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The Impact of Custom Semirigid Foot Orthotics on Pain and Disability for Individuals With Plantar Fasciitis

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Study Design: Single-group, pre-, and postintervention repeated measures design.
Objective: To determine the impact of custom semirigid foot orthotics on pain and disability for individuals with plantar fasciitis.
Background: Few studies have examined the efficacy of foot orthotics for plantar fasciitis, and no single study has yet examined the effects of semirigid foot orthotics on an established quality-of-life instrument.
Methods and Measures: Eight men and 7 women (mean ages 44.7 ± 9.0 years) who reported having plantar fasciitis symptoms for an average of 21.3 ± 23.7 months participated in the study. Subjects were timed for a 100-m walk at a self-selected speed, then they rated the pain they experienced during the walk using a 10-cm visual analog scale. Subjects also completed the pain and disability subsections of the Foot Function Index questionnaire. All measures were acquired before the fabrication of custom semirigid foot orthotics and 12 to 17 days following onset of foot orthotic use.
Results: Postorthotic 100-m walk times were not significantly different ($t = 0.39$, $P = 0.70$) than preorthotic values. Postorthotic pain ratings (mean = 0.7 ± 0.7) for the 100-m walk were significantly less than (Wilcoxon $t = 1$, $P < 0.005$) preorthotic pain ratings (mean = 3.0 ± 1.7). Postorthotic Foot Function Index pain subsection ratings (Wilcoxon $t = 0$, $P < 0.005$) were significantly less than preorthotic ratings, demonstrating a 66% reduction in pain ratings. Postorthotic Foot Function Index disability subsection ratings (Wilcoxon $t = 0$, $P < 0.005$) were significantly less than preorthotic ratings, demonstrating a 75% reduction in disability ratings.
Conclusion: Custom semirigid foot orthotics may significantly reduce pain experienced during walking and may reduce more global measures of pain and disability for patients with chronic plantar fasciitis. *J Orthop Sports Phys Ther 2002;32:149–157.*

Key Words: *heel pain, orthotics, plantar fasciitis*

RESEARCH REPORT

Incidence rates for plantar fasciitis are not available, but several authors have suggested that plantar fasciitis is the most common cause of heel pain and constitutes approximately 15% of all foot-related problems.[1,9,23] Plantar fasciitis is an overuse injury characterized by inflammation of the plantar aponeurosis and perifascial structures.[12,16,17] Patients with plantar fasciitis commonly report pain that is most noticeable upon initial weight bearing in the morning,[8,17,26] after periods of inactivity,[8,12,17] after standing on hard, unyielding surfaces,[10] while standing on tiptoes,[23] or climbing stairs.[23] The pain often decreases after a few minutes of weight bearing but gradually increases throughout the day.[12,17,23] A prominent clinical sign associated with plantar fasciitis is tenderness to palpation of the medial calcaneal tuberosity and the medial aspect of the proximal longitudinal arch.[8,12,16,21]

Several factors have been suggested as contributing to the development of plantar fasciitis. A decrease in height of the longitudinal arch may stretch the plantar fascia and increase tensile stress

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This study was approved by the Committee for the Protection of the Rights of Human Subjects at the University of North Carolina at Chapel Hill.
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imposed on the medial calcaneal tuberosity.[8,16] Conditions associated with pronation, such as pes planus,[9] compensation for a tight gastrocnemius,[16] and weight bearing over an externally rotated lower extremity,[16] may predispose patients to plantar fasciitis. Other contributing factors may be pes cavus,[16] fat-pad degeneration,[16,24] repetitive microtrauma of the plantar fascia,[16,23] excess body weight,[24] and sudden increases in activity level.[13]

A variety of interventions have been suggested to treat plantar fasciitis. Conservative treatments of plantar fasciitis include stretching,[6,12,18,21,26] night splints,[12,18,26] corticosteroid injections,[8,10,18,26] thermal modalities,[12,16] prefabricated shoe inserts,[18,21,26] and custom foot orthotics.[4,18,21,26] Practitioners frequently incorporate multiple interventions to treat plantar fasciitis.

