Sonographically guided intratendinous injections of hyperosmolar dextrose/lidocaine: a pilot study for the treatment of chronic plantar fasciitis

M B Ryan,[1] A D Wong,[2] J H Gillies,[3] J Wong,[4] J E Taunton[5]

[1] Experimental Medicine Program, University of British Columbia, British Columbia, Canada; [2] Department of Radiology, St Paul's Hospital, Vancouver, British Columbia, Canada; [3] Department of Rheumatology, St Paul's Hospital, Vancouver, British Columbia, Canada; [4] Department of Medicine, University of British Columbia, British Columbia, Canada; [5] Department of Family Practice, University of British Columbia, British Columbia, Canada

Correspondence to: Mr Michael B Ryan, 602-1355 west 14th Avenue Vancouver V6H 1R2, Canada; mryan76@gmail.com

Accepted 30 September 2008
Published Online First 19 November 2008

ABSTRACT

Objective: To report on the effectiveness of sonographically guided injections of hyperosmolar dextrose at reducing the pain associated with chronic plantar fasciitis.

Design: Case series.

Setting: Ultrasound division of St Paul's Hospital.

Patients: 20 referrals (3 men, 17 women; age 51 (SD 13) years) from local sports medicine primary care practitioners who had failed previous conservative treatments.

Interventions: A 27-gauge needle administered a 25% dextrose/lidocaine solution under sonographic guidance at 6 week intervals returning for a median of three consultations.

Main outcome measures: Visual analogue scale (VAS) items for pain levels at rest (VAS1), activities of daily living (VAS2), and during or after physical activity (VAS3) were recorded at baseline and at the final treatment consultation (post-test). A telephone interview conducted an average of 11.8 months after the post-test consultation provided a measure of long-term follow-up.

Results: 16 patients reported a good to excellent outcome, while the symptoms in 4 patients were unchanged. There was a significant decrease ($p<0.001$) in all mean VAS items from pre-test to post-test: VAS1 (36.8 (SD 25.6) to 10.3 (10.9)), VAS2 (74.7 (20.8) to 25.0 (27.7)) and VAS3 (91.6 (9.2) to 38.7 (35.1)) and there were no apparent changes after the follow-up interview.

Conclusions: Sonographically guided dextrose injections showed a good clinical response in patients with chronic plantar fasciitis insofar as pain was reduced during rest and activity. Further studies including a control group are needed to validate these outcomes.

Plantar fasciitis, or its pseudonyms ''painful-heel syndrome'' or ''chronic plantar heel pain'', is a common injury among athletes in running-based sports as well as professions requiring prolonged periods of weight bearing. It is reported to account for 15% of all adult foot complaints requiring professional consultation, and, in a survey of 2002 running injuries, plantar fasciitis was the third most prevalent injury.[1 2] People over the age of 40 years are primarily affected; typical complaints involve morning pain, pain on standing after periods of inactivity, and pain with running subsiding after warm-up and returning later in the workout.[3]

There is limited evidence for the effectiveness of any one treatment for plantar fasciitis. In many cases, patients are recommended or prescribed a multitude of treatments of varying degrees of conservatism, usually starting with exercises to stretch and strengthen the plantar intrinsic musculature of both the foot and the calf, ice, supportive footwear, and activity modification.[1 4] Depending on outcomes, physicians may try prescription non-steroidal anti-inflammatory medication, night-splints, off-the-shelf or custom-made in-shoe orthotic devices, and/or corticosteroid injections (which are delivered either blindly or through ultrasound guidance).[5 6] Extracorporeal shock wave therapy (ESWT) may be indicated for some patients.[7 8] Surgery may be considered; however, as with most soft-tissue overuse injuries, it is not considered until all other measures have failed.[9 10]

The Cochrane Review Group concluded after reviewing 19 randomised trials involving 1626 patients that there is only limited evidence for the effectiveness of local corticosteroid injections, and the efficacy of all other apparent treatments has not been sufficiently proven in randomised controlled trials.[4] Some authors have suggested that plantar fasciitis represents a self-limiting condition without explicit proof of a treatment benefit over a wait-and-see approach.[1] In general, the clinical course of plantar fasciitis is reported as favourable, with resolution of symptoms in more than 80 per cent of patients within 12 months.[1] The concern for the practitioner lies with the roughly 20 per cent of patients who are non-responders to conservative treatment.

