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SONOGRAPHIC EVALUATION OF PLANTAR FASCIA FOLLOWING LOW-LEVEL LASER THERAPY IN PLANTAR FASCIITIS

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ABSTRACT

Background: Plantar fasciitis is the most common cause of inferior heel pain resulted from repeated trauma leading to a microscopic tear in the plantar fascia. There is a need to study the non-invasive nature of low-level laser therapy in reducing pain and enhance healing. Therefore the study aimed to find out the efficacy of low-level laser therapy in plantar fasciitis.

Methods: The study design is a pre-post experimental design. Thirty patients(21 females & 9 males) with plantar fasciitis who fulfilled the inclusion criteria participated in the study. Baseline parameters using musculoskeletal ultrasonogram of the plantar fascia, numerical pain rating scale, ankle joint mobility testing and foot and ankle ability measure questionnaire were recorded. Subjects in the control group received ultrasonic therapy, while the experimental group received irradiation of Low-Level Laser Therapy (LLLT) for two weeks comprising 12 sessions and the above-specified outcome measures were re-evaluated after two weeks.

Results: The results showed significant improvement in pain severity ($p<0.04$) and ankle dorsiflexion range of motion ($p<0.00$) and ankle ability measure but no significant change in plantar fascia thickness following low-level laser therapy was observed. A positive correlation ($r=0.9$) was found between plantar fascia thickness and post foot and ankle ability measure-ADL scores ($p=0.02$).

Conclusion: The findings suggest that low-level laser therapy helps in pain reduction and improving range of motion in plantar fasciitis with minimal effect on the thickness of plantar fascia.

Keywords: low-level Laser therapy, plantar fasciitis, musculoskeletal ultrasonogram, thickness and plantar fascia.

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INTRODUCTION

The most common foot pathology is the inflammation of plantar fascia termed as plantar fasciitis causing heel pain. Plantar Fascia originates from the medial calcaneal tubercle which is a thick fibrous aponeurosis of the foot. It is thought that repetitive force or overuse for long periods of standing or running causes damage to the fascia which can be acute or chronic. It is characterized by medial heel pain in mornings and pain increases in weight-bearing activities. Most factors which influence plantar fasciitis includes altered foot biomechanics, ill fit footwear, pronated foot, and obesity. The increase of pain and inflammatory symptoms were found to correlate positively with an increase in plantar fascia thickness. The various interventions in treating plantar pain include manual therapy, stretching, orthotics, physical agents and therapeutic exercises.

Inflammation to the fascia is found in both sedentary and athletic people who are thought to be a result of repetitive stress either from lifestyle or exercise.Due to its poorly understood mechanism, the treatment choice for plantar fasciitis is quite challenging. Histopathology studies revealed that plantar fasciitis possesses derangement of fibrous tissue similar to degenerative changes leading to tendinosis rather than inflammation.

Standardized symptoms for plantar fasciitis shows early morning stiffness or pain after a rest period which aggravates with movements and long periods of weight bearing. The typical physical examination findings of plantar fasciitis were localized tenderness over the medial calcaneal tubercle and presence of discomfort on passive dorsiflexion of the great toe. Now the standardized method for diagnosis and confirmation of plantar fasciitis is ultrasonogram and magnetic resonance imaging. Prevalence studies reveal that 1 in 10 people develop plantar fasciitis and common among middle-aged female individuals of obese category and young male involved in athletic activities[1-3].

It was observed that the analysis of plantar fascia thickness and echogenicity of tissue are the standard parameters being measured in sonographic studies. In symptomatic individuals, the thickness of fascia ranges from 2.9 mm to 6.2 mm and hypoechoic. If the thickness of plantar fascia is more than 4mm, then it is considered as plantar fasciitis.The non-invasive, inexpensive musculoskeletal ultrasonography was found to be a reliable tool in affording excellent spatial resolution of superficial tissues and the procedure was well tolerated by patients [4].Mederic et al., 2009 conducted a study on 39 runners who had a history of heel pain in which 8% of individuals showed abnormal fascia. This study stated that during evaluation of heel pain syndromes musculoskeletal ultrasonogram can always be considered[5].

Treatment mechanisms have broad ranging from cryotherapy, stretching, formal physical therapy, night splints, custom orthotics, counter heel cups, low dye taping, varied injection therapies, iontophoresis, extracorporeal shock therapy, and fasciotomy. Recent studies suggest that less invasive techniques are more effective in providing long-term relief.