Limited research is available regarding the outcomes of plantar fasciitis treatment regimens. Martin et al[18] conducted a retrospective study in which all patients received a resting dorsiflexion night splint, a prescription for an oral nonsteroidal anti-inflammatory medicine, one physical therapy visit, and either a custom foot orthotic or a prefabricated heel cup. Pfeffer et al[21] used stretching in conjunction with heel cups or rigid custom foot orthotics. A retrospective study by Wolgin et al[26] examined the long-term results of 100 patients who were provided a handout of conservative intervention options and allowed to choose their own treatment regimen. Lynch et al[17] examined the effects of taping and a long metatarsal pad for 4 weeks followed by 6 weeks of orthotic treatment. The study by Lynch et al[17] did not describe the characteristics of the foot orthotics used (eg, rigid or semirigid). In these studies, the use of multiple interventions makes it difficult to determine the effectiveness of any specific intervention.

Clinical experience indicates that custom foot orthotics are used commonly as an intervention for plantar fasciitis; however, there is little information available on their mechanism of action and how they affect treatment outcomes. Two previous research reports may be helpful in regard to the mechanism of action of orthotics.[14,15] Kogler et al[15] performed a cadaver study that compared the effects of five different foot orthotics and an oxford shoe on strain of the plantar fascia. Plantar fascia strain was lowest for loading conditions in which the foot orthotics provided a higher medial longitudinal arch. Kitaoka et al[14] also reported that two foot orthotic devices were effective in maintaining medial longitudinal arch height when axial loads were imposed on cadaveric foot specimens. The studies by Kogler et al[15] and Kitaoka et al[14] speak to the need for a custom-fitted orthotic that is both comfortable and provides sufficient medial longitudinal arch height to protect against excessive tensile strain of the plantar fascia.

Three general categories of foot orthotics are rigid, semirigid, and soft. These categories are based on the stiffness of the moldable materials used for the orthotic, which determines the temperature needed to render the materials malleable before the molding process.[20] Smith et al[25] suggest that rigid foot orthotics are used primarily to control motion, semirigid foot orthotics to control motion and provide some shock absorption, and soft foot orthotics to provide shock absorption with less motion control. Pfeffer et al[21] compared rigid custom foot orthotics to soft heel inserts and reported that the rigid foot orthotics were no more effective than the heel inserts in reducing pain associated with plantar fasciitis. In the latter study, subjects who used the rigid foot orthotics more than 8 hours per day actually reported increased pain levels. Pfeffer et al[21] suggested that a less rigid custom foot orthotic might have been more effective than the rigid orthotic. Our own clinical experience suggests that rigid foot orthotics may be effective in maintaining medial longitudinal arch height, but may impose excessive and uncomfortable compressive stress on the proximal insertion site of the plantar fascia.

Few studies have examined the efficacy of foot orthotics for plantar fasciitis. We have not identified a single study that uses an established quality-of-life instrument to measure the effects of custom semirigid foot orthotics on pain associated with plantar fasciitis. The purpose of this study, therefore, was to determine the impact of custom semirigid foot orthotics on pain and disability for individuals with plantar fasciitis.

METHODS

Subjects

Potential subjects were recruited using fliers and contacts with local physical therapy clinics, physician offices, and health clubs. Eight men and 7 women participated in the study. Subjects were 18 years or older and reported having medial arch or heel pain for a period of at least 1 month before participation in the study. An additional inclusion criterion was tenderness to palpation along the posteromedial aspect of the longitudinal arch or over the medial calcaneal tubercle. Subjects were excluded if they reported (1) any other lower-extremity injury during the previous 6 months; (2) receiving a plantar steroid injection within the previous 3 months; (3) use of nonsteroidal anti-inflammatory medications within the previous 1 week; (4) use of custom foot orthotics previously; (5) any other painful foot condition such as bunion, corn, or ingrown toe nail; or (6) any other lower-extremity neuromuscular condition that affected activities of daily living.

Subjects agreed to not receive any other form of treatment for their plantar fasciitis during their enrollment in the study. The study protocol was approved by the Committee for the Protection of the Rights of Human Subjects at the University of North Carolina at Chapel Hill. Each subject signed a statement of informed consent, and the rights of each subject were protected throughout the course of the study.

Instrumentation

The Foot Function Index[3,22] questionnaire was used to assess pain and disability associated with each subject's plantar fasciitis. The Foot Function Index is a functional outcome measure that consists of three subsections: pain, disability, and activity. A study by Budiman-Mak et al[3] examined test-retest reliability, internal consistency, and construct and criterion validity of the questionnaire. The study involved 87 patients with rheumatoid arthritis of foot and ankle joints, with a mean age of 61 years. Subjects completed the Foot Function Index on site, then repeated the administration of the Foot Function Index at home 1 week later and mailed the questionnaire to the investigators. Test-retest reliability calculated with intraclass correlation coefficients (ICC) for the total Foot Function Index score was ICC = 0.87. Reliability ICC values for the subsections were ICC = 0.70 for pain, ICC = 0.84 for disability, and ICC = 0.81 for activity. Internal consistency, or the degree to which items on the Foot Function Index measures the same characteristic, was assessed using Cronbach's alpha. Internal consistency was equal to 0.96 for the entire Foot Function Index, 0.95 for the pain subsection, 0.93 for the disability subsection, and 0.73 for the activity subsection. The Foot Function Index was originally developed as an outcome measure for patients with rheumatoid arthritis. Budiman-Mak et al[3] suggested that their results could be generalized to patients with other painful and disabling conditions, because nothing in the design of the Foot Function Index was specific to rheumatoid arthritis as the source of pathology.

Only the pain and disability subsections of the Foot Function Index were used in our study. Clinical experience suggests that most of the questions on the activity subsection do not apply to patients with plantar fasciitis (eg, questions related to the use of assistive devices and staying in bed most of the day). We also deleted a question from the pain subsection that pertains to foot pain ''before you get up in the morning,'' because most patients with plantar fasciitis do not complain of pain in the morning until they stand on the affected foot. The pain and disability subsections of the Foot Function Index consist of questions for which the subject is asked to rate aspects of pain and disability that are related to their foot condition using 10-cm visual analog scales. The pain subsection consisted of 6 questions and the disability subsection had 9 questions. The subsections, as used in this study, appear as Appendix A (pain) and Appendix B (disability).

Two additional instruments were used for a 100-m walk task. A standard stopwatch was used to measure time needed to complete a 100-m walk. A 10-cm visual analog scale was used by the subjects to rate the pain they experienced during the 100-m walk. The descriptor placed at the left end of the 10-cm line was ''No Pain,'' and the descriptor placed at the right end of the 10-cm line was ''Worst Possible Pain.''[2,19] Finally, a metric ruler was used to measure pain ratings on the 10-cm visual analog scale and to score the Foot Function Index.

Procedure

All potential subjects attended an initial screening session to determine if they met the inclusion-exclusion criteria. If the inclusion-exclusion criteria were met, the subject signed a statement of informed consent. If the subject's affected foot or feet had the appearance of excessive pronation based on a qualitative assessment of medial longitudinal arch height and calcaneal angle,[11] shoes were recommended that had a straight last, a stiff heel counter, and stiffness of the rear portion of the shoe to minimize bending and twisting of the shoe.[11] If the subject did not own shoes that had these characteristics, the investigators recommended, but did not require, that the subject purchase new shoes before reporting for testing.

Subjects then attended a clinic visit during which they were assessed by the principal investigator for structural alignment[11] and walking gait. Any previous interventions by healthcare personnel for their plantar fasciitis were recorded. The use of nonprescription medications and over-the-counter arch supports and heel cups was also recorded. Subjects completed the pain and disability subscales of the Foot Function Index. Subjects then performed a timed 100-m walk at a self-selected walking speed for which they were asked to ''walk at a comfortable pace.'' The 100-m walk task required that each subject walk back and forth twice on a 25-m distance that was marked on a flat, dry surface. Immediately following completion of the walking task, subjects rated any pain experienced during the walk using a 10-cm visual analog scale labeled ''No Pain'' at the left, and ''Worst Possible Pain'' at the right. A stopwatch was used to measure the time needed to complete the 100-m walk to the nearest second, but subjects were masked to the fact they were timed for the task.

Bilateral custom semirigid foot orthotics were made for each subject by the principal investigator based on individual needs of each subject. The orthotic blank (Fastech, Troy, MI) consisted of four layers. A vinyl top layer (Figure 1A) covered a second layer of 2.4-mm low-density material designed

for shock absorption. A third layer consisted of a 2.5-mm-thick thermoplastic core (Figure 1B). The bottom layer was a leather covering (Figure 1B). The orthotic blank was heated in a convection oven at 250° F for approximately 5 minutes, then molded to the plantar surface of the subject's foot.

