

PLANTAR FASCIA-SPECIFIC STRETCHING EXERCISE IMPROVES OUTCOMES IN PATIENTS WITH CHRONIC PLANTAR FASCIITIS

A PROSPECTIVE CLINICAL TRIAL WITH TWO-YEAR FOLLOW-UP

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Background: In a previous investigation, eighty-two patients with chronic proximal plantar fasciitis for a duration of more than ten months completed a randomized, prospective clinical trial. The patients received instructions for either a plantar fascia-stretching protocol or an Achilles tendon-stretching protocol and were evaluated after eight weeks. Substantial differences were noted in favor of the group managed with the plantar fascia-stretching program. The goal of this two-year follow-up study was to evaluate the long-term outcomes of the plantar fascia-stretching protocol in patients with chronic plantar fasciitis.

Methods: Phase one of the clinical trial concluded at eight weeks. At the eight-week follow-up evaluation, all patients were instructed in the plantar fascia-stretching protocol. At the two-year follow-up evaluation, a questionnaire consisting of the pain subscale of the Foot Function Index and an outcome survey related to pain, function, and satisfaction with treatment was mailed to the eighty-two subjects who had completed the initial clinical trial. Data were analyzed with use of a mixed-model analysis of covariance for each outcome of interest.

Results: Complete data sets were obtained from sixty-six patients. The two-year follow-up results showed marked improvement for all patients after implementation of the plantar fascia-stretching exercises, with an especially high rate of improvement for those in the original group treated with the Achilles tendon-stretching program. In contrast to the eight-week results, the two-year results showed no significant differences between the groups with regard to the worst pain or pain with first steps in the morning. Descriptive analysis of the data showed that 92% (sixty-one) of the sixty-six patients reported total satisfaction or satisfaction with minor reservations. Fifty-one patients (77%) reported no limitation in recreational activities, and sixty-two (94%) reported a decrease in pain. Only sixteen of the sixty-six patients reported the need to seek treatment by a clinician.

Conclusions: This study supports the use of the tissue-specific plantar fascia-stretching protocol as the key component of treatment for chronic plantar fasciitis. Long-term benefits of the stretch include a marked decrease in pain and functional limitations and a high rate of satisfaction. This approach can provide the health-care practitioner with an effective, inexpensive, and straightforward treatment protocol.

Level of Evidence: Therapeutic Level II. See Instructions to Authors for a complete description of levels of evidence.

Proximal plantar fasciitis is the most common cause of heel pain, affecting more than two million Americans each year¹⁻³. Resolution of symptoms occurs in the majority of patients within ten months. However, approximately 10% of such individuals go on to have chronic pain⁴. In an initial study by DiGiovanni et al.⁵, eighty-two patients with chronic proximal plantar fasciitis for a duration of at least ten

months completed a randomized, prospective eight-week clinical trial. The patients were divided into a group managed with a plantar fascia-specific stretching protocol and a group managed with an Achilles tendon-stretching protocol. Although improvement was noted in both groups at the time of the eight-week follow-up, the group managed with the non-weight-bearing plantar fascia-stretching protocol was found

to have superior results with regard to pain, function, and overall satisfaction compared with those managed with the Achilles tendon-stretching protocol. The major goal of the tissue-specific plantar fascia-stretching protocol was to optimize tissue tension through a controlled stretch of the plantar fascia by recreation of the windlass mechanism (metatarsophalangeal joint dorsiflexion and ankle dorsiflexion). This stretching protocol was developed by us and was a modification of a more traditional plantar fascia stretch, which typically involves weight-bearing with limited toe dorsiflexion². Additionally, a key component of the protocol was focused on limiting microtrauma and associated chronic inflammation by performing the exercises prior to the first steps in the morning or after prolonged sitting or inactivity. The plantar fascia-stretching technique is illustrated in Figure 1.