With the literature reviewed, the stretching maneuver has been found to exhibit significant long-term results in Plantar Fasciitis. It has been concluded that inflexibility of the calf muscle can lead to extreme foot pronation and overcompensation of the fascia at first toe, thereby increasing the stress at the origin of the fascia. Therefore, it is assumed that calf stretches are a profitable treatment at the initial stage of rehabilitation program [6]. A study [7] stated that noninvasive therapy showed more reduction of heel pain in chronic plantar fasciitis.

A newly emerging technology has gained momentum over the past three decades in treating injuries of soft tissue, even though its acceptance rate and scientific evidence remains diverse.Low-power lasers are effectively utilized to enhance healing of wounds, reduction of pain and inflammation for all musculoskeletal injuries. Despite all these uses, its efficacy remains contentious.It was reported that there were no side effects of the therapy and treatment sessions were well tolerated by patients[8]. The revised heel pain guidelines by Robroy et al. in 2014 advocates the use of low-level laser therapyin reducing pain and enhance activities of daily living [8].

It is noted that Low-Level Laser Therapy (LLLT) requires further research to prove as an efficient treatment for plantar fasciitis [9] and further studies are needed to confirm its efficacy [10].In spite of its effects in chronic plantar fasciitis, further studies are warranted [11]. Hence the present study intends to analyze the effectiveness of low-level laser therapy on plantar fascia thickness using musculoskeletal ultrasonogram in plantar fasciitis.

METHODOLOGY

The experimental study using an evidence-based tool was approved by the ethics committee for student's proposal, Sri Ramachandra University (REF:CSP/16/AUG/50/232). The Quasi-experimental design (pre and post-test) was conducted in the out patientphysiotherapy department of Sri Ramachandra Hospital, Chennai.

The estimated sample to obtain a significance level of 5% ($p<0.05$) and a power of 80% (open Epi Software Version 3) was considered. Based on a study [9], a sample of 26 subjects are required, but considering the attrition rate, a minimum of 30 samples are needed.

Subjects with a medical diagnosis of plantar fasciitis of both genders with a minimal duration of fewer than three months and testing positive for windlass test in weight-bearing were recruited for the study. The subjects with the previous history of trauma, surgery and soft tissue injuries around the ankle joint, subjects with rheumatoid arthritis and connective tissue disorders were excluded.

The eligible subjects were allotted into two groups namelythe control group and experimental group. Informed consent was obtained from all the subjects for voluntary participation in the study. The baseline evaluation of subjects was assessed,and both groups received the active intervention for 12sessions for two weeks. The baseline measurements included plantar fascia thickness measurement and echogenicity using musculoskeletal ultrasonography, pain severity using numeric pain rating scale (NPRS), ankle dorsiflexion range using goniometer and a functional scale of Foot and Ankle Ability Measure (29 item Questionnaire).

The subjects were assessed for pain type, character, duration, severity, irritability, and nature. The study subjects rated their pain severity in a scale often points using the Numerical Pain Rating Scale (NPRS)[12]. All the details were secured, and the same assessment procedure was followed at the end of the session for the analysis.The procedure of performing the windlass test was by extending the first metatarsophalangeal joint in weight bearing,and the patient's heel pain was reproduced when assessed. The subject with heel pain was asked to stand on a step stool; the procedure involves the passive extension of first metatarsophalangeal joint with flexion of the interphalangeal joint.The maneuver was continued to provoke the subject's pain responses.

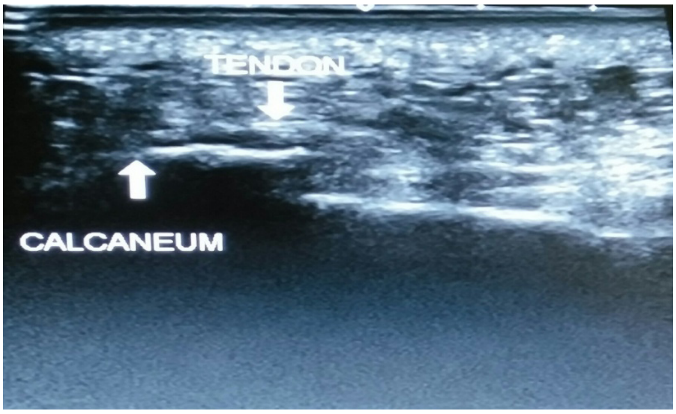
The range of motion for ankle joint was measured in high sitting with the axis of the goniometer over lateral malleoli; movable arm parallels to 5th Metatarsal and stationary arm in longitudinal axis with the fibula. The patient was instructed to pull their foot towards them (for dorsiflexion) and then drop down from the neutral position for plantarflexion range of motion. The functional outcome of the ankle and foot complex was assessed by using the Foot and Ankle Ability Measure (FAAM) questionnaire [13]. The 100% scale used to identify the prognosis of activities of daily living. The ADL subscale was used for the study and sports subscale was not applicable for the above population.