The subject was seated on a stool for the orthotic-molding process. The heated orthotic blank was placed on a foam cushion, and the principal investigator placed the subject's foot on the orthotic blank. The subject's rearfoot was maintained in a relatively neutral position (ie, calcaneus midline qualitatively aligned with the midline of the distal leg) for molding. The principal investigator applied one hand to the proximal dorsal surface of the foot, imposing an inferior force of approximately 223 N (50 lbs). The investigator's other hand applied a superior force of approximately 22 N (5 lbs) to the underside of the foam cushion to push the orthotic blank against the plantar surface of the foot. The foot was held in place for approximately 2 minutes, then the orthotic blank was prepared for the application of posting material.

Contact cement was applied and allowed to dry to the bottom of the orthotic blank and to the thermal cork (Figure 1C) used for posting. The thermal cork was heated for approximately 30 seconds to increase pliability and was attached to the inferior surface of the orthotic blank for all subjects. The cork material was ground to accommodate the specific requirements of the subjects. Cork material was left to fill the concavity underneath the medial longitudinal arch portion of the orthotic. A medial rearfoot post was provided for subjects who demonstrated foot pronation associated with varum of the distal leg. The need for medial forefoot posting was based on a qualitative assessment of the magnitude of forefoot varus present.[11] Aliplast (Alimed, Dedham, MA) was used for any additional posting or filling of the medial longitudinal arch. Additional grinding was performed after application of the Aliplast to make any final modifications for posting or filling of the medial longitudinal arch.

Subjects were asked to wear the foot orthotics as frequently as possible over the next 12 to 17 days during waking hours. Each subject kept a daily log to

