

# Effects of Light on Pain and Function in Patients with Plantar Fasciitis: A Pilot Study

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## ABSTRACT

**Objective:** The aim of this study was to determine whether a combination of visible (624 nm) and infrared (850 nm) light could improve outcomes when added to a typical treatment program to treat plantar fasciitis.

**Methods:** Fourteen subjects with plantar fasciitis were randomly assigned to two groups. Both groups received heat, electrical stimulation, soft tissue mobilization and stretching exercises. One group (experimental) also received the combination light energy. The interventions proceeded two times weekly for 4 weeks. Pre and post-intervention measures of Visual Analog

Scale (VAS) score and Foot Function Index (FFI) score were used to evaluate intervention effectiveness.

**Results:** Both groups improved on VAS and FFI scores. The experimental group improved 2.9 MCID units on the FFI and 3.53 MCID units on the VAS. The control group improved 1.5 MCID units on the FFI and 2.8 MCID units on the VAS.

**Conclusion:** While the conservative treatment program employed resulted in improvements in both groups, the addition of the combined 624 nm and 850 nm light provided a greater clinical level of improvement in function and pain when compared to the basic conservative program alone.

**Key Words:** Plantar fasciitis, light therapy, conservative management

## INTRODUCTION

Plantar fasciitis is defined as a localized inflammation and degeneration of the proximal plantar aponeurosis (Leauge, 2008). Pain resulting from the condition is commonly localized to the region around the medial tuberosity of the calcaneus. In more severe cases, the pain may radiate proximally (Young, 2012). The classic symptom of plantar fasciitis is pain that is most bothersome with the first steps out of bed in the morning (L. Barry, A. Barry, & Chen, 2002; Forcum, Hyde, Aspegren, & Lawson, 2010) or after periods of prolonged sitting (Young, 2012). Per year, plantar fasciitis affects 2 million people in the United States, making it the most common foot condition seen in physical therapy clinics (McPoil et al., 2008). While plantar fasciitis can affect both active and sedentary adults of all ages (Cole, Seto, & Gazewood, 2005), it is usually seen as an overuse injury in athletes, particularly runners (Stuber & Kristmanson, 2006). A rapid increase in the distance, intensity, duration, or frequency of activities (i.e. jumping, sprinting) is a common training error that is known to aggravate the condition (Young, 2012). It is also likely to occur in persons who are obese, possess abnormal foot biomechanics, or spend the majority of the day on their feet (Cole et al, 2005; Stuber & Kristmanson, 2006). The treatment of plantar fasciitis is accomplished by utilizing interventions that fall into one of the following three categories: reduction of pain and inflammation, reduction of tissue stress, or restoration of muscular strength and tissue extensibility (Cornwall & McPoil, 1999). The specific approaches to treatment vary greatly and consist of surgical interventions (most radical), injections, anti-inflammatory medications, and conservative care (McPoil et al., 2008; Stuber & Kristmanson, 2006). The realm of conservative treatment can be further broken down into physical agents/modalities, soft tissue therapy/massage, taping, night splints, stretching, ice, heat, strengthening, orthotics, and patient education (Stuber & Kristmanson, 2006). There is agreement in the literature that conservative treatment is ultimately effective in about 90% of patients (Gill, 1997), but there is not a clear consensus on any one particular treatment regimen. Light, visible and infrared, has been suggested as a treatment modality for various musculoskeletal conditions (Ng & Fung, 2008; Basford, 1999; Basford, Sheffield, & Harmsen, 1999) and could be a potential physical agent for the treatment of plantar fasciitis. Enwemeka (2012) has suggested combined red (624 nm) and infrared (850 nm) light to be an effective adjunctive treatment for plantar fasciitis. In an earlier article, Basford et al (1998) did not find light to be an effective treatment for plantar fasciitis. We felt it important to investigate these

conflicting positions, especially since we chose to use light adjunctively, as it would likely be used in a clinical setting.

In order to investigate these competing positions in the literature, we delivered a combination of agents / techniques that were all very common in clinical practice. We observed and recorded changes in pain and functional ability in patients receiving either a treatment plan consisting of heat, electrical stimulation, friction massage (all delivered simultaneously) and basic stretches compared to the same treatment plan with the addition of combined red (624 nm) and infrared light (850). The ultimate goal of this study was to determine whether combined red (624 nm) and infrared (850nm) light could provide any improved outcome when added to a typical treatment program designed to conservatively manage cases of plantar fasciitis.