The changes reported after a relatively short period of intervention were positive and were linked to the specificity of the tissue-stretching technique⁵; however, the long-term effects of the plantar fascia-specific stretching protocol on pain and activity limitations in patients with chronic proximal plantar fasciitis are not known. The purpose of this study was to evaluate the long-term outcomes of the plantar fascia-specific stretch in patients with chronic plantar fasciitis. We



Fig. 1

Plantar fascia-stretching exercise. The patient crossed the affected leg over the contralateral leg. While placing the fingers across the base of the toes, the patient pulled the toes back toward the shin until he or she felt a stretch in the arch or plantar fascia. The patient confirmed that the stretch was correct by palpating tension in the plantar fascia. (Reprinted from: DiGiovanni BF, Nawoczenski DA, Lintal ME, Moore EA, Murray JC, Wilding GE, Baumhauer JF. Tissue-specific plantar fascia-stretching exercise enhances outcomes in patients with chronic heel pain. A prospective, randomized study. *J Bone Joint Surg Am.* 2003;85:1270-7.)

hypothesized that the improvement in symptoms noted at eight weeks would persist at the two-year follow-up interval.

Materials and Methods

One hundred and one patients were enrolled in phase one of this prospective randomized clinical trial between January 1, 2001, and June 1, 2001. All subjects gave informed consent, and the study was approved by the institutional review board at the University of Rochester and was conducted in the Movement Analysis Laboratory at Ithaca College, Department of Physical Therapy, University of Rochester campus. There were thirty-three men and sixty-eight women, with a mean age of forty-five years (range, twenty-three to sixty years), and all had had chronic heel pain for more than ten months⁵. All patients exhibited maximal tenderness with palpation at the origin of the plantar fascia on the medial calcaneal tubercle, confirming a diagnosis of proximal plantar fasciitis. Patients were excluded if they had a history of systemic disease, prior heel surgery, or heel pain that was not consistent with the diagnosis of proximal plantar fasciitis.

All patients received prefabricated full-length soft insoles (Spenco cross trainer; Spenco, Waco, Texas), a three-week course of celecoxib, and viewed an educational video on plantar fasciitis. They were randomized to receive either a plantar fascia tissue-stretching protocol (Group A) or an Achilles tendon-stretching protocol (Group B). To perform the plantar fascia stretch (see Figure 1), the patient was instructed to first cross the affected leg over the contralateral leg while seated. The patient then applied force distal to the metatarsophalangeal joints on the affected side, pulling the toes upward toward the shin until a stretch was felt in the sole of the foot. Tension in the plantar fascia was palpated with the contralateral hand while performing the stretch. Both groups were instructed to hold the assigned stretch for ten seconds and to repeat it ten times. The patients were instructed to follow the assigned protocol three times per day, and those in the plantar fascia-stretching group were encouraged to perform it prior to any weight-bearing. The patients completed the pain subscale of the Foot Function Index and an outcome survey that incorporated generic and condition-specific outcome measures related to pain, function, and satisfaction with treatment. Eighty-two patients (a response rate of 81%), which included forty-six patients from Group A and thirty-six from Group B, returned for follow-up evaluation after eight weeks.

At the conclusion of phase one, all patients managed with the Achilles tendon-stretching protocol were given the plantar fascia-specific stretching protocol. They were instructed to perform the exercise in a manner similar to that used by the original group managed with the plantar fascia-stretching protocol (i.e., three times a day, with the first stretch done before the first step was taken in the morning, the patient holding the stretch for a count of ten and repeating it ten times). They were asked to perform the stretching protocol for a minimum of eight weeks, and thereafter as pain necessitated. In addition, the patients were encouraged to continue the use of the prefabricated insole provided to them in phase one of the study.

TABLE I Regression Coefficients from Mixed-Model Analyses of the Visual Analog Scale Scores from the Pain Subscale of the Foot Function Index

