

## Therapeutic Ultrasound and Photobiomodulation Applied on the Palm of Hands: A New Treatment for Fibromyalgia – A Man Case Study

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### Abstract

Fibromyalgia is a chronic disorder put in the spotlight in the last decades. Known since the 1920s, the disease is described by multiple painful points, of heightened sensitivity to touch that prevails in women, and afflict 3% to 10% of worldwide population. Fibromyalgia affects skeletal muscles and soft tissues. However, although there is no joint pain. Pharmacological treatment consists in analgesics and anti-inflammatory drugs to ease the pain. In addition, antidepressants, anxiolytics and anticonvulsants can be prescribed to control pain crises. Non-pharmacological approaches as therapeutic ultrasound and photobiomodulation are an alternative for pain relief. Recently, the synergic action of therapeutic ultrasound and photobiomodulation has emerged as an alternative to treat fibromyalgia in women when applied at the palm of hands. The success of the treatment is attributed to stimulation of neuroreceptors close to blood vessels located at the palm of hands and found to be in higher incidence in fibromyalgic patients when compared to healthy patients. This study aimed to evaluate the synergic effect of therapeutic ultrasound and photobiomodulation applied to the palm of hands of a fibromyalgic man patient. Evaluation was based on Quality Life Questionnaire (SF-36) and Visual Analogue Scale (VAS). Results show the treatment could improve the patient's quality of life (SF-36) and reduce pain (VAS), indicating a new therapeutic approach to treat chronic disorders like fibromyalgia, reducing pain and increasing quality of life of fibromyalgic patients.

**Keywords:** Fibromyalgia; Photobiomodulation; Therapeutic ultrasound; Ultra-laser; Palm of hands

### Introduction

Fibromyalgia is considered a modern disease, being highlighted in the last 20 years with improvement of clinical diagnosis based on symptoms and signs. However, several are the terminologies encountered previously, with a record similar to the disease dating from 1824 in England, when Balfour reported cases of patients with painful stitches and increased sensitivity to touch [1].

Fibromyalgia is a chronic condition that affects the muscles and soft tissues, although it does not affect the joints, causing severe pain spread throughout the body, adding up to 18 pain points. The prevalence of the disease is higher in women, but can also affect men, affecting 3% to 10% of the adult population. This condition strongly interferes with the patient's lifestyle and daily routine [2], impacting patient's life and social and occupational function [3], resulting in a negative impact on patient's quality of life [4,5].

Treatment approach to Fibromyalgia can rely on medications or therapeutics. Pharmacological approach consists of analgesics and anti-inflammatory drugs to ease the pain. In addition, antidepressants, anxiolytics and anticonvulsants can be prescribed to control pain crises [6,7]. Non-pharmacological treatments used so far can include therapeutic ultrasound and photobiomodulation as an alternative pain relief. Physical exercise and dietary have also shown to contribute to clinical improvement of Fibromyalgia patients [8-12].

Technological resources as low-level laser therapy (or photobiomodulation) have proven to be efficient as anti-inflammatory and analgesic therapeutics by enzymatic modulation and mitochondria activation, increasing the ATP supply and anti-inflammatory effect by activation of transcriptional factors, new protein synthesis and cell proliferation [13]. Therapeutic ultrasound is widely used to ease muscle pain due to its analgesic, anti-inflammatory and thermal tissue action, resulting in vasodilatation and increase in the speed of nervous signaling [14].

The synergic action of therapeutic ultrasound and low-level laser therapy have been used in fibromyalgia and osteoarthritis treatment, combining both therapeutic approaches in one single piece of equipment developed by our group and named ultra-laser. First trials of the synergic effect of ultrasound and photobiomodulation report a decrease in pain sensation, as well as improve functional capacity after treatment by the ultra-laser therapy [15-18]. By these results it is hypothesized that analgesic effect is obtained overlapping the effect of photobiomodulation and therapeutic ultrasound on tissue [15-18].

Moreover, the new technology that put together laser and ultrasound therapeutics in one single piece of equipment is used not only in local pain, but also on palm of hands, revealing a new therapeutic approach for fibromyalgia treatment. Palm of hands of fibromyalgic patients have greater sensory nerve fibers surrounded by blood vessels than non-fibromyalgic patients [19]. In addition, it is believed that peripheral neurovascular disorders can affect the patient's pain threshold, resulting in general and excessive fatigue of muscle fibers due to lower oxygen supply, leading to sleep disorders related to

hyperalgesia [20]. It is also important to emphasize that cerebral blood flow changes can also play a role in managing pain on fibromyalgic patients [21], which could affect the organism systemically.

## Study of Case

Patient of the male gender, caucasian, 43 years old, weighing 105 kg and 1.74 m of height, body mass index 34.69 kg/m<sup>2</sup>. Patient was admitted in our clinical research unit with no previous diagnosis of rheumatic disease as osteoarthritis, lupus, arthritis or systemic psoriasis. The main complaint was a constant widespread pain, summing up 15 trigger points, for at least 10 years. The patient had a depressive condition and limited movement because of excessive pain. In addition, the pain resulted in functional restriction of daily activities, reflecting in social and familiar relationships. Moreover, he also reported sleep disorders because of generalized pain. For pain relief, patient used analgesics, anti-inflammatory and antidepressants as treatment. The clinical condition of fibromyalgia was pointed out by medical evaluation.

The treatment on palm of hands proposed by this work consisted of 10 sessions of ultra-laser therapy. The patient's condition was compared before and after treatment by Quality Life Questionnaire (SF-36) and Visual Analogue Scale (VAS). The patient consented to treatment and the study was approved by the hospital ethical committee (resolution 466/2012).

## Equipment and Protocol of Instrumentation

This research used an ultra-laser prototype, equipment developed by the Technological Support Laboratory (LAT) of the Institute of Physics of São Carlos (IFSC), University of São Paulo (USP). The prototype consisted of a therapeutic ultrasound assembled together to a low-level laser source, enabling ultrasound and light emission by the transducer (Figure 1).



**Figure 1:** The ultra-laser prototype in use. The equipment was assembled to emit ultrasound and light field at the same time. For fibromyalgia, the treatment proposed was on the palm of hands.

The protocol proposed for treatment of fibromyalgia consisted of two times a week application, summing up to 10 sessions in total. Application was made at palm of both hands with constant rotation of the transducer, and it comprised the whole area, for three minutes per hand, totalizing six minutes application per session. During application, the probe was kept upright, always keeping a 90° angle between the transducer and the palm of the hand.

Transparent ultrasound conductive gel was used to reduce static and help transmit the ultrasