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THE EFFECTS OF EXTRACORPOREAL SHOCKWAVE THERAPY, JOINT MOBILIZATIONS AND EXERCISE ON PAIN, FUNCTION, RANGE OF MOTION, JOINT BIOMECHANICS AND STRENGTH IN PLANTAR FASCIITIS

Paolo Sanzo

School of Kinesiology, Lakehead University, Thunder Bay, Canada

This study assessed the effects of extracorporeal shockwave therapy (ECSWT) on pain, function, mobility, biomechanics, and strength in patients with plantar fasciitis. Ninety-seven subjects randomly assigned to either ECSWT alone or combined with joint mobilizations or exercise were examined before and three months after treatment. There was significant improvement in the P4 Pain Scale ($p=.0001$) and Lower Extremity Functional Scale ($p=.0001$) scores; ankle mobility for plantarflexion ($p=.001$) and dorsiflexion ($p=.0001$) and; first metatarsophalangeal (MTP) flexion ($p=.002$) and extension ($p=.004$). There was significant improvement in joint biomechanics within groups over time and between groups with improvement noted in the talocrural anterior and posterior glide ($p=.0001$), subtalar medial and lateral glide ($p=.0001$), and first MTP anterior and posterior glide ($p=.001$)

KEY WORDS: Heel pain, 4-item Pain Intensity Measure, Lower Extremity Functional Scale, accessory glide

INTRODUCTION: Musculoskeletal injuries continue to contribute to the escalating costs of healthcare worldwide. It is estimated that the cost of musculoskeletal disorders in the United States (USA) is approximately 149 billion dollars per year. The economic impact of these disorders is similar in other parts of the world globally. In Europe, musculoskeletal disorders are the most expensive of all disease categories. In Australia, they are second only to cardiovascular disease (Wearing, S.C., Hennig, E.M., Byrne, N.M., Steele, J.R. & Hills, A.P, 2006). With the costs of healthcare rising and the financial crisis and economic difficulty in most nations, the treatment of musculoskeletal disorders can impart a large cost to individuals, public healthcare systems and third party payers. It is imperative that appropriate choices are made by patients and healthcare providers for treatment.

While an emphasis on the importance of physical activity has been implemented worldwide in an attempt to control chronic disease states and obesity, it has been paralleled by an increase in some common overuse musculoskeletal disorders. This, in turn, may contribute to rising healthcare costs. Plantar fasciitis (PF) is one such disorder and the most common cause of heel pain today. It is estimated that approximately two million people are treated for PF in the USA yearly and that 10% of the population will develop PF in the course of a lifetime. PF also accounts for approximately 11-15% of visits to medical professionals yearly (Rompe, J.D., 2009).

The treatment for PF may include a variety of interventions ranging from conservative treatment to surgical intervention with variable success rates reported. Despite the number of suggested treatments, there are few high quality, randomized controlled trials that support the treatments. It is also difficult to compare the results of the studies that have been performed on the treatment of PF due to the variability in the treatment protocols between studies.

One of the suggested treatments for PF is the use of extracorporeal shockwave therapy (ECSWT). The studies that are available on the use of ECSWT have examined the effects of ECSWT in isolation but rarely in combination with other treatments. Therefore, the purpose of this study was to assess the effects of ECSWT alone or in combination with joint mobilizations or exercise on heel pain, function, mobility, biomechanics, and strength in patients with PF.

METHODS: The design for this study was a randomized clinical trial pre-test post-test design. Participants included both men and women between the ages of 18 and 70 years who were

able to complete the questionnaires and give informed consent. Subjects were randomly assigned to one of the three treatment groups consisting of ECSWT, ECSWT and joint mobilizations to the talocrural, subtalar and first metatarsophalangeal (MTP) joint, or ECSWT and stretching exercises for the gastrocnemius, soleus, and plantar fascia and with strengthening exercises for the ankle, and foot. A detailed initial assessment and anthropometric measures were taken. Active and passive range of motion (ROM) for the ankle and first MTP joint was measured and recorded in degrees using a goniometer. Accessory movement testing was performed examining the joint biomechanics and mobility of the talocrural, subtalar, and first MTP joints. Accessory movements were recorded as normal, hypomobile, or hypermobile. Resisted isometric strength of the ankle was also measured and recorded. During the initial assessment, subjects also filled out the 4-item Pain Intensity Measure (P4) and Lower Extremity Functional Scale (LEFS). After the initial assessment, the subject was treated based upon the random group allocation. Each subject received three treatments in total spaced one week apart over a three week period of time. A three month follow up assessment was performed with each subject and all measures repeated. A mixed model repeated measure ANOVA was used to analyze the P4 and LEFS scores and changes in ROM, strength, and joint biomechanics.