	Visual Analog Scale Score on the Pain Subscale of the Foot Function Index*					
	Item 1 (Pain at Its Worst)		Item 2 (First Steps in the Morning)		Total Score (Items 1-7)	
	Score	P Value	Score	P Value	Score	P Value
Time (two years compared with eight weeks)	-29.8 (5.5)	<0.0001	-37 (5.2)	<0.0001	-20.3 (4)	<0.0001
Group (A compared with B)	-13.6 (4.7)	0.0202	-20.9 (5.3)	0.0131	-11.2 (4.4)	0.0289
Time and group		0.2954		0.0096		0.4776
Group A: eight week change from baseline	-25.9 (3.4)	<0.0001	-28.8 (4.2)	<0.0001	-19.6 (3)	<0.0001
Group B: eight week change from baseline	-12.3 (3.7)	0.0014	-9.7 (4.6)	0.0379	-8.3 (3.2)	0.0106
Group A: two year change from baseline	-47.9 (4.3)	<0.0001	-48.1 (5)	<0.0001	-36 (3.8)	<0.0001
Group B: two year change from baseline	-42 (4.6)	<0.0001	-46.7 (5)	<0.0001	-28.6 (4)	<0.0001
Group difference at eight weeks	-13.6 (4.7)	0.0262	-19.1 (5.9)	0.0094	-11.2 (4.4)	0.0579
Group difference at two years	-5.9 (6.2)	0.7786	-1.4 (7.1)	0.9967	-7.4 (5.5)	0.5373

*The values are given as the estimated mean with the standard error in parentheses. The p value represents the significance of the test that the mean is zero. Group A = patients managed with plantar fascia-stretching exercises, and Group B = patients managed with Achilles tendon-stretching exercises.

At the time of the two-year follow-up, a questionnaire was mailed to the eighty-two patients seen at the eight-week follow-up visit. The questionnaire addressed pain, function, and satisfaction with treatment. The patients were also asked about symptom duration, the need for additional treatment over the past two years, and the type of treatment. Additionally, they were asked to complete the same items from the pain subscale of the Foot Function Index⁶ as were completed in phase one of the study (see Appendix). Similar to the earlier investigation, the changes in the numeric scores for the first two items on the pain subscale of the Foot Function Index were selected a priori to be evaluated separately, as these items were thought to be most clinically relevant to the symptoms of the patients. These questions were "How severe is your heel pain at its worst?" (item 1) and "How severe is your heel pain after you first get up in the morning with the first few steps?" (item 2). The total score, for items 1 through 7, was also analyzed and reported. In addition to addressing pain, function, and satisfaction with treatment, the patients were queried with regard to symptom duration, the need for additional treatment, and the type of treatment.

Statistical Methods

The data were analyzed longitudinally with use of a mixed-model analysis of covariance for each outcome of interest. This approach allows for the interdependence that exists between measurements taken from the same subject. The change in the visual analog scale score from baseline for items 1 and 2 of the Foot Function Index, as well as for the total score, was calculated and analyzed longitudinally for the two-year period. Since change was calculated as the score at time *t* minus the score at baseline, a negative change represents an improvement in the score. Included in the model as independent variables were a variable representing the treatment received

during the first eight-week period (plantar fascia-stretching compared with Achilles tendon-stretching), a time variable (eight weeks or two years), and a group and time interaction to allow for possible differences between the two groups at different time-points. Also included were the baseline variables of age, gender, body mass index, weight, hours spent standing during the day, and the duration of the symptoms. In order to simplify the interpretation, the duration of the symptoms was dichotomized into two levels: a short symptom duration (two years or less) and a long symptom duration (more than two years). To assess whether the change was related to baseline heel pain, the baseline visual analog scale score was added as an independent variable in this model. The model described above was fit for the visual analog scale scores on the total pain subscale, as well as separately for item 1 and item 2 of the Foot Function Index. Linear contrasts of fitted model parameters were constructed and were used to test the specific hypothesis of interest. Standard diagnostic tools were used to assess model fit and to identify any possible statistical outliers. All statistical tests were two-sided and were based on a nominal significance level of 0.05. Descriptive methods were used to evaluate self-reported outcome measures focusing on pain, function, and satisfaction with treatment.

Results

At the two-year follow-up evaluation, complete data sets were obtained from sixty-six patients (thirty-nine from Group A and twenty-seven from Group B), representing an 80% response rate; fifty patients had responded by mail and sixteen, by telephone. Regression coefficients for the main effects (time and group), as well as the interaction, are presented in Table I. Group A was managed with the plantar fascia-stretching program, and Group B was managed with the Achilles tendon-stretching program. Note that negative values