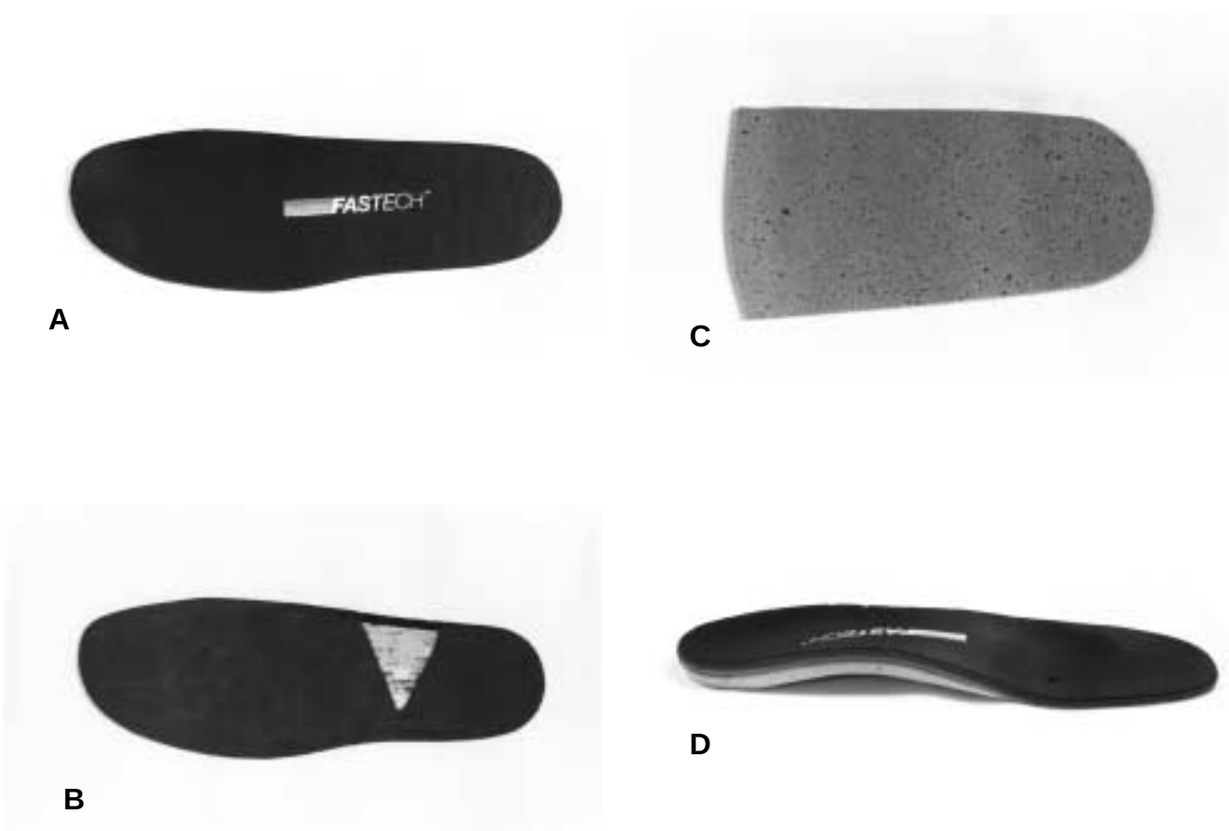

FIGURE 1. Materials used for foot orthotic fabrication: (A) superior view of orthotic blank; (B) inferior view of blank, depicting leather covering and cutout view of thermoplastic core material within the blank; (C) thermal cork used for posting and arch fill, and (D) medial view of orthotic after thermal cork has been added and shaped using a grinder.

record orthotic wear time. Subjects were instructed to contact the principal investigator if they experienced discomfort wearing the foot orthotics. Only one subject required modifications of the foot orthotics several days following the initial fabrication, secondary to an increase in medial longitudinal arch pain. These symptoms were attributed to the stiffness of the medial longitudinal arch support provided by the orthotic. All thermal cork and Aliplast were removed from the bottom of the orthotic blanks, and medium-grade Plastazote (Alimed, Dedham, MA), a softer material, was applied to replace the cork that had been removed.

The subjects returned for follow-up assessment 12 to 17 days after receipt of the foot orthotics, or after the last foot orthotic modification. Our experience has been that patients usually require less than 1 week to accommodate to semirigid foot orthotics dispensed for plantar fasciitis. We chose an interval of 12 to 17 days between assessments to allow for a 1-week adjustment period, followed by 1 week of time that could be used as a basis for completing the Foot Function Index. At the second testing session, subjects completed the pain and disability subsections of the Foot Function Index and repeated the 100-m walk test. Pre- and postorthotic testing was performed at the same time of day (± 1 hour) for individual subjects so that the time of day would not be a confounding variable. Diaries for orthotic wear were collected, and the average wear time per day was computed for each subject. Pre- and postorthotic pain ratings for the 100-m walk task were scored by measuring to the nearest mm the distance from the left end of the 10-cm line to the vertical mark made by the subject.

Each of the two subsections of the Foot Function Index was scored in the manner described by Budiman-Mak et al.[3] Each 10-cm horizontal line on a subsection was divided into 10 1-cm segments numbered from 0 to 9, left to right. The location of the subject's mark on each line was then scored from 0 to 9 based on its location on the line. The subject's score on each subsection was expressed as a percentage score. The scores for all subsection items marked by the subject were added. This sum was then divided by the product of 9 multiplied by the number of items answered on the subsection and expressed in percentage form. Any item marked by a subject as ''Not Applicable'' (NA) was not included in the percentage computation. Each score on a subsection is expressed as a percentage of the maximum pain or maximum disability that could have been scored on the subsection. The investigators scored each of the Foot Function Index subsections and were not masked as to whether the subject had completed the questionnaire being scored before or following foot orthotic intervention.

Subjects were contacted by telephone 2 to 6 months following the postorthotic measurements and were asked if they were continuing to use their foot orthotics on a daily basis.

Data Analysis

Descriptive statistics were generated for subjects relative to age, mass, and height. Descriptive statistics were also computed for orthotic wear time and days between pre- and postorthotic assessments. A paired *t*-test with an alpha level of 0.05 was used to assess the effects of foot orthotics on 100-m walk time. Wilcoxon's matched-pairs signed-ranks test[7] (alpha = 0.05) was used to compare pre- and postorthotic values for the 100-m walk pain ratings, the pain subsection scores of the Foot Function Index, and the disability subsection scores of the Foot Function Index.