DISCUSSION AND RESULTS: The sample consisted of 97 subjects (27 males and 70 females) with a mean age of 48 years. The mean length of time that heel pain was present was 40 weeks with 48 left feet and 49 right feet examined and treated. Descriptive data for height, weight, and body mass index (BMI) is summarized in Table 1.

There was a significant decrease in heel pain following treatment with all groups having a reduction in P4 Pain scores ($p=.0001$) and in function as noted in the LEFS scores ($p=.0001$). Figure 1 illustrates the P4 and LEFS scores for all groups.

There was a significant improvement in ankle plantarflexion ($p=.001$), and dorsiflexion ($p=.0001$), and a reduction in first MTP flexion ($p=.002$) ROM over time for all groups. There was also a significant difference between groups for plantarflexion ($p=.018$), dorsiflexion ($p=.04$), and first MTP flexion ($p=.019$) with subjects having ECSWT and joint mobilizations demonstrating the greatest change in ROM compared to the other groups. There was no significant change in ROM for ankle inversion and eversion, and first MTP extension following treatment. There was no significant change in ankle strength following treatment.

Table 1
Demographic Information

| | Age (years) | Gender | Height (cm) | Weight (kg) | BMI (kg/meter ²) |
|------------|-------------|------------|-------------|-------------|------------------------------|
| ECSWT | 49 ± 10.4 | 13 M, 22 F | 167 ± 11.7 | 88 ± 12.1 | 31.6 |
| ECSWT/mobs | 47 ± 7.9 | 8 M, 22 F | 170 ± 11.0 | 85 ± 10.8 | 29.4 |
| ECSWT/exer | 48 ± 8.9 | 6 M, 26 F | 169 ± 9.7 | 87 ± 13.2 | 30.5 |
| Sample | 48 ± 9.1 | 27 M, 70 F | 169 ± 10.6 | 87 ± 12.0 | 30.5 |

With accessory movement and biomechanical assessment of joint glide, 18% demonstrated hypomobility with anterior glide, and 30% with posterior glide of the talocrural joint; 56% demonstrated stiffness with medial and lateral glide at the anterior and posterior subtalar joints and; 21% demonstrated stiffness with anterior and posterior glide at the first MTP joint before treatment. There was a significant improvement in talocrural joint anterior and posterior glide ($p=.0001$); subtalar joint medial and lateral glide ($p=.0001$) and; first MTP joint anterior and posterior glide ($p=.001$) following treatment for all groups. There was a significant difference between treatment groups for posterior glide ($p=.0001$) at the talocrural joint, medial and lateral glide ($p=.0001$) at the subtalar joint, and in anterior and posterior glide ($p=.0001$) at the first MTP joint. The ECSWT and joint mobilization group consistently demonstrated a greater improvement in accessory glide when compared to the other treatment groups.

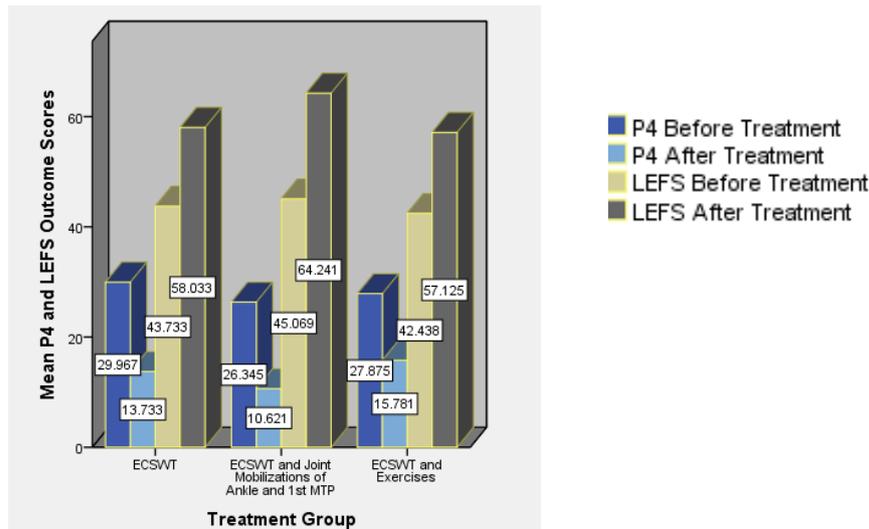


Figure 1. P4 and LEFS scores before and after treatment by treatment group.