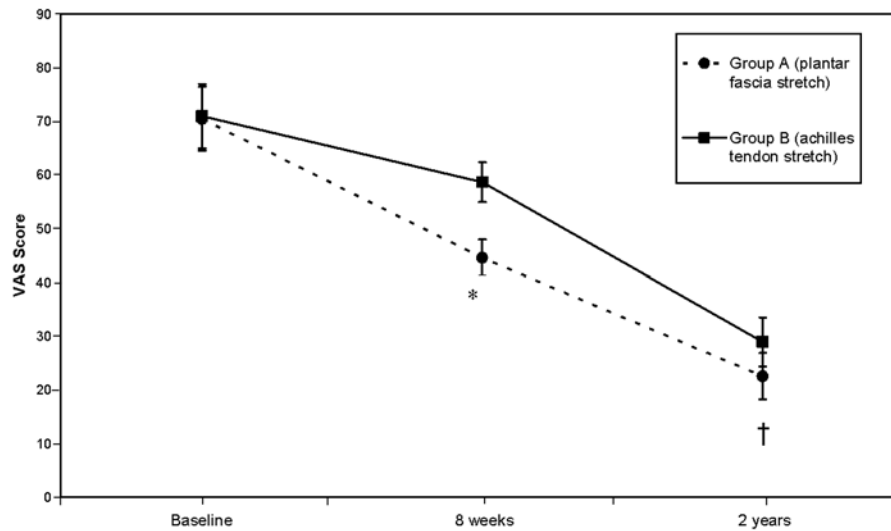


Fig. 2

Pain at its worst: item 1 on the pain subscale of the Foot Function Index. The asterisk indicates a significant improvement at eight weeks in the group managed with the plantar fascia-stretching protocol (A) compared with the group managed with the Achilles tendon stretch (B) ($p = 0.03$). No significant difference was found between the groups at two years once all subjects were given the plantar fascia-specific stretching protocol ($p = 0.78$). The dagger indicates a significant improvement in both groups from the baseline measurements ($p < 0.0001$).

reflect a reduction in pain scores for each dependent measure. Following implementation of the plantar fascia-stretching program in all patients at eight weeks, significant improvement in the pain score was noted ($p < 0.0001$). This was observed for item 1, item 2, and the total visual analog scale score

on the Foot Function Index. The trend of improvement continued, and, at the two-year follow-up, both groups had similar amounts of overall pain reduction compared with the initial baseline pain. In fact, in contrast to the results at the eight-week follow-up, those at the two-year follow-up showed

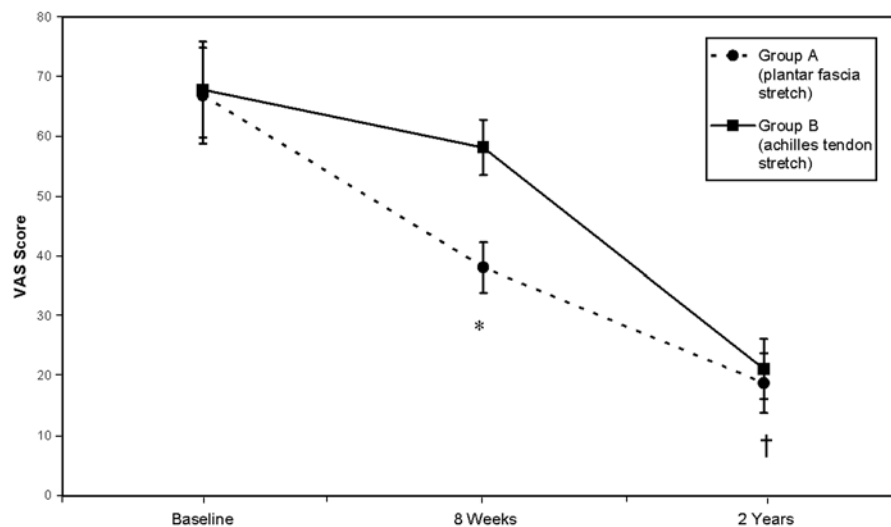


Fig. 3

First steps in the morning: item 2 on the pain subscale of the Foot Function Index. The asterisk indicates a significant improvement at eight weeks in the group managed with the plantar fascia-stretching protocol (A) compared with the group managed with the Achilles tendon stretch (B) ($p = 0.009$). No significant difference was found between the groups at two years once all subjects were given the plantar fascia-specific stretching protocol ($p = 0.997$). The dagger indicates a significant improvement in both groups from the baseline measurements ($p < 0.0001$).