RESULTS

Descriptive statistics for the 15 subjects appear in the Table. The average duration of arch or heel pain symptoms, or both, before participation in the study was 21.3 ± 23.7 months (range = 2–96 months). Subjects wore their foot orthotics an average of 12.5 ± 2.1 hours per day during the 12 to 17 days that separated pre- and postorthotic measurements (mean = 14.1 ± 1.7 days).

Eight of the subjects (53%) had plantar fasciitis that was associated with excessive pronation based on a qualitative assessment of medial longitudinal arch height and calcaneal angle.[11] The feet of the remaining 7 subjects (43%) appeared cavus, based on a qualitative assessment of medial longitudinal arch height. Recommendations were made to 4 of the subjects (26%) with excessive pronation to buy more supportive shoes before enrolling in the study. Two of these subjects (13%) purchased new shoes before testing and used the new shoes during their participation in the study. Fourteen of the 15 subjects (93%) had used two or more interventions for their arch / heel pain before enrolling in the study. Eleven of the subjects (73%) had used over-the-counter arch supports previously. Ten of the subjects (67%) had used over-the-counter anti-inflammatory medication before the week that preceded enrollment in the study. Two subjects (13%) had received steroid injections before the 3 months that preceded enrollment in the study. The design of the foot orthotics primarily involved a custom support under the medial lon-

TABLE. Descriptive statistics for subject characteristics. Values are means ± SD.

Variables	Men (n = 8)	Women (n = 7)
Age (yr)	43.8 ± 6.2	45.9 ± 11.9
Mass (kg)	86.1 ± 13.3	73.5 ± 24.2
Height (cm)	184.0 ± 6.0	165.1 ± 5.1

gitudinal arch and a medial forefoot post for 4 subjects to address a forefoot varus malalignment. Follow-up telephone contacts were made 2 to 6 months following the postintervention measurements (mean = 3.6 ± 1.3 months). All subjects reported at the time of follow-up that they were continuing to use their foot orthotics on a daily basis.

Preorthotic 100-m walk times (mean = 81.2 ± 15.3 seconds) were not significantly different ($t = 0.39$, $P = 0.70$) than postorthotic walk times (mean = 80.6 ± 13.8 seconds). Preorthotic pain ratings for the 100-m walk (mean = 3.0 ± 1.7) were significantly greater ($t = 1$, $P < 0.005$) than postorthotic pain ratings (mean = 0.7 ± 0.7). Additionally, only 1 subject (6%) had a postorthotic 100-m walk pain rating that was greater than the preorthotic value (a 2-mm difference).

As indicated in the testing procedure section, each subsection score for the Foot Function Index was expressed as a percentage of the maximum pain or maximum disability that could have been scored on the subsection. The mean reduction (preintervention score − postintervention score) in Foot Function Index pain raw scores following the intervention was 34.9% ± 16.6%, and the mean reduction in Foot Function Index disability raw scores was 27.2% ± 13.1%. These reductions in subsection scores might also be expressed as the difference in pre- and postintervention scores as a percentage of the preintervention measurements:

$$\frac{\text{preintervention score} - \text{postintervention score}}{\text{preintervention score}} \times 100\%$$

Expressed in this manner, the percentage reduction in pain subsection scores following intervention was 66%, and the percentage reduction in disability subsection scores was 75%. Wilcoxon's matched-pairs signed-ranks test results indicated that postorthotic values were significantly less ($t = 0$, $P < 0.005$) than preorthotic values for both subsections of the Foot Function Index (Figure 2). All subjects had postorthotic Foot Function Index scores that were less than preorthotic values for both subsections of this instrument.

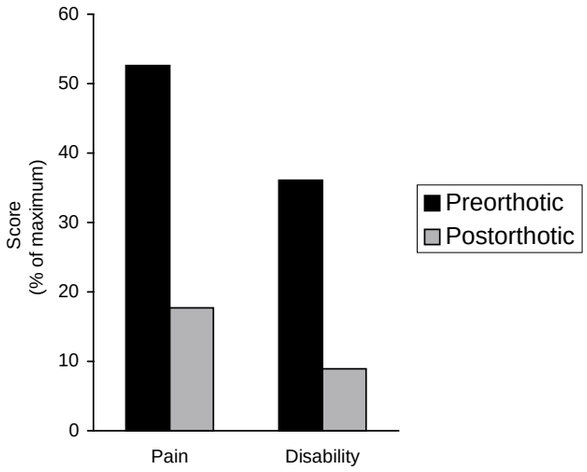

FIGURE 2. Mean pain and disability subsection scores for the Foot Function Index questionnaire before and following foot orthotic intervention.