The results of our study found that all groups had decreased heel pain and improved function following treatment. The greatest improvement in P4 and LEFS scores occurred when joint mobilizations of the talocrural, subtalar, and first MTP joints were combined with ECSWT. ECSWT has been shown to be an effective tool at reducing plantar heel pain and our findings concur with the available literature (Chuckpaiwong, B., Berkson, E.M. & Theodore, G.H., 2009; Gollwitzer, H., Diehl, P., Rhalfs, V.W. & Gerdsmeyer, L., 2007). The present study used self-report measures to monitor the effects of treatment on pain and function. Future studies should combine alternate pain measures such as the use of palpation via a dolorimeter in combination with a self-report pain outcome measure. Similarly, function can be examined by combining a self-report outcome questionnaire with objectively assessing the functional tolerances of standing, walking, jumping or running or other sport specific task.

Despite the number of proposed treatments for PF, there are few high quality, randomized controlled clinical trials that support the treatments. It is also difficult to compare the results of the studies that are available for several reasons. The variability in the treatment protocols between studies, the fact that some studies have used a variety of treatments in combination, the variability in the dosage and duration of treatments, the study design and types of controls used, the statistical power, the sample size and the length or lack of follow up weakens the results of some of the studies available. Some patients have also responded positively to placebo and this adds further controversy to what intervention should be used (Malay, D.S., Pressman M.M., Assili, A., Kline, J.T., York, S., Buren, B., ... LeMay, C., 2006). This may, however, be explained by the self limiting nature of the disorder and that in some cases heel pain will resolve over time no matter what the intervention is. Again, future study designs should incorporate a short and long term follow up with clear and consistent treatment parameters to note the changes over time and truly evaluate the long term success of treatment.

There are limited studies available that have examined the use of joint mobilization and exercise to treat PF patients. Positive effects have been reported with the use of joint mobilizations on joint biomechanics and mobility in patients with PF. Manual therapy directed to the hip, knee, and ankle combined with exercises were superior to the use of electrical therapeutic modalities and exercise in the treatment of plantar heel pain (Cleland, J.A., Abbott, J.H., Kidd, M.O., Stockwell, S., Cheney, S., Gerrard, D.F. & Flynn, T. W., 2009). Our findings have shown similar results and a consistent trend of greater improvement in heel pain, function, ROM, and joint biomechanics when ECSWT was combined with joint mobilization. No studies are available that combine joint mobilizations with ECSWT in the

treatment of PF. Healthcare providers, athletes and coaches should consider this as an important treatment combination for consideration for first line treatment to assist with a quick return to activity, function, or sport.

There are also very limited studies on the combination of exercise with ECSWT as well. Contradictory findings have been reported that an eight week stretching program for the plantar fascia was superior to the use of ECSWT (Rompe, J.D., Cacchio, A., Weil Jr., L., Furia, J.P., Haist, J., Reiners, V., ... Maffulli, N., 2010). The proposed therapeutic benefits of the stretching program were unclear and there has been no clear explanation as to why the treatment worked nor had the optimal stretch or the intensity, speed, load, and frequency of the stretch been clearly defined. It was not possible to conclude whether the satisfaction reported by the patients in their study was related to the outcome or the process of treatment that led to the improvement. Future studies comparing the use of different stretching and strengthening exercises in patients with PF may provide valuable information to the limited data especially in combination with ECSWT. Healthcare providers normally do not treat with a single modality or treatment approach but rather a combination of techniques or approaches to achieve optimal results. Our study results have demonstrated that combining ECSWT and manual therapy may provide better results in patients and athletes complaining of PF allowing them to return to activity and sport quicker and also control healthcare cost. Further investigation is required examining the effects of combined treatment in PF.

CONCLUSION: PF is a common cause of heel pain that can be difficult to treat. ECSWT offers an exciting, beneficial and relatively new intervention for the treatment of PF. Consideration of its use in combination with manual therapy to the foot and ankle seems to provide optimal results on pain, function, mobility and joint biomechanics.

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