome after PRP treatment. With a minimum follow-up of five months no complications were encountered, therefore we propose this is a safe treatment option for plantar fasciitis.

Our findings in the present study, 80.3% of the patients with a decrease in FFI after PRP injection treatment and 67.2% satisfaction in treated patients, compared well with other published studies (*4,14,19*). In a recent published study, Martinelli *et al* showed good results (92.9% of the patients rated PRP injection acceptable or better) when patients were treated with three PRP injections in plantar fasciitis (*19*). In the study of Barrett *et al* 78% of the patients reported resolution of their plantar fasciitis after PRP treatment (*4*). Both studies had relatively small patient numbers, respectively 14 and nine patients. In 64% of the patients in the study of Kumar *et al* were satisfied and would undergo an injection again (*14*).

Higher prevalence of plantar fasciitis in patients with obesity is already described in other studies (*25*). Overweight is defined by the World Health Organisation as BMI greater than 25, obese is defined as BMI greater than 30. In our patient group, BMI of the patients was mean 29.1 (SD ± 4.5) which is consistent with other studies (*29,33*).

Table III. — Treatment satisfaction

	N	Percentage	Cumulative percentage
Excellent	23	37.7 %	37.7%
Good	12	19.7 %	57.4%
Acceptable	6	9.8 %	67.2%
Unsatisfied	20	32.8 %	100 %

Outcome of the general satisfaction question.

Table IV. — SF – 12 outcome after treatment

	Outcome
PCS	42.9 (± 11.7)
MCS	51.2 (± 6.8)

Abbreviations: PCS, Physical Component Summery; MCS, Mental Component Summery.

All values are presented as mean (± standard deviation).

There are some limitations in this study which need to be addressed.

First, our inclusion and exclusion criteria were straightforward. The criteria were formulated to compose a representative group of patients from our clinical practice. The broad inclusion criteria may explain why some of our patients had no benefit of PRP injection. Patients who underwent corticosteroid injection and patients who underwent extracorporeal shock wave therapy, before PRP injection, were also included. We presume good patient selection is needed to obtain better results. Although, we found no significant relation between a specific patient characteristic and inferior PRP outcome which can confirm our assumptions.

Secondly, numerous brands, concentrations and doses of PRP are available and the best sort of PRP is not known. The mechanism for healing by PRP is not fully understood and is probably depended upon platelet and leukocyte numbers and specific platelet derived growth factors. Furthermore it is not known how much PRP has to be injected (*11*). This may contribute to the variation of results in the literature. Standardization of PRP protocol is needed before different studies can be compared (*30,34*).

Thirdly, we did not compare the thickness of the plantar fascia before and after treatment by using ultrasound which is done in studies by Barrett *et al* and in Ragab *et al* (*4,28*). Both studies found a significant decrease in plantar fascia thickness after PRP injection treatment. We found no evidence in the literature if thickness of the plantar fascia is related to severity of the disease or related to the complaints of the patient. Therefore we did not measure the plantar fascia thickness.

Fourthly, the retrospective design of this study. Questionnaires are less reliable when patients complete them afterwards. Although we believe presenting this outcome is important for further prospective studies.

Fifth limitation, we did not use ultrasound to guide our PRP injections. Kane *et al* showed no advantages of ultrasound guidance over direct palpation of the most tender area for guidance for the injection (*13*).

Finally, it is suggested a peppering technique could induce more vascularisation and could lead to better results (*24*). We did inject the PRP by a peppering technique in all patients in this study. Patients were advised to perform stretching exercises after PRP-injection. We assume stretching exercise would not bias our results, since the main intervention was PRP injection and stretching did not help our patients before the intervention with PRP.

Until now no study has been undertaken which compared PRP injection with a control group who receives placebo treatment. It is important to realize plantar fasciitis is a self-limiting impairment, therefore we do not know if PRP treatment improves our outcome. Healing rates of conservative treatment and natural healing are almost equal when different studies are compared (*15,23*). It is possible that conservative treatment studies just measured natural healing time and not the effect of conservative treatment when no control group has been added. For corticosteroids, a placebo controlled trail has been undertaken which showed no benefit for corticosteroids after a longer period than four weeks (*20*).