DISCUSSION

The mean age of subjects in this study (44.7 ± 9.0 years) is comparable to previous reports in the literature regarding the typical age of patients who incur plantar fasciitis.[6,17,26] Foot orthotic intervention had no significant effect on 100-m walk times. Subjects maintained fairly constant self-selected walking speeds for pre- and postorthotic measurements. The effect of foot orthotics on self-selected walking speed was not a focus of this research, and the reliability of the timed 100-m walk was not documented. Equivalence of pre- and postintervention walk times, however, indicates that walking speed may not have been a confounding variable for subjects' ratings of pain for the walking task. Consequently, pain ratings for the 100-m walk task indicate that subjects experienced less pain following foot orthotic intervention for a similar walking speed.

Perhaps the most meaningful results of this study, and for the subjects who participated in the study, pertain to the more global assessments of pain and disability measured by the Foot Function Index subsections. Postorthotic scores on both subsections were less than preorthotic scores for all subjects. Anecdotal remarks by subjects at the time of postorthotic assessments and during the follow-up telephone contacts confirmed that subjects generally were able to perform activities of daily living with less pain and less difficulty. All subjects also reported during the follow-up telephone contacts that they were continuing to use their foot orthotics on a daily basis.

The review of literature suggests that mechanical factors causing a decrease in the height of the medial longitudinal arch may contribute to the onset of plantar fasciitis.[8,9,16,23,24] The results of this study and the investigations by Kogler et al[15] and Kitaoka et al[14] suggest that custom semirigid foot orthotics may maintain medial longitudinal arch height sufficiently to reduce tensile stress within the plantar fascia and effect statistically and clinically significant reductions in pain and disability. Eleven of our 15 subjects had used over-the-counter arch supports before enrolling in our study. These arch supports might have not maintained medial longitudinal arch height sufficiently to reduce tensile stress within the plantar fascia.

A limitation of this study involves the absence of a control group or alternative treatment group. Subjects in our study read in the consent form that the

purpose of the study was to investigate the effectiveness of custom foot orthotics for their heel and arch pain. Our study design could not control any bias of the results or placebo effect created by communicating this information to the subjects. Due to the absence of a control group, we cannot provide assurance that the foot orthotic intervention was solely responsible for the changes observed in the study variables or that some other intervention would be more effective. These results should be viewed as preliminary support for the use of custom semirigid foot orthotics for the treatment of plantar fasciitis until similar studies are conducted that address the limitations of our study design.

Having acknowledged the limitations of the study design, several points may be noteworthy. Subjects in our study had experienced arch or heel pain, or both, for an average of 21 months before enrollment in our study. Pre- and postintervention measurements on the Foot Function Index were documented over a period of 12 to 17 days for each subject. We do not believe that the natural course of tissue healing alone would explain the magnitude of changes in pain and disability scores over this period of time for all subjects, since symptoms had been experienced for such a long time before the subjects' enrollment.

Our subjects also had used multiple treatment interventions before enrollment in our study. Eleven subjects had used noncustom arch supports, and 10 subjects had used nonsteroidal anti-inflammatory medication. We did not measure the effects of these prior interventions on pain and disability for our subjects. Subjective reports from subjects at the time of enrollment, however, indicated that these prior interventions were not effective in reducing pain or improving functional ability. Clinical examination at the time of enrollment also indicated the presence of arch or heel pain, or both.

Clinicians may wish to consider several factors relative to selecting custom semirigid foot orthotics as an intervention for plantar fasciitis. The reduction in 100-m walk pain ratings and Foot Function Index assessments of pain and disability was achieved within a relatively short period of time in this study (average 2 weeks). Cost in terms of dollar amount and the patient's time away from work and leisure activities also may be important considerations. Our clinic charges approximately $320.00 for an evaluation and time and materials required to fabricate the foot orthotics used in our study. These costs are comparable to those reported recently in the study by Pfeffer et al.[21] The average time required for the clinic evaluation and fabrication of the orthotics is 1 hour and 45 minutes. Only 1 of the 15 subjects in this study required a second visit for modification of the foot orthotics following the initial fitting. Custom semirigid foot orthotics may be a cost-effective, conservative intervention considering the results of this study and costs related to prescription medication or multiple clinic visits for other conservative interventions.