## METHODS

**Subjects:** After obtaining Institutional Review for Human Subjects approval, male and female subjects were recruited from the university community where the research was conducted via flyers, advertisements, and electronic mail. Participants were invited to attend an informational meeting if they believed they might be appropriate for the study as advertised. All responding potential subjects met with the researchers, had the study design and procedures (including risks) explained. They then provided consent if still interested. The principal investigator examined each potential subject to ensure she / he met all of the eligibility criteria, including the presentation of signs and symptoms indicating plantar fasciitis. The diagnosis was confirmed by pain at the origin of or in the proximal plantar fascia, absence of any neurological findings, as well as by “first step” pain in the morning. The participant’s plantar fasciitis symptoms must have been disabling to the point that normal daily function was disrupted. Additional inclusion criteria included:

- Subjects were at least 18 years of age,
- Provided informed consent, and
- Had a history of foot pain persisting for at least six consecutive weeks.

Participants were excluded if they had heel pain from causes other than plantar fasciitis such as,

- A heel fracture or heel surgery (within the previous six months),
- Arthritis,
- A major foot deformity,
- Minimal disability (condition did not interfere with daily activities),
- Comorbidities such as diabetic or peripheral neuropathy, abnormal foot sensation/motor function, or
- If the individual had already started a plantar fasciitis treatment regimen.

Subjects were also excluded if they exhibited certain contraindications to planned treatment modalities such as acute inflammation, active bleeding, malignancies, thrombophlebitis, impaired mental capacity, active infection in the area, and/or if they had a pacemaker. Participants who fulfilled inclusion criteria and provided written informed consent were randomly assigned into one of two groups. Each subject was assigned a random number taken from a table of random numbers. Those numbers were then blindly drawn and assigned to each group alternatingly until the groups were filled. Ultimately, 14 subjects were included in the

study, each group having 7 subjects. Table 1 displays details for each group.

**Table 1. Subject characteristics.**

Group Assignment	Gender	Age (yrs.)	Weight (kg.)	Height (cm)
A (Experimental)	F	53	86.36	64
A	F	70	79.55	63
A	F	53	74.09	70
A	F	46	104.54	66
A	F	60	67.27	72
A	F	51	127.27	65
A	F	19	54.54	61
	<b>MEANS</b>	<b>50.29</b>	<b>84.80</b>	<b>65.85</b>
	<b>Standard Deviation</b>	<b>15.79</b>	<b>53.60</b>	<b>3.89</b>
B (Control)	M	68	74.09	69
B	F	38	52.27	64
B	F	66	90.90	61
B	M	53	100	71
B	M	56	174.54	72
B	F	53	65.45	66
B	M	57	109.09	70
	<b>MEANS</b>	<b>55.86</b>	<b>95.20</b>	<b>67.57</b>
	<b>Standard Deviation</b>	<b>9.89</b>	<b>88.47</b>	<b>4.04</b>

**Interventions:** Each subject received treatment based on group assignment. Both groups were taught a daily stretching protocol. The stretching program consisted of the following exercises.

1. Achilles tendon stretch using a wall (4x30 seconds),
2. Gastrocnemius/Soleus stretch seated with belt (4x 30 seconds), and
3. Self-Mobilizing massage using a ball or cola bottle (3-5 minutes).

Participants were asked to record compliance with the stretching program on a log sheet and were allowed to maintain regular daily activities.

Group A (Experimental) received heat, electrical stimulation (biphasic stimulation, 5 pulses per second, 250 microsecond pulse duration, at maximum comfortable sensory intensity) and soft tissue mobilization, all delivered simultaneously to the plantar surface of the foot using the Dynatronics Quad 7 device coupled with the Dynatronics Solaris Plus to provide electrical stimulation. The heat, electrical stimulation and the soft tissue mobilization were all delivered for 15 minutes each session via a hand-held probe arrangement that is part of the Quad 7 equipment. Group A additionally received a combination 624nm and 850nm light treatment

using the Dynatronics Solaris Plus. The light treatment was administered at 9 J/cm<sup>2</sup> to three locations from the proximal to distal ends of the plantar fascia. Group B (Control) had the exact same set of interventions minus the application of light. All subjects were treated two times weekly (home stretching done daily) for four weeks.

Subjects were allowed to continue wearing any orthotics previously prescribed, but no new orthotics/inserts were allowed during the intervention. Subjects were asked to refrain from using any other types of therapies including chiropractic, oral non-steroidal or steroidal anti-inflammatory drugs, or topical or locally injected steroids for the duration of the study.

