Original Article

CONTINUOUS ULTRASOUND FOR CHRONIC PLANTAR FASCIITIS TREATMENT

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SUMMARY

In this study, the efficiency of continuous high-power ultrasound was assessed for plantar fasciitis treatment. Twenty two individuals were assessed, reporting pain lasting more than six months, through a functional questionnaire and visual scale for pain at the first morning load. Twenty seven feet were distributed into two groups: group 1 (stretching + ultrasound turned off) and group 2 (stretching + 2 w/cm^2 ultrasound). After 15 treatment sessions, an analysis of the absolute values and improvement percentages for collected variables was performed. A functional improvement was seen for both groups, with no difference between them. The analysis of the absolute values for pain intensity (at first, eighth, and last session) showed similarity between groups. The improvement percentage for 15 sessions did not present differences between both groups. That percentage was also calculated for two periods (before and after the eighth session). It was noted that the improvement percentage on all 15 sessions for group 2 (46.5%) was inferior to the percentage of the first eighth sessions for group 1 (54.6%). Thus, the high-power continuous ultrasound did not add value for function and pain; additionally, only specific stretching exercises were efficient in reducing more than 50% of the pain in chronic plantar fasciitis.

Keywords: Plantar fasciitis, Ultrasound, Physical therapy; Heel.

INTRODUCTION

Plantar fasciitis (PF) is a degenerative syndrome of the plantar fascia[1,2], which affects about 10% of the population at least in one moment in life, being obese women at menopause age most affected [2,3]. It presents many etiological reasons, but the most common cause is mechanical, involving compressive forces making foot's longitudinal arch flat [1,2]. Inflammation occurs by repeated microtraumas at the origin of plantar fascia over the calcaneal medial tuberosity. Traction forces during the support phase on gait lead to an inflammatory process, resulting in fibrosis and degeneration [3]. Calcaneal spur, and medial calcaneal nerves, lateral plantar nerve and fifth toe abductor nerve trapping may be involved, usually, when an inflammation picture is already established on plantar fascia [1,3].

The disease is accelerated or become more severe as a result of flexibility lost, as in calcaneal tendon retraction, of excessive drills, fatigue, fascial inextensibility, and poor mechanics [1]. The most important clinical aspect is localized pain at medial calcaneal tuberculum during morning support[2-4].

Conservative treatment based on physical therapy and analgesic agents is usually enough, although recovery is slow (up to 18 months)[2,3-5]. Another kind of non-surgical treatment is therapy with shock waves, introduced during the decade of 1990, which has been used for chronic cases[6]. This acts mechanically, fragmenting fibrosis and fascia calcification, and also acts as an analgesic agent, improving local stream and fostering tissue healing [6,7]. This therapy, originally developed from lithotripsy, has shown good outcomes (88-94% improvement), as well as low risks and minimal side effects for the patient [6,7]. Nevertheless, this is a new technology, therefore, hardly accessible for population

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in general. Furthermore, there is no consensus about the most efficient therapeutic parameters; and, also, it is important to highlight the high cost of the equipment and the lack of knowledge about long-term effects[3,7].

Therapeutic ultrasound (US), described as a high-frequency mechanical wave, transmits energy through vibration, and is extensively used in clinics [8,9]. Ultrasonic generators are able to deliver energy in two modalities: continuous or pulsed. In the continuous form, the wave power (measured as w/cm^2) remains steady, and its expected effects also involve the production of deep heat, increased local blood flow, pain relief, and also, if used in high powers (1.3 to 3.0 w/cm^2), it acts on fibrosis termination[8,9].

Thus, we see that the use of high-power continuous US is a potential indication for chronic PF treatment, since the therapy with shock waves, through similar effects, is presenting good results. Furthermore, the U/S is a widely available, low-cost equipment.

Therefore, the objective of this study was to test high-power, continuous-mode US efficacy in chronic PF treatment.

PATIENTS AND METHODS

This was a prospective, randomized and double-blind study. For that reason, 22 adult individuals were included, who do not regularly practice any physical activity, feeling pain for more than six months, with calcaneal pain intensity above four centimeters (cm), in a 10-cm scale, in which zero corresponds to absence of pain, and 10, maximum pain. Individuals with neurological disorders, local infection, tumor, coagulation disorders, conjunctive tissue diseases, uncontrolled diabetes, sensitivity deficit, pregnancy were not included. The individuals were informed and instructed about the purpose of the present study, and, subsequently, signed a consent term, as approved by local Committee on Ethics, agreeing in participating.

The patients should come three times a week, and on the first, eighth and last treatment session, pertinent evaluations were made by a "blind" investigator. All the process, intervention and evaluations demanded 15 sessions, constituting a total of five weeks.

The initial evaluation was comprised of anamnesis, in which questions were asked about the general identification of each participant, also involving questions about associate and previous diseases, previous medications and therapies.