After meeting the inclusion criteria and completion of baseline measurements, 30 subjects with the diagnosis of plantar fasciitis were enrolled in the study. The uninvolved plantar fascia was measured and used for comparing the involved side test values. Enrolled subjects were taken for musculoskeletal ultrasonogram which was carried out initially and after which subjects are allocated to groups.

The noninvasive investigation was performed by the same radiologist, who was blinded of group allocation, using a 7.5MHz linear array transducer. The fascia was scanned in the origin and mid-distribution of the fascia with the subject in prone lying, with extended knees and feet hanging out of the examination bed.The coupling gel was used as a conducting medium over the examining part with an adjusted focus on the depth of the fascia is noted. Quantitative measurement was taken at reference points thrice to avoid errors and average values were considered. During the ultrasonogram study, the radiologist analyzed the presence of bony spurs, perifascial edema/fluid collections, calcifications, echogenic appearance and fibrillary pattern.

Control Group: Ultrasound therapy [14] was given with patient in prone lying and foot out of the couch. Treatment head of 3MHz was chosen with the intensity of 0.75W/cm2 was used with a duration of 10 minutes for two weeks and 12sessions.

Figure 1: Evaluation of Plantar fascia



Intervention Group: A portable laser machine with a microprocessor was used with two probes – visible and infrared probes. The subject was positioned in prone lying and foot placed out of the couch. The visible probe is chosen first,which consisted of continuous irradiation of stationary mode over the medial calcaneal tubercle and then continuous scanning irradiation along the fascia. The dosage averaged 240mW and the frequency of the laser probe is 5000Hz. A depth of 4.5cm was calculated with specific mark area almost 1.5cm^2 over the tendon insertion and 3cm^2 along the fascia with a power density of 0.16 W/cm^2 and 0.08 W/cm^2 respectively [15]. The dosage of active treatment was 8.4Joules at the origin and along the fascia. The period was 30 minutes at the origin and 5 minutes along the fascia for about two weeks and 12 sessions were completed.

In both groups, the session was followed by Gastro-Soleus stretching exercise for two weeks everyday with two sessions. The subjects were positioned in long sitting; a self-stretching was taught with the help of a towel with 30 seconds hold and five repetitions. After two weeks of intervention, post measurements were taken.

Data analysis:

The results are presented with mean and standard deviation. The unpaired t-test was used to test the differences between pre and post measurements. The relationship between variables was analyzed using the Pearson correlation coefficient (r). The p-values of <0.05 were considered statistically significant.

RESULTS

The experimental study analyzed the pre and post values of 30 subjects with plantar fasciitis following low-level laser therapy. The demographic characteristics of both the groups are outlined in Table 1 depicting both groups were similar at baseline measurements except ankle dorsiflexion ROM.

Table 1: Demographic Details

CHARACTERISTICS	CONTROL GROUP	EXPERIMENTAL GROUP
Age (years)	33.2±12.51 (23-45)	28.6±11.81 (19-41)
Baseline plantar fascia thickness at calcaneum level (mm)	2.84±0.59	2.78±0.16
Baseline plantar fascia thickness at fascia level (mm)	2.62±0.50	2.42±0.22
Pain severity	5.4±2.57	7.8±2.39
Dorsiflexion ROM (degrees)	19±2.78	6±5.20
FAAM-ADL(scores)	57±25.48	56±16.68

FAAM-ADL- Foot and Ankle Ability Measure-Activities of daily living, ROM-Range of Motion

The mean scores of plantar fascia thickness, pain severity, ankle joint dorsiflexion ROM and FAAM-ADL scale were compared between groups using unpaired t-test. The broad aim of this experimental study is to analyze the effectiveness of low-level laser therapy on the thickness of plantar fascia is tabulated in table 2. The between-group analysis of variables exhibits no statistically significant improvement in thickness of plantar fascia at two levels following low-level laser therapy. Moreover, low-level laser therapy was found to reduce pain severity (p-0.04) significantly with improved ankle dorsiflexion range of motion (p-0.003), and significant improvement in FAAM-ADL scores (p-05) was noted between groups.