A final matter for discussion relates to our use of the Foot Function Index and future use of this questionnaire to assess interventions for plantar fasciitis. The original work on the Foot Function Index by Budiman-Mak et al[3] involved an assessment of the reliability and internal consistency of this instrument with subjects who were older than our subjects, who had rheumatoid arthritis rather than plantar fasciitis, who underwent different procedures in terms of test-retest time intervals, and for whom the location of data acquisition was different. Furthermore, we modified the original questionnaire for our study and were not masked during the scoring of the questionnaire. Additional testing is necessary to determine if the reliability and internal consistency of the questionnaire we used are comparable to values reported by Budiman-Mak et al.[3]

We suggest additional modifications of the pain and disability subsections of the Foot Function Index questionnaire if this instrument is used to assess patients or research subjects with plantar fasciitis. Perhaps the most consistent symptom reported by these patients is arch or heel pain, or both, during initial weight bearing in the morning.[8,17,26] We suggest that the pain subsection include a question regarding how severe the individual's foot pain is "when you first stand in the morning," and that the disability subsection include a question regarding how much difficulty the individual has "walking immediately after rising from bed in the morning."

CONCLUSION

Custom semirigid foot orthotics may significantly reduce pain experienced during walking, and may reduce more global measures of pain and disability for patients with chronic plantar fasciitis. Our results were obtained within a relatively short period of time for subjects who had experienced chronic symptoms associated with plantar fasciitis, and who had used multiple interventions before using the semirigid foot orthotics provided during the study. Semirigid foot orthotics similar to the ones used in this study may be a cost-effective intervention for plantar fasciitis considering the limited number of clinic visits required to fabricate and adjust the orthotics.

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APPENDIX A

Foot Function Index Pain Subsection

The line to the right of each item represents the amount of foot pain that you experienced during the last week relative to several questions. On the far left is "No pain" and on the far right is "The worst pain imaginable." Place a vertical mark on the line to indicate how bad your foot pain was during the last week in response to each of the questions. If a particular question does not apply, please mark that item NA on the line to the far right of the question.

How Severe Is Your Foot Pain				**NA**
1. At its worst?	No pain	_____	Worst pain Imaginable	_____
2. When you walked barefoot?	No pain	_____	Worst pain Imaginable	_____
3. When you stood barefoot?	No pain	_____	Worst pain Imaginable	_____
4. When you walked wearing shoes?	No pain	_____	Worst pain Imaginable	_____
5. When you stood wearing shoes?	No pain	_____	Worst pain Imaginable	_____
6. At the end of the day?	No pain	_____	Worst pain Imaginable	_____

_____/_____ = _____ %

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APPENDIX B

Foot Function Index Disability Subsection

The line to the right of each item represents the amount of difficulty you had during the past week performing an activity because of your foot condition. On the far left is "No difficulty" and on the far right is "So difficult unable." Place a vertical mark on the line to indicate how much difficulty you had performing each activity because of your feet during the past week. If you did not perform an activity during the past week, mark that item NA.

How Much Difficulty Did You Have				**NA**
1. Walking around the house?	No difficulty	_____	So difficult unable	_____
2. Walking outside on uneven ground?	No difficulty	_____	So difficult unable	_____
3. Walking four or more blocks?	No difficulty	_____	So difficult unable	_____
4. Climbing stairs?	No difficulty	_____	So difficult unable	_____
5. Descending stairs?	No difficulty	_____	So difficult unable	_____
6. Standing on tip toe?	No difficulty	_____	So difficult unable	_____
7. Getting out of a chair?	No difficulty	_____	So difficult unable	_____
8. Climbing up or down curbs?	No difficulty	_____	So difficult unable	_____
9. Walking fast or running?	No difficulty	_____	So difficult unable	_____

_____/_____ = _____ %

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For administration of these tests, the lines should be 10 cm in length.

RESEARCH REPORT