Functional evaluation, performed on the first and last sessions, used a questionnaire employed by AOFAS[10] - American Orthopaedic Foot and Ankle Society, which evaluates, through scores from 0 to 100, in which a higher score corresponds to a better condition (pain, function, alignment) of the foot-ankle complex.

For following-up the painful picture during morning support, evaluations were performed through a 10-cm analogical visual scale (AVS) (Figure 1) on the first, eighth and last sessions.

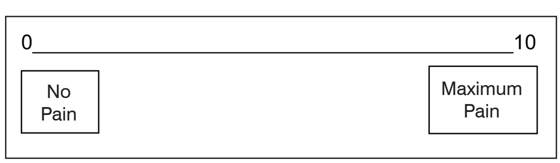

***Figure 1 –** Analogical Visual Scale (AVS) of 10 cm for evaluating pain severity at first morning support.*

Two groups were formed through randomization by sort. Bilaterally compromised individuals randomly chose a number for each foot, so, one foot could remain in group 1 while the contralateral one could be in group 2. Thus, participants' feet were distributed as follows:

- Group 1 (kinesiotherapy + US off)
- Group 2 (kinesiotherapy + US effective)

Kinesiotherapy involved five stretching exercises, each one lasting three minutes, for the leg posterior musculature and plantar fascia[11]. US was applied with the following parameters: continuous mode, base frequency of 1MHz, power 2 w/cm^2, applied during three minutes on each region (calcaneus medial tuberosity and on the 2 cm distal to tuberosity). The instrument's transducer headstock remained steady, being moved for a few seconds, only when discomfort or pain were reported, in order to obtain ultrasound waves concentration, thus achieving a focal application without producing undesirable effects on adjacent tissues.

Numerical data achieved with scores of AOFAS[10] questionnaire and the data achieved on pain evaluation were analyzed both in absolute values – by comparing baseline and end status for functionality, and, initial, on the eighth session and final for pain on first morning support – and in relative values for function gain and pain relief, respectively. For this, the improvement percentage was achieved by the calculus:

Considering X as any variable, and times 1 and 2 as different intervention periods, with time 1 preceding time 2, we have:

$$\frac{|X\ time1 - X\ time2|\ x\ 100}{X\ time1}$$

The statistical analysis was performed through Student's t-test and Wilcoxon's tests for comparisons before and after treatment. The analyses between both groups were performed through Student's t-test and Mann-Whitney's test for parametric and non-parametric data, respectively. Also, for the pain intensity study collected on the first, eighth and last session, the Friedmann's test with Dunn's post test was used.

RESULTS

Taking bilateral cases into account, 27 feet were allocated to groups, resulting in group 1: 13 feet, and group 2: 14 feet.

Groups' homogenization concerning the level of pain, function at baseline, body weight, time of pain presence, and age was confirmed by statistically addressing baseline data.

Case series: mostly women, in their fifth decade of life. The use of anti-inflammatory agents was common, as well as inappropriate shoes, periods above six hours in stand-up position, and overweight presence. Associate and previous diseases are shown on Table 1 .

Functional Evaluation: the analysis of scores obtained from AOFAS[10] questionnaire has shown a post-procedural improvement, that is, an increase of scores for both groups, with no significant difference to each other (Figure 2A). The same similarity was seen for improvement percentages (Figure 2B).

Pain Evaluation: the analysis of absolute values for pain levels at the three evaluation points has shown that both groups presented a significant improvement during the 15 procedure sessions (Figure 3A). The pain level average at the end of treatment was statistically equivalent for groups 1 and 2 (Figure 3A).

	Group 1	Group 2
Hyperlipidemia	2	2
Hypertension	2	3
Osteoarthrosis Knees	2	1
Ankle Fracture	2	1
Ligament injury	3	2
Calcaneal spur	2	4

***Table 1 –** Distribution of related and previous diseases between groups.*

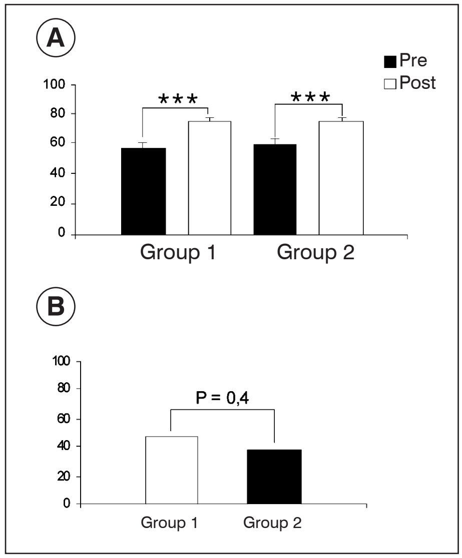

***Figure 2 –** Graphs showing the evolution of absolute and percentage numbers of scores achieved with AOFAS questionnaire. A) Pre- and post-treatment absolute values for group 1 (US off) and for group 2 (US on). B) Improvement percentage for both groups. P ≤ 0.001 (***).*