Prolotherapy is a technique in which a small volume of an irritant solution (proliferant) is injected at multiple sites around a ligament or tendon insertion.[11] This solution initiates a localised inflammatory response at the site of injection, which induces fibroblast proliferation and subsequent collagen synthesis from the resultant upregulation and migration of various growth factors responsible for tissue repair.[12 13] In the case of dextrose, it is speculated that the proliferative response results from the higher osmolarity of the injected solution relative to the interstitial tissue, and, correspondingly, the treatment solution is often referred to as ''hyperosmolar dextrose''. Evidence exists for the stimulation of transforming growth factor β-1, platelet-derived growth factor, connective tissue growth factor, epithelial growth factor and basic fibroblastic growth factor from mesangial cells, smooth muscle cells and gingival fibroblasts respectively upon exposure to various levels of glucose.[14–18] Topol *et al* (2005) report that 12.5% dextrose/0.5% lidocaine injections administered blindly at 1 month intervals are highly effective in their population of elite soccer and rugby players with chronic groin pain.[19]

We report on a modification of this therapeutic injection technique for the treatment of chronic plantar fasciitis. Instead of injecting peripherally to the ligament, or performing the procedure blindly, we administered intraligamentous injections of hyperosmolar dextrose/lidocaine under ultrasound guidance, targeting the abnormally thickened and hypoechoic areas in the ligament in order to stimulate healing. The present study describes the effectiveness of ultrasound-guided dextrose/lidocaine injections on pain removal in a population suffering chronic plantar fasciitis. Previous research from our group reports good results from sonographically guided intratendinous dextrose/lidocaine injections for patients with chronic painful Achilles tendinosis.[20]

MATERIALS AND METHODS

Twenty consecutive patients, three men and 17 women (mean age 51.2 (SD 12.6) years) with chronic plantar fasciitis with symptoms for more than 6 months (median 21 months; range 7–228 months) participated in this prospective study. Diagnosis of plantar fasciitis was made on the basis of pain at, or around, the plantar surface of the heel or the medial longitudinal arch. All patients in the study group were referred from board-certified sport medicine specialists within the local Vancouver area and must have failed the previous conservative treatments prescribed. Treatments included home-based physiotherapy-prescribed exercises (n = 10), custom foot orthotics (n = 7) (two included heel lifts), therapeutic ultrasound (physiotherapist) (n = 4), ESWT (n = 4), massage (registered massage therapist) (n = 3), prescribed medication (in all cases non-steroidal anti-inflammatory) (n = 3), cortisone injections (n = 3). The majority of subjects were runners (n = 13) and six individuals reported spending prolonged periods of time with weight-bearing activities (i.e. standing and walking) at work.

Exclusion criteria included patients with acute plantar foot pain or symptoms associated with acute trauma. Patients who had had surgery or interventional procedures within the preceding 6 months were also excluded. All patients were fully informed and provided written consent. The study was approved by the local institutional ethics review board.

Ultrasound examination

The ultrasound examination and the injection procedure were performed by a radiologist (AW) with extensive experience in musculoskeletal ultrasound. The plantar fascia and surrounding tissue were examined with the patient in a prone position. The ultrasound examination was performed on a Philips HDL 5000 using both a 5–12 MHz and a 7–15 MHz linear array high resolution transducer. The ligament in its entirety was examined in the longitudinal and transverse planes. Care was taken to image the plantar fascia parallel with the fibres in the longitudinal plane and perpendicular to the fibres in the transverse plane to avoid artefacts such as anisotrophy (fig 1). Colour flow Doppler was used to diagnose neovascularity.