Table 2: Analysis of outcomes between groups

	Control Mean ± SD	Experimental Mean ± SD	Mean difference	p-value
MSK-USG Calcaneum level(mm)	2.78±0.49	2.72±0.18	0.06	0.37
Fascia level(mm)	2.52±0.47	2.34±0.23	0.18	0.18
Pain severity	3.8±2.84	6.4±2.58	2.6	0.04*
Dorsiflexion ROM (degrees)	20±0	11±6.81	15.5	0.003*
FAAM-ADL (scores)	51±36.88	66±23.83	15	0.05*

MSK-USG-Musculoskeletal ultrasonogram, FAAM-ADL- Foot and Ankle Ability Measure-Activities of daily living,ROM-Range of Motion * Significant at p≤ .05, unpaired t-test

The within-group analysisof plantar fascia thickness was better at fascia level than at the calcaneum level denoting a reduction in thickness following intervention in both groups. The mean difference of pain severity reduction was equal in both groups whereas the within-group analysis in experimental group bettered ankle dorsiflexion range with a mean difference of 5 degrees.FAAM-ADL outcome showed a greater mean difference of 10 points in the experimental group, whereas a decline in functional score was observed in the control group.

The Correlation was tested between the primary outcome and functional outcomes using Pearson's correlation(r) test.A strong positive correlation was observed (r = 0.9) between plantar fascia thickness and post FAAM score (p=0.02) in table 3.

Table 3: Correlation between fascia thickness & FAAM-ADL scores

Component 1	Component 2	Pearson Correlation(r)	p-value
Fascia thickness	Post-FAAM-ADL	0.87	0.02*

FAAM-ADL- Foot and Ankle Ability Measure-Activities of daily living

* Significant at p ≤.05, Pearson correlation coefficient

DISCUSSION

Musculoskeletal ultrasonography is an ideal imaging diagnostic tool for plantar fasciitis which has good sensitivity and specificity. It is a non-invasive, inexpensive and easy technique to be performed. Several studies have done to label the characteristic findings of plantar fasciitis. The thickened plantar fascia (more than 4mm) is an uncompromising criterion for diagnosing plantar fasciitis. There is a marked increase in thickness is noted in the aponeurosis of plantar fascia when compared with the uninvolved foot. The inflamed fascia is hypoechoic and fibrillated in a uniform manner representing reparative processes after edema, micro tears, and degeneration of fiber.

The Qualitative assessment of fascia includes echogenicity, spur formation at calcaneum, oedematous perifascia and fibrillary pattern of the fascia. These parameters were considered for analysis which was similar to the outcomes of previous studies. The origin of the fascia or the proximal area of fascia was hypoechoic in all symptomatic heels and six subjects presented with calcifications in the calcaneal region — none of the subjects represented with a spur, perifascial edema, and fibrillary pattern.Huerta in 2007 concluded that gender is an absolute prognosticator of plantar fascia thickness and current results also show insignificant differences were observed between genders.

The current study findings on plantar fascia thickness in both groups showed minimal and insignificant changes. There was an even difference of 0.06 mm changes in plantar fascia thickness at the calcaneal level between the groups. However an insignificant change in plantar fascia thickness was derived when compared with the control group. Evaluation of pain using NPRS showed improvement at all test situations [16]. They [9] concluded insignificant differences between groups when compared for plantar fascia thickness, but pain scores showed statistically significant when compared between the groups.

The thickness of the plantar aponeurosis showed no significant changes in both groups. It is important to make a note that the subject's contralateral asymptomatic side was used as a for the normal aponeurosis thickness for that particular individual. The mean thickness of plantar fascia in subjects without plantar fasciitis was 2.5mm at the calcaneal level and 2.35mm at fascial level.

The literature states the minimum clinically important difference for FAAM-ADL is 8 points. The control group receiving ultrasonic therapy showed a mean difference of FAAM score as 9 points, whereas the experimental group is receiving LLLT the difference was 12 points. These changes were noted with 12 sessions for two weeks of duration of the intervention. The MCID of FAAM-ADL of 8.9 points was achieved at four weeks of intervention was reported [17]. Hence within a short duration of LLLT, a clinical difference in functional outcomes was observed.

Of the outcomes, the range of motion for ankle dorsiflexion was found to be highly significant (p=.003) in improvement when compared between the groups. The significant changes in dorsiflexion range were noted in a group which received ultrasonic therapy. Even though gastro-soleus stretching [18] was rendered in both groups evenly; the study results of the within-group analysis were insignificant to changes in ankle ROM.