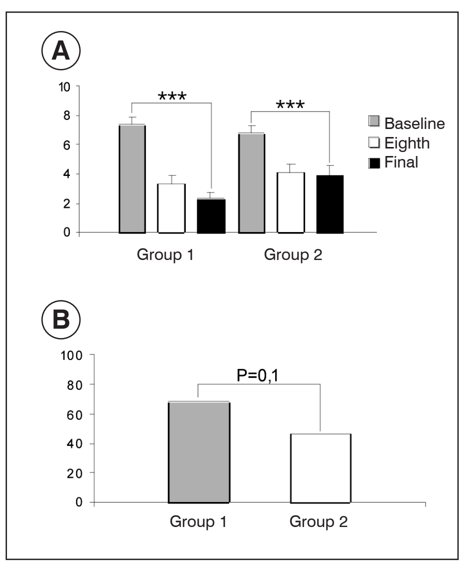

***Figure 3 -** Graphs showing the evolution of absolute and percentage values of measurement (in centimeters) achieved with the visual scale for pain severity (AVS). A) Absolute values of baseline, eighth and end treatment session for group 1 (US off) and group 2 (US on).*
B) Improvement percentage for both groups concerning pain. P ≤ 0.001 (***).

By comparing values concerning improvement percentage, that is, the amount of reduced pain, we can see that, in group 1, there was no significant gain difference between both analyzed periods (before the eighth session and after eighth session), while group 2 showed a better outcome on the first treatment period. However, comparing the first intervention period for both groups, no significant differences were seen, as well in the second period.

A comparison was also made between the groups concerning total pain improvement percentage (Figure 3B). By statistically addressing values, the groups achieved, within the whole intervention period, similar results. Two results from group 2 showed negative values, with those cases showing calcaneal spur.

With the analysis performance, we saw that despite the statistical similarity checked, there was a significant numeric difference between the averages of improvement percentage of groups: by comparing the average up to the eighth session on group 1 (54.64%) to the total average on group 2 (46.52%), it is noticed that the first is superior.

DISCUSSION

PF is a common cause of hindfoot pain[2,12]. Pain is usually moderate to severe, predisposing to functional disability, which, for the studies case series, involved gait, daily life activities and labor difficulties, reaching to the point of finding some medical leave cases.

It is worthy to highlight an interesting aspect, noted on some individuals' evaluation of previous history. Reports of frequent ankle sprains and some of fractures at the same region could suggest that the presence of instability or mechanical change - trauma sequels – have contributed to PF onset. No similar information was found in referred literature.

Calcaneal spur was seen in four people, with two bilateral cases. The presence of such change was not considered as a triggering factor for the disease in our case series, due to the absence of spur in 81% of the individuals [3,13].

Using US as an intervention mean on PF, Crawford[14] did not achieve significant results. Although we also could not show higher treatment effectiveness, the characteristics of each study were totally different. Crawford used low intensity (0.5 w/cm²) and pulsed mode of application, while we used high-power (2.0 w/cm²) and continuous mode, this being especially indicated to chronic processes treatment [8,9]. It was observed that the proposed method did not add functional and pain gains, and, performing only stretching drills during 15 or more sessions, would be efficient for reducing pain.

By checking individual values obtained for group 2, it was noticed that the worst results occurred in people presenting with calcaneal spur, showing that US may not be a good intervention method for those cases.

Average values for pain improvement percentage in both groups were negative during the period from eighth to last session due to few worsening cases compared to gains previously achieved in the first eight sessions. Nevertheless, the majority of patients (nine in each group) presented with improvement levels in that period, showing the need of an extended treatment, as mentioned by literature [2,3-5,7,15].

The initial intention, for group 2, was to direct the ultrasonic beam, with the objective of obtaining the micro destruction of the affected tissue. However, temporary pain to US intervention made the steady application impossible. Thus, the equipment's headstock position was slightly changed for a few seconds, until pain ceased. One alternative could be an increased application time. In this case, even with subtle headstock movements, a higher ultrasonic energy concentration could be achieved on affected region. Even considering that possibility, Pfeffer et al.[4] previously reported that, for people remaining at standup position most of the time, as in the case of most of our patients, only stretching exercises would be more effective than other therapies.

Therapeutic US is also indicated, as an analgesic agent, to other causes of talagia, such as plantar adipose cushion inflammation, tarsal tunnel syndrome, calcaneal spur, nervous branch compressions [3]. In these cases, however, equipment modulations would be different than those used in this study. Nonetheless, we believe that other treatment methods would be more efficient, such as, for example, rest and proper shoe wearing, accompanied by a stretching program aiming to increase ankle's dorsiflexion [11].

CONCLUSIONS

- Local application of high-power continuous-mode US does not add value to functionality and pain relief in chronic PF, especially in cases with calcaneal spur.
- Stretching exercises for fascia and leg's posterior musculature is efficient for reducing plantar pain and for functional improvement in chronic PF.

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