Hyperosmolar dextrose injection

A 2.5 ml syringe was filled with 1 ml of 2% lignocaine (20 mg/ml) and 1 ml of 50% dextrose (25 g/50 ml) (dextrose monohydrate 500 mg) giving a 25% dextrose solution. Care was taken to expel all the air from the syringe and needle prior to the injection. The injection procedure was performed under aseptic conditions using a 27 G needle. Abnormal hypoechoic areas and anechoic clefts/foci in the thickened portion of the plantar fascia were targeted under ultrasound guidance using the 7–15 MHz Hockey Stick linear array transducer. The volume of solution injected varied slightly from ligament to ligament and depended on the degree of resistance, spread of solution within the ligament and extent of the abnormality. Generally less than 0.5 ml was injected at any one site. Between one and three sites were injected during a treatment session. The ligament was reimaged following the injection procedure to assess for spread of the dextrose solution and identify any intrasubstance or partial tears which became more conspicuous following the injection.

The patient was instructed to refrain from any heavy loading activity during the week following the procedure. Patients were cautioned against taking aspirin or other anti-inflammatory agents to relieve any discomfort. Acetaminophen-based analgesia was allowed.

The patient was asked to return for repeat ultrasound and injection approximately every 6 weeks depending on scheduling. This continued until either the patient's symptoms resolved or no improvement was evident, at which time the treatment was discontinued.

Data collection

At the initial consultation all patients were asked to fill out an information questionnaire containing brief questions regarding their condition, including participation in sporting activity, length of symptomatic period, previous and current treatments and level of disability.

Visual analogue scale (VAS) scores (100 mm) were recorded for assessment of pain at the baseline consultation (pre-test), and at the final treatment consultation (post-test). VAS scales have been shown to be reliable, valid and responsive tools in assessing pain levels in patients rehabilitating from a musculoskeletal condition.[21] A follow-up telephone interview conducted a mean of 11.8 months (range 6–20 months) following the patient's final treatment session (follow-up) assessed long-term outcomes by asking the patients to rate their current levels of pain at rest, during activities of daily living, and during or after sport or activity on a scale from 0 to 100. Patients were asked to complete a Visual Analogue Scale item for pain at rest (VAS1), pain during normal daily activity (VAS2), and pain during or after sporting or other physical activity (VAS3).

Data analysis

Descriptive and mean comparisons of the study data were analysed using SPSS statistical software (copyright 2006, version 15.0.1.). Paired samples t test compared the change in scores from baseline (pre-test) to post-test for the three visual analogue scale items. While the follow-up telephone interview did serve as a quantitative measure of pain, its results were not formally analysed due to the difference in administration from the earlier visual analogue scale items. Statistical significance for this study was set at a p value of 0.05.

RESULTS

There were no reported complications from the injection of hyperosmolar dextrose/lidocaine into the plantar fascia in our subject population. A median of three injection sessions (range 1 to 12) were necessary for either a satisfactory treatment outcome or determining that the patient was not responding. The majority of treatment sessions required only one injection site per treatment session (74.7%) with a mean volume of 0.7 (SD 0.45) ml. Patients returned for follow-up consultations 5.6 (2.0) weeks after each treatment session. The average time

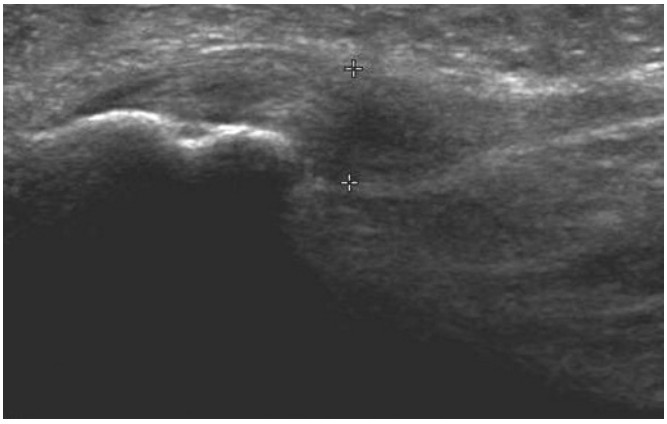

Figure 1 Ultrasound image of calcaneal insertion of plantar fascia with cursor marker indicating exaggerated tendon thickness and hypoechoic region.

period required to administer all treatment injections was 22 (15) weeks.