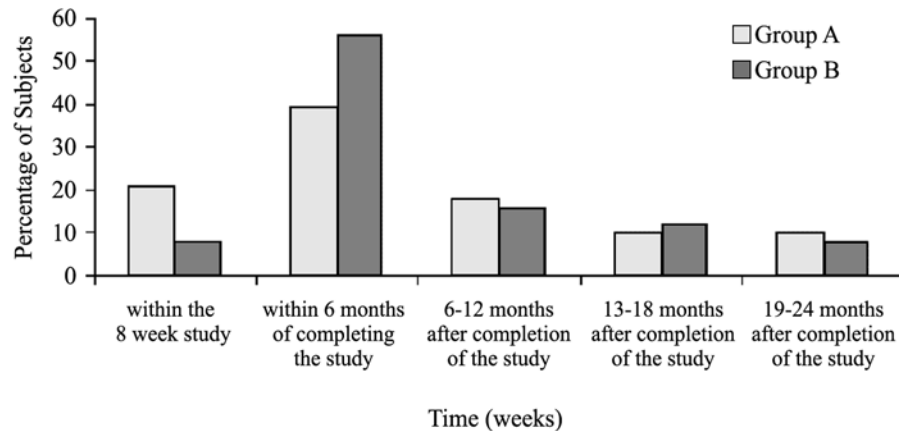


Fig. 4
Time needed to achieve the best results.

no significant differences between the groups for item 1 (worst pain; $p = 0.78$) and item 2 (first steps in the morning; $p = 0.997$) of the Foot Function Index (Figs. 2 and 3). Baseline variables were not significantly different between the groups.

The full regression analysis for all variables, including baseline variables, can be found in the Appendix.

Groups A and B were combined for descriptive analysis as no significant differences were found between them at two years. The responses based on pain, function, satisfaction, and need to seek additional treatment demonstrated an overall positive response. Forty-one (62%) of the sixty-six patients achieved the best results within six months after initiation of the plantar fascia-specific stretching program (Fig. 4). Sixty-two patients (94%) reported no pain or less pain than before treatment, with thirty-eight (58%) reporting no pain. In addition, fifty-one patients (77%) reported no limitation in recreational activities or activities of daily living, and sixty-one patients (92%) reported total satisfaction (forty-two patients) or satisfaction with minor reservations (nineteen patients) with the treatment protocol. Within the two-year follow-up period, only twelve (18%) of the sixty-six patients reported the need to seek additional treatment by a physician and four (6%) reported seeking treatment by a physical therapist. Of the patients who reported the need to seek additional treatment during the two-year follow-up, none underwent surgery. The nonsurgical interventions included one or more of the following: different shoe inserts, injections, night splints, and/or taping.

Discussion

The outcome for individuals with acute plantar fasciitis has been studied and is typically favorable. The vast majority, approximately 90%, have resolution of the symptoms within ten months⁴. The outcome for the other 10% with chronic plantar fasciitis is not well understood. Prolonged symptoms may lead to further treatments, including surgical intervention. However, despite varied surgical methods, the typical recovery is prolonged and often does not allow for full function. A fre-

quently used surgical approach, partial plantar fascia release with nerve release, has resulted in mixed outcomes. Davis et al.⁴ reported that <50% of patients with chronic heel pain were totally satisfied with the results of surgical intervention. Although Conflitti and Tarquinio⁷ noted a high satisfaction rate, only 57% of their patients had no functional limitation post-operatively. Consequently, we believe that it is important to further optimize nonoperative treatments prior to considering surgical options.

The majority of the nonoperative treatments for plantar fasciitis have demonstrated positive or encouraging results, although a long duration of symptoms is not uncommon. These modalities include night splints⁸⁻¹⁰, prefabricated and custom-made inserts, shoe modifications, stretching exercises, nonsteroidal anti-inflammatory medications, cortisone injections, application of a cast, shock wave therapy^{11,12}, or any combination of these modalities^{2-5,13-15}. However, outcome investigations of the noninvasive therapies have focused primarily on acute plantar fasciitis or have had limitations in study design. Furthermore, few investigations have reported on the long-term benefits. In a recent randomized, controlled study of the short-term and long-term effectiveness of high-energy shock wave treatment for chronic plantar fasciitis, Ogden et al.¹¹ reported that 77% of all patients who had one or more treatments had good or excellent results.