Most studies for plantar fasciitis are case series, which have less patients and mostly no control group. We are looking forward to the multicentre study of Peerbooms *et al* which is now being performed (*27*). In this study corticosteroid injections will be compared to PRP injections in 120 patients with plantar fasciitis (*27*).

In conclusion, PRP injections can be used as a first line treatment in patients with plantar fasciitis, when conservative treatment has failed. PRP injection is a safe treatment modality and seems to give functional improvement of the foot.

REFERENCES

1. Acevedo JI and Beskin JL. Complications of plantar fascia rupture associated with corticosteroid injection. *Foot Ankle Int* 1998 ; 19 : 91-97.

2. **Aksahin E, Dogruyol D, Yuksel HY *et al.*** The comparison of the effect of corticosteroids and platelet-rich plasma (PRP) for the treatment of plantar fasciitis. *Arch Orthop Trauma Surg* 2012 ; 132 : 781-785.
3. **Barrett SJ and O'Malley R.** Plantar fasciitis and other causes of heel pain. *Am Fam Physician* 1999 ; 59 : 2200-2206.
4. **Barrett SL and Erredge SE.** Growth factors for chronic plantar fasciitis ? *Podiatry Today* 2004 ; 17 : 37-42.
5. **Buchbinder R.** Clinical practice. Plantar fasciitis. *N Engl J Med* 2004 ; 350 : 2159-66.
6. **Budiman-Mak E, Conrad KJ, Roach KE.** The Foot Function Index : a measure of foot pain and disability. *J Clin Epidemiol* 1991 ; 44 : 561-570.
7. **Cole C, Seto C and Gazewood J.** Plantar fasciitis : evidence-based review of diagnosis and therapy. *Am Fam Physician* 2005 ; 72 : 2237-2242.
8. **Crawford F, Atkins D, Young P, Edwards J.** Steroid injection for heel pain : evidence of short-term effectiveness. A randomized controlled trial. *Rheumatology (Oxford)* 1999 ; 38 : 974-977.
9. **Crawford F and Thomson C.** Interventions for treating plantar heel pain. *Cochrane Database Syst Rev* 2003 : CD000416.
10. **Cutts S, Obi N, Pasapula C and Chan W.** Plantar fasciitis. *Ann R Coll Surg Engl* 2012 ; 94 : 539-542.
11. **Foster TE, Puskas BL, Mandelbaum BR, Gerhardt MB and Rodeo SA.** Platelet-rich plasma : from basic science to clinical applications. *Am J Sports Med* 2009 ; 37 : 2259-2272.
12. **Gosens T, Peerbooms JC, van Laar W and den Oudsten BL.** Ongoing positive effect of platelet-rich plasma versus corticosteroid injection in lateral epicondylitis : a double-blind randomized controlled trial with 2-year follow-up. *Am J Sports Med* 2011 ; 39 : 1200-1208.
13. **Kane D, Greaney T, Shanahan M*, et al.*** The role of ultrasonography in the diagnosis and management of idiopathic plantar fasciitis. *Rheumatology (Oxford)* 2001 ; 40 : 1002-8.
14. **Kumar V, Millar T, Murphy PN and Clough T.** The treatment of intractable plantar fasciitis with platelet-rich plasma injection. *Foot (Edinb)* 2013 ; 23 : 74-7.
15. **League AC.** Current concepts review : plantar fasciitis. *Foot Ankle Int* 2008 ; 29 : 358-366.
16. **Lee TG and Ahmad TS.** Intralesional autologous blood injection compared to corticosteroid injection for treatment of chronic plantar fasciitis. A prospective, randomized, controlled trial. *Foot Ankle Int* 2007 ; 28 : 984-990.