Most of our patients responded well to the ultrasound-guided dextrose/lidocaine injections, as reflected in the significant difference between the pre-test and post-test VAS values (table 1). The effect sizes, or Cohen's *d* values, for the difference in pre and post-test VAS1, VAS2 and VAS3 values were 1.3, 1.9, and 2.0, respectively. After the 11.8 month follow-up period, 12 patients reported being asymptomatic, four reported good outcomes (70–80% reduction in pain with return to activity), and four reported not responding to the treatment at all.

DISCUSSION

Chronic overuse injury to tendon follows a degenerative pathway that results in breakdown of extracellular constituents, namely type I collagen and proteoglycans, leading to tissue disorganisation.[22 23] The tensile strength of the tendon unit is reduced, and reinjury of the structure is increasingly likely when high load is reapplied.

The present study indicates that injections of dextrose/lidocaine under ultrasound guidance appear to reduce the pain in a majority of patients with chronic plantar fasciitis. All patients were referred from board-certified sports medicine physicians, and all patients had previously failed their prescribed conservative treatment regimen. Eighty per cent of patients undergoing this treatment reported good to excellent outcomes in pain reduction at the cessation of their treatment.

Similar findings have recently been published using sonographically guided intratendinous injections of dextrose to treat chronic insertional and non-insertional Achilles tendinosis.[20] A mean reduction in pain levels of 88%, 84% and 78% while at rest, performing activities of daily living, and during or after physical activity, respectively, was reported. Structurally, there was a mean reduction in tendon thickness, number of tendons with anechoic clefts or foci, and degree of neovascularity. Ninety-six per cent of patients contacted at 12 month follow-up reported either being asymptomatic or having a treatment satisfaction level of 70–90%.

Table 1 A summary of baseline and outcome scores for visual analogue scales (VAS) and follow-up telephone interview at rest, with activities of daily living and during sport/activity

	Pre-test VAS (mm)	Post-test VAS (mm)	Follow-up telephone interview
Pain at rest	36.8 (25.6)	10.3 (10.9)*	12.1 (21.0)
Pain with daily living	74.7 (20.8)	25.0 (27.7)*	21.6 (29.5)
Pain with sport/activity	91.6 (9.2)	38.7 (35.1)*	35.1 (41.4)

Results are expressed as mean (SD).
*Indicates significant difference ($p<0.001$).

The concept of using ultrasound guidance in the delivery of a therapeutic agent directly to the injured plantar fascia has been documented in the case of corticosteroids. Several authors report the success of steroid injections; however, there is limited evidence for this treatment without consistent results from well designed randomised controlled trials.[24–26] Results from steroid injections must also be weighed against the risks of plantar fascial rupture.[27 28] Consequently, while the Cochrane group acknowledged the popularity of steroid injections, it concluded that their treatment efficacy is useful only in the short term and to a limited degree.[4]

In the administration of cortisone to the plantar fascia, there is some discussion as to the necessity of using ultrasound guidance for optimal clinical efficacy. Tsai *et al* (2005) recommend using ultrasound guidance for improved injection accuracy, which could result in patients tolerating greater direct pressure on the plantar fascia and having a lower recurrence rate than patients receiving palpation-guided injections.[29] However, these results were not in agreement with Kane *et al* (2001), who reported no significant difference in pain levels between their ultrasound guidance and palpation control groups.[30] Sonography is implemented in our study as much to provide a comment of changing tissue structure with treatment progression as for its usefulness in refining the clinical protocol of injecting dextrose into the plantar fascia.