**Outcomes Measures:** Two common measures were used to evaluate the effectiveness of the interventions employed. The Foot Function Index (FFI), a self-administered index entailing 23 items divided into 3 sub-scales measuring the impact of foot pathology on function in terms of pain, disability and activity restriction, was administered prior to the beginning of treatment and then at the end of the 8 treatment sessions (Landorf & Radford, 2008). The FFI has been evaluated and validated as a reasonable method to monitor patients with foot disorders (SooHoo, Samimi, Vyas, & Botzler, 2006). The Visual Analogue Scale (VAS), also administered pre- and post-intervention, was used to quantify reported/experienced pain. The VAS consists of a 10cm line with 'no pain' at one end and 'worst pain imaginable' at the other end (Revill, Robinson, Rosen, & Hogg, 1976). Subjects were asked to rate their current pain by placing a mark on the line. The line was then measured with a 10 cm ruler and given a numerical value (Scott & Huskisson, 1976). The VAS has undergone extensive validation to justify its use in clinical practice (Jensen, Karoly, & Braver, 1986). According to Jensen et al (1986), the scale is valid and reliable and the VAS has already been used in several PF studies (Wearing, Smeathers, & Urry, 2003; Wearing et al, 2007). The outcome measures were self-administered (to eliminate researcher bias) and completed upon initial examination and at the conclusion of four weeks of treatment. A member of the research team who was uninvolved in any physical treatments explained the outcome measures instructions, further eliminating the potential for bias.

**Data Analysis:** Data were analyzed using dependent and independent Student t-tests. SPSS 20 was the software package employed.

## RESULTS

Baseline characteristics (Table 1) of both groups were similar, although the experimental group had no male subjects vs. 4 males (57%) in the control group. Both the experimental group and control group improved in VAS and FFI scores. The experimental group demonstrated a statistically significant decrease in pain ( $t(6)=4.31$ ,  $p=.005$ ) with a mean change of 3.18 cm ( $sd=1.95$ cm, 95%  $CI=1.37-4.98$ ); as well as a statistically significant increase in function ( $t(6)=5.42$ ,  $p=.002$ ) with a mean change of 20.17 points ( $sd=9.85$ , 95%  $CI=11.1-29.3$ ). While the control group demonstrated a decrease in pain (mean=2.5 cm,  $sd=2.79$ , 95%  $CI=-.08-5.1$ ) and an increase in function (mean=10.6,  $sd=13.24$ , 95%  $CI=-1.6-22.9$ ), neither was statistically significant ( $t(6)=-2.37$ ,  $p=.056$ ;  $t(6)=2.13$ ,  $p=.078$  respectively). The post treatment difference between the groups for pain ( $p=.608$ ) or function ( $p=.152$ ) did not reach a significant level.

## DISCUSSION

The use of visible and infrared light energy in the treatment of various musculoskeletal conditions is becoming more common. Since FDA approved the use of low-level lasers in 2002

(Dellagatta & Nolen, 2012) all manner of opinion has been expressed as to their effectiveness and application. Therapeutic light does amplify cell metabolism (Dellagatta & Nolan, 2012). The clinical challenge today is to determine which conditions respond best to light and which wavelengths, application techniques, and doses are clinically effective. We, like many in the field, found the literature related to using light in the treatment of plantar fasciitis confusing and contradictory. This study demonstrates that light may be a potentially effective adjunctive treatment modality. We emphasize the term “adjunctive” because studies (Basford et al, 1998) examining light as a single treatment modality are less supportive.

Stretching, heat, electrical stimulation and soft tissue mobilization are potentially effective interventions. While the change from pre-treatment to post-treatment in the control group was not statistically significant, the score differences on the two measures employed were interesting. Minimal clinical important difference (MCID) is a measure that is particularly important to clinicians. As Landorf and Redford (2008) reported, the MCID for the VAS is 0.9 cm. The MCID for the Foot Function Index is 7. The control group in our study improved more than the MCID on both tools.

When one examines the changes for the experimental group (received light energy), the statistically significant pre- to post-treatment changes seen on the VAS were three times the MCID and just less than three times the MCID for the FFI. The results of the study, though the sample size is small, do suggest that light energy may have clinical value in the treatment of plantar fasciitis, particularly when the light is used in conjunction with other commonly employed conservative modalities.

This study suffers from its small sample size. We computed a post hoc power analysis and found, for the dependent t-tests (within groups changes), the power was 0.3191. The power when comparing control to experimental (independent t-test) was 0.223. In the second case particularly, we could easily have made an error accepting the null (no difference between groups at post-treatment measurement) due to the low power. There was clearly a clinically significant difference between the groups. Had the sample size been larger, the difference, if it held, could have been statistically significant.

Our intention is to continue this line of investigation. Increasing the sample size is needed to strengthen the confidence the clinician can have in these outcomes. Still, the suggestion that light energy (624nm combined with 850 nm @ 9 J/cm<sup>2</sup>) may be a clinically helpful adjunctive treatment modality in the management of plantar fasciitis seems supported by this data.

## CONCLUSIONS

The data collected in this investigation led us to draw the following conclusions.

1. Heat, electrical stimulation, soft tissue mobilization and stretching produced at least a clinically significant level of improvement in the treatment of plantar fasciitis as measured by the VAS and the FFI.
2. The addition of combined 624 nm & 850 nm light at 9 J/cm<sup>2</sup> to the program of heat, electrical stimulation, soft tissue mobilization, and stretching may produce a greater improvement in the scores on the VAS and FFI in patients with plantar fasciitis.

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