The physiological effect of ultrasonic therapy proves the findings of the study results. The ultrasonic treatment affected the sensitivity of sensory receptors, such muscle spindle in skeletal muscle leading to increased ROM. Secondly, the thermal effects of ultrasound therapy are increasing the extensibility of the skin & muscle that has influenced the tissue elasticity. These two physiological changes of ultrasonic treatment[19] were postulated to be the reasons to have a positive impact on ankle ROM.

In another study, it was concluded that laser irradiation had shown relief in chronic pain because of suppressing pain through serotonin metabolism. There are a lot of possibilities for LLLT to trigger fibrous tissue regeneration and the healing process is enhanced. For almost a decade, tissue healing and biostimulation effects are enhanced by stimulating the tissue repair by laser therapy which has been useful in treating musculoskeletal disorders.

By the context of this particular protocol, the findings of the current study shall interpret with further clinical and imaging studies which are required to support treatment protocols. In summary, low-level laser therapy and ultrasonic therapy [20] contribute healing of fascia and reductionof pain severity.

The limitation of the current study includes a small sample size and duration of intervention with follow-up. Demographic data like BMI should have been considered as obesity is a major contributing factor for plantar fasciitis. Further randomized controlled trials in LLLT were warranted to prove its efficacy in plantar fasciitis.

CONCLUSION

The study concludes that low-level laser therapy and ultrasonic therapy has minimal improvement on plantar fascia thickness with two weeks of intervention. Low-level laser therapy was found to be effective in reducing pain severity in plantar fasciitis. Ultrasonic treatment with gastrosoleus stretching has profound effects on ankle dorsiflexion range of motion.There is a strong positive relationship between plantar fascia thickness and FAAM-ADL scores.Overall-low-level laser therapy exhibited positive results of clinical outcomes in plantar fasciitis.

REFERENCES

[1] Tahririan, M. A., Motififard, M., Tahmasebi, M. N., & Siavashi, B. Plantar fasciitis. *Journal of Research in Medical Sciences : The Official Journal of Isfahan University of Medical Sciences*. 2012; *17*(8): 799–804. http://doi.org/10.1136/bmj.e6603.

[2] Scher, D. L., Belmont, P. J., Bear, R., Mountcastle, S. B., Orr, J. D., & Owens, B. D. The incidence of plantar fasciitis in the United States military. *J Bone Joint Surg Am*.2009;*91*(12): 2867–2872. http://doi.org/10.2106/JBJS.I.00257.

[3] Hill, C. L., Gill, T. K., Shanahan, E. M., & Taylor, A. W. Prevalence and correlates of foot pain and stiffness in a population-based study: The North West Adelaide Health Study. *International Journal of Rheumatic Diseases*.2010;*13*(3):215–222. http://doi.org/10.1111/j.1756-185X.2010.01475.

[4] Sabir, N., Demirlenk, S., Yagci, B., Karabulut, N., & Cubukcu, S. Clinical utility of sonography in diagnosing plantar fasciitis. *Journal of Ultrasound in Medicine*.2005;*24*(8): 1041-1048. http://doi.org/24/8/1041 [pii].

[5] Hall, M. M., Finnoff, J. T., Sayeed, Y. A., & Smith, J. Sonographic Evaluation of the Plantar Heel in Asymptomatic Endurance Runners. *J Ultrasound Med*.2015;*34*(10): 1861–1871. http://doi.org/10.7863/ultra.14.12073.

[6] Garrett, T. R., & Neibert, P. J. The effectiveness of a gastrocnemius-soleus stretching program as a therapeutic treatment of plantar fasciitis. *Journal of Sport Rehabilitation*.2013;*22*(4): 308–12. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/23752554.

[7] Latt, L. D., Christensen, D. N., Mcnelly, A. L., Slayton, M. H., Amodei, R. C., & Cindy, D. Randomized Controlled Trial of Intense Therapeutic Ultrasound for the Treatment of Chronic Plantar Fasciitis. *Foot & Ankle Orthopaedics*.2016;*1*(1); 1–2. http://doi.org/10.1177/2473011416S00112.

[8] Basford, J. R., Malanga, G. A., Krause, D. A., & Harmsen, W. S. A randomized controlled evaluation of low-intensity laser therapy: Plantar fasciitis. *Archives of Physical Medicine and Rehabilitation*. 1998;*79*(3); 249–254. http://doi.org/10.1016/S0003-9993(98)90002-8.