There are some limitations to consider with the present pilot study. The case-series design and the lack of control group limit the evidence of the treatment effect. Neither the physician administering the dextrose nor the patient was blinded to the treatment. While there was a significant improvement in pain scores from the baseline consultation to the final consultation that remained until follow-up, we cannot comment on the exact treatment mechanism, whether from the needle stick injury, the dextrose, or the average of 6 months needed to conduct the treatment.

Despite the absence of a control group and a formal randomisation scheme, the results of this study introduce a potential treatment indicating long-term efficacy in pain relief for a patient group experiencing chronic plantar fasciitis. A

What is already known on this topic

- Chronic overuse plantar fasciitis may be difficult to treat with conventional therapies and there is little agreement in the literature on accepted treatments for recalcitrant cases.
- While cortisone injections may be effective, they carry a risk of ligament rupture.

What this study adds

Introduces a treatment alternative that appears to be effective at relieving pain and improving the sonographic appearance at the plantar fascia.

multi-arm clinical trial implementing proper blinding of the practitioner and participant and randomisation into a treatment group, an anaesthetic-only group, or a wait-and-see group would provide greater insight into the specific role that dextrose plays in the effectiveness of this treatment regimen.

In conclusion, sonographically guided intraligamentous injections of hyperosmolar dextrose/lidocaine showed good clinical response in patients with long-standing plantar fasciitis with significant reduction in tendon pain at rest and during tendon-loading activities.

Acknowledgements: The authors wish to thank WorkSafeBC for their contribution to this project as well as Nike Inc. for their continued support.

Competing interests: None.