17. **Lemont H, Ammirati KM and Usen N.** Plantar fasciitis : a degenerative process (fasciosis) without inflammation. *J Am Podiatr Med Assoc* 2003 ; 93 : 234-237.
18. **Lynch DM, Goforth WP, Martin JE *et al.*** Conservative treatment of plantar fasciitis. A prospective study. *J Am Podiatr Med Assoc* 1998 ; 88 : 375-380.
19. **Martinelli N, Marinozzi A, Carni S *et al.*** Platelet-rich plasma injections for chronic plantar fasciitis. *Int Orthop* 2013 ; 37 : 839-842.
20. **McMillan AM, Landorf KB, Gilheany MF *et al.*** Ultrasound guided corticosteroid injection for plantar fasciitis : randomised controlled trial. *BMJ* 2012 ; 344 : e3260.
21. **Monto RR.** Platelet-rich plasma and plantar fasciitis. *Sports Med Arthrosc* 2013 ; 21 : 220-4.
22. **Monto RR.** Platelet-Rich Plasma Efficacy Versus Corticosteroid Injection Treatment for Chronic Severe Plantar Fasciitis. *Foot Ankle Int* 2014
23. **Neufeld SK and Cerrato R.** Plantar fasciitis : evaluation and treatment. *J Am Acad Orthop Surg* 2008 ; 16 : 338-346.
24. **Okcu G, Erkan S, Senturk M, Ozalp RT, Yercan HS.** Evaluation of injection techniques in the treatment of lateral epicondylitis : a prospective randomized clinical trial. *Acta Orthop Traumatol Turc* 2012 ; 46 : 26-29.
25. **Orchard J.** Plantar fasciitis. *BMJ* 2012 ; 345 : e6603.
26. **Peerbooms JC, Sluimer J, Bruijn DJ, Gosens T.** Positive effect of an autologous platelet concentrate in lateral epicondylitis in a double-blind randomized controlled trial : platelet-rich plasma versus corticosteroid injection with a 1-year follow-up. *Am J Sports Med* 2010 ; 38 : 255-262.
27. **Peerbooms JC, van Laar W, Faber F *et al.*** Use of platelet rich plasma to treat plantar fasciitis : design of a multi centre randomized controlled trial. *BMC Musculoskelet Disord* 2010 ; 11 : 69.
28. **Ragab EM and Othman AM.** Platelets rich plasma for treatment of chronic plantar fasciitis. *Arch Orthop Trauma Surg* 2012 ; 132 : 1065-1070.
29. **Riddle DL, Pulisic M, Pidcoe P, Johnson RE.** Risk factors for Plantar fasciitis : a matched case-control study. *J Bone Joint Surg Am* 2003 ; 85-A : 872-877.
30. **Sampson S, Gerhardt M and Mandelbaum B.** Platelet rich plasma injection grafts for musculoskeletal injuries : a review. *Curr Rev Musculoskelet Med* 2008 ; 1 : 165-174.
31. **Shetty VD, Dhillon M, Hegde C, Jagtap P, Shetty S.** A study to compare the efficacy of corticosteroid therapy with platelet-rich plasma therapy in recalcitrant plantar fasciitis : a preliminary report. *Foot Ankle Surg* 2014 ; 20 : 10-3.
32. **Stuber K and Kristmanson K.** Conservative therapy for plantar fasciitis : a narrative review of randomized controlled trials. *J Can Chiropr Assoc* 2006 ; 50 : 118-133.
33. **Toomey EP.** Plantar heel pain. *Foot Ankle Clin* 2009 ; 14 : 229-245.
34. **Vannini F, Di Matteo B, Filardo G *et al.*** Platelet-rich plasma for foot and ankle pathologies : a systematic review. *Foot Ankle Surg* 2014 ; 20 : 2-9.
35. **Ware J, Jr., Kosinski M and Keller SD.** A 12-Item Short-Form Health Survey : construction of scales and preliminary tests of reliability and validity. *Med Care* 1996 ; 34 : 220-233.
36. **Young CC, Rutherford DS and Niedfeldt MW.** Treatment of plantar fasciitis. *Am Fam Physician* 2001 ; 63 : 467-474, 477-478.