Treatment with a night splint has shown especially encouraging results in well-designed, prospective, randomized studies^{9,10}. Although limited to short-term follow-up, the splints have been shown to be effective for recalcitrant plantar fasciitis in the majority of patients^{8-10,16}. The splint incorporates ankle dorsiflexion and toe dorsiflexion, effectively recreating the windlass mechanism, and it can be likened to the plantar fascia stretch used in the current study. Yet there are three major advantages inherent to the plantar fascia stretch. One advantage is that it can be performed throughout the course of the day, especially prior to standing and after prolonged sitting, which is not possible with the night splint. Additionally, issues related to patient comfort and

compliance that may limit the use of a night splint are not factors typically associated with the plantar fascia stretch. Lastly, the plantar fascia stretch may be more cost-effective.

Stretching exercises, although central to most treatment protocols, have rarely been evaluated in isolation or for their long-term benefits. In evaluating the data from the current study, as well as our phase-one clinical trial, we noted an overall positive response to the plantar fascia stretch. In regard to pain and the visual analog scale scores at the eight-week follow-up evaluation, both groups showed significant improvement from baseline in favor of the group managed with the plantar fascia stretch. At eight weeks, all subjects were given the plantar fascia-stretching protocol and improvement continued. At the two-year follow-up evaluation, these changes from baseline were significant for both groups ($p < 0.0001$) (Table I). The trend of improvement, as shown by the slope of the changed scores, suggests that the plantar fascia stretch was a major contributor to this improvement, and the groups were no longer different at the two-year follow-up evaluation (Figs. 2 and 3; Table I). It is important to note that because there was no control (or nonintervention) group, we cannot definitively conclude that this finding is solely a result of the plantar fascia stretch compared with a stretching protocol in general. However, the original design of phase one of the study, in which only subjects with chronic symptoms (more than ten months in duration) were included, was chosen to minimize the possibility of improvement secondary to time alone.

The descriptive analysis provides important information about long-term function and patient expectations to aid us when counseling patients. The data indicate that >90% of patients will be satisfied and experience a reduction in symptoms. Furthermore, the chance of returning to full activity as well as the chance that no further treatment will be needed is >75%. These results are particularly encouraging when considering the high level of pretreatment pain, as depicted by the visual analog scale scores, and the fact that all subjects had had chronic symptoms for at least ten months.


The expected rate of improvement is often a central question for patients seeking treatment for plantar fasciitis, and this study provides important information in this regard. As noted in Figure 4, the majority of subjects achieved the best results within six months, with a small percentage improving in subsequent months. Consequently, we suggest the use of the plantar fascia-specific stretching protocol for six months and, if it is not successful at that point, then another treatment approach should be pursued.

The strengths of this study are based in its original prospective, randomized design and the long-term information available at two years. In addition, stringent patient inclusion criteria were used. If patients did not exhibit the classic signs and symptoms of proximal plantar fasciitis, including tenderness localized to the medial calcaneal tubercle and pain with the first steps in the morning, they were excluded from the study. In addition, patients with chronic symptoms for at least ten months were intentionally chosen to minimize the effect

of a natural improvement based on the passage of time, which is often noted in individuals with acute plantar fasciitis. Yet, study limitations do exist. There were attrition rates of about 20% at the eight-week study period and again at the two-year follow-up evaluation. This could have led to altered results. An additional limitation is that the optimal position to achieve an effective stretch of the plantar fascia is not known. Further studies are needed to determine optimal ankle and foot configurations that would further refine the plantar fascia-specific stretch.

For patients with chronic proximal plantar fasciitis, this study reinforces the value of the plantar fascia-stretching protocol. We believe that it is an important component of treatment, superior to the traditional weight-bearing Achilles tendon stretch. These results provide us with an effective, inexpensive, and straightforward treatment protocol for the treatment of chronic proximal plantar fasciitis.

Appendix

 The pain subscale of the Foot Function Index and the details of the regression analysis are available with the electronic versions of this article, on our web site at jbjs.org (go to the article citation and click on "Supplementary Material") and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM). ■

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