REFERENCES

1. **Buchbinder R.** Plantar Fasciitis. *N Engl J Med* 2004;**350**:2159–66.
2. **Taunton J,** Ryan M, Clement D, *et al*. A retrospective case-control analysis of 2002 running injuries. *Br J Sports Med* 2002;**36**:95–101.
3. **Khan K,** Maffulli N. Tendinopathy: an Achilles heel for athletes and clinicians. *Clin J Sports Med* 1998;**8**:151–4.
4. **Crawford F,** Thomson C. Interventions for treating plantar heel pain. *Cochrane Database Syst Rev* 2003;(3)CD000416.
5. **Powell M,** Post WR, Keener J, *et al*. Effective treatment of chronic plantar fasciitis with dorsiflexion night splint: a cross over prospective randomized outcome study. *Foot Ankle Int* 1998;**19**:10–18.
6. **Pfeffer G,** Bacchetti P, Deland J, *et al*. Comparison of custom and prefabricated orthoses in the initial treatment of proximal plantar fasciitis. *Foot Ankle Int* 1999;**20**:214–21.
7. **Rompe JD,** Hopf C, Nafe B, *et al*. Low-energy extracorporeal shock wave therapy for painful heel: a prospective controlled single blind study. *Arch Orthop Trauma Surg* 1996;**115**:75–9.
8. **Rompe JD,** Kullmer K, Riehle HM, *et al*. Effectiveness of low energy extracorporeal shock waves for chronic plantar fasciitis. *Foot Ankle Surg* 1996;**2**:215–21.
9. **Davies MS,** Weiss GA, Saxby TS. Plantar fasciitis: how successful is surgical intervention? *Foot Ankle Int* 1999;**20**:803–7.
10. **Sammarco GJ,** Helfrey RB. Surgical treatment of recalcitrant plantar fasciitis. *Foot Ankle Int* 1996;**17**:520–6.
11. **Rabago D,** Best TM, Beamsley M, *et al*. A systematic review of prolotherapy for chronic musculoskeletal pain. *Clin J Sport Med* 2005;**15**:376–82.
12. **Lui Y,** Tipton C, Matthes R, *et al*. An in situ study of the influence of a sclerosing solution in rabbit medial collateral ligaments and its junction strength. *Connect Tissue Res* 1983;**11**:95–102.
13. **Jensen K,** Rabago D, Best T, *et al*. Early inflammatory response of knee ligaments to prolotherapy in a rat model. *J Orthop Res* 2008;**26**:816–23.
14. **Oh JH,** Ha H, Yu MR, *et al*. Sequential effects of high glucose on mesangial cell transforming growth factor-beta 1 and fibronectin synthesis. *Kidney Int* 1998;**54**:1872–8.
15. **DiPaolo S,** Gesualdo L, Ranieri E, *et al*. High glucose concentration induces the overexpression of transforming growth factor-beta through the activation of a platelet-derived growth factor loop in human mesangial cells. *Am J Pathol* 1996;**149**:2095–106.
16. **Murphy M,** Godson C, Cannon S, *et al*. Suppression subtractive hybridization identifies high glucose levels as a stimulus for expression of connective tissue growth factor and other genes in human mesangial cells. *J Biol Chem* 1999;**274**:5830–4.
17. **Fukuda K,** Kawata S, Inui Y, *et al*. High concentration of glucose increases mitogenic responsiveness to heparin-binding epidermal growth factor-like growth factor in rat vascular smooth muscle cells. *Arterioscler Thromb Vasc Biol* 1997;**17**:1962–8.
18. **Ohgi S,** Johnson PW. Glucose modulates growth of gingival fibroblasts and periodontal ligament cells: correlation with expression of basic fibroblast growth factor. *J Periodontal Res* 1996;**31**:579–88.
19. **Topol G,** Reeves D, Hassanein KM. Efficacy of dextrose prolotherapy in elite male kicking-sport athletes with chronic groin pain. *Arch Phys Med Rehabil* 2005;**86**:697–702.
20. **Maxwell N,** Ryan M, Taunton J, *et al*. Sonographically guided intratendinous injection of hyperosmolar dextrose to treat chronic tendinosis of the Achilles tendon: a pilot study. *Am J Roentgenol* 2007;**189**:W215–20.
21. **Crossley K,** Bennell K, Cowan S, *et al*. Analysis of outcome measures for persons with patellofemoral pain: which are reliable and valid? *Arch Phys Med Rehabil* 2004;**85**:815–22.
22. **deMos M,** van El B, DeGroot J, *et al*. Achilles tendinosis: changes in biochemical composition and collagen turnover rate. *Am J Sports Med* 2007;**35**:1549–56.
23. **Fu S,** Chan K, Rolf CG. Increased deposition of sulfated glycosaminoglycans in human patellar tendinopathy. *Clin J Sport Med* 2007;**17**:129–34.
24. **Blockey NJ.** The painful heel. A controlled trial of the value of hydrocortisone. *BMJ* 1956:1277–8.
25. **Crawford F,** Atkins D, Young P, *et al*. Steroid injection for the treatment of plantar fasciitis: evidence of short term effectiveness. A randomised controlled trial. *Rheumatology* 1999;**38**:974–7.
26. **Gudeman SD,** Eisele SA, Heidt RS, *et al*. Treatment of plantar fasciitis by iontophoresis of 0.4% Dexamethasone. A randomised, double-blind, placebo controlled study. *Am J Sports Med* 1997;**25**:312–16.
27. **Acevedo JI,** Beskin JL. Complication of plantar fascia rupture associated with corticosteroid injection. *Foot Ankle Int* 1998;**19**:91–7.
28. **Sellman JR.** Plantar fascia rupture associated with corticosteroid injection. *Foot Ankle Int* 1994;**15**:376–81.
29. **Tsai W,** Hsu C, Chen CPC, *et al*. Plantar fasciitis treated with local steroid injection: comparison between sonographic and palpation guidance. *J Clin Ultrasound* 2005;**34**:12–16.
30. **Kane D,** Greaney T, Shanahan M, *et al*. The role of ultrasonography in the diagnosis and management of idiopathic plantar fasciitis. *Rheumatology* 2001;**40**:1002–8.

Sonographically guided intratendinous injections of hyperosmolar dextrose/lidocaine: a pilot study for the treatment of chronic plantar fasciitis

M B Ryan, A D Wong, J H Gillies, J Wong and J E Taunton

Br J Sports Med 2009 43: 303-306 originally published online November 19, 2008
doi: 10.1136/bjsm.2008.050021