[9] Kiritsi, O., Tsitas, K., Malliaropoulos, N., & Mikroulis, G. Ultrasonographic evaluation of plantar fasciitis after low-level laser therapy: Results of a double-blind, randomized, placebo-controlled trial. *Lasers in Medical Science*.2010;*25*(2):275–281. http://doi.org/10.1007/s10103-009-0737-5.

[10] Macias, D. M., Coughlin, M. J., Zang, K., Stevens, F. R., Jastifer, J. R., & Doty, J. F. Low-Level Laser Therapy at 635 nm for Treatment of Chronic Plantar Fasciitis: A Placebo-Controlled, Randomized Study. *The*

Journal of Foot and Ankle Surgery : Official Publication of the American College of Foot and Ankle Surgeons.2015b;*54*(5): 768–72. http://doi.org/10.1053/j.jfas.2014.12.014.

[11] Jastifer, J. R., Catena, F., Doty, J. F., Stevens, F., & Coughlin, M. J. (2014). Low-Level Laser Therapy for the Treatment of Chronic Plantar Fasciitis: A Prospective Study. *Foot & Ankle International*.2014;*35*(6): 566–571. http://doi.org/10.1177/1071100714523275.

[12] McCaffery, M., & Beebe, a. Pain: Clinical manual for nursing practice. The Numeric Pain Rating Scale. *Pain*;1989. http://doi.org/10.1016/0885-3924(90)90052-L.

[13] Borloz, S., Crevoisier, X., Deriaz, O., Ballabeni, P., Martin, R. L., & Luthi, F. Evidence for validity and reliability of a French version of the FAAM. *BMC Musculoskeletal Disorders*. 2011;*12*(1): 40. http://doi.org/10.1186/1471-2474-12-40.

[14] Franson, J., & Draper, D. *Heat Penetration into Soft Tissue with 3 MHz Ultrasound Jared. All Theses and Dissertations*. 2013. Retrieved from http://scholarsarchive.byu.edu/etd/3444.

[15] Pascual Huerta, J., & Alarcon Garcia, J. M. Effect of gender, age and anthropometric variables on plantar fascia thickness at different locations in asymptomatic subjects. *European Journal of Radiology*.2007;*62*(3): 449–453. http://doi.org/10.1016/j.ejrad.2007.01.002.

[16] Hjermstad, M. J., Fayers, P. M., Haugen, D. F., Caraceni, A., Hanks, G. W., Loge, J. H., Kaasa, S. (2011). Studies comparing numerical rating scales, verbal rating scales, and visual analogue scales for assessment of pain intensity in adults: A systematic literature review. *Journal of Pain and Symptom Management*. http://doi.org/10.1016/j.jpainsymman.2010.08.016.

[17] Cleland, J. A., Abbott, J. H., Kidd, M. O., Stockwell, S., Cheney, S., Gerrard, D. F., & Flynn, T. W. Manual physical therapy and exercise versus electrophysical agents and exercise in the management of plantar heel pain: a multicenter randomized clinical trial. *The Journal of Orthopaedic and Sports Physical Therapy*.2009;*39*(8): 573–585. http://doi.org/10.2519/jospt.2009.3036.

[18] DiGiovanni, B., Nawoczenski, D., Malay, D., Graci, P., Williams, T., WIlding, G., & Baumhauer, J. (2006). Plantar Fascia-Specific Stretching exercise improves Outcomes in Patients with Chronic Plantar Fasciitis. *The Journal of Bone and Joint Surgery*.2006;*88-A*(8): 1775–1782. http://doi.org/10.2106/JBJS.E.01281.

[19] Slayton, M. H., Amodei, R. C., Compton, K. B., Latt, D., & Kearney, J. Musculoskeletal treatments using intense therapy ultrasound: Clinical studies for chronic plantar fasciitis and lateral epicondylitis. In *2016 IEEE Healthcare Innovation Point-Of-Care Technologies Conference (HI-POCT)* (pp. 208–211). IEEE. http://doi.org/10.1109/HIC.2016.7797733.

[20] Martin, R. L., Davenport, T. E., Reischl, S. F., McPoil, T. G., Matheson, J. W., Wukich, D. K., & McDonough, C. M. Heel pain-plantar fasciitis: revision 2014. *The Journal of Orthopaedic and Sports Physical Therapy*.2014;*44*(11): A1–33. http://doi.org/10.2519/jospt.2014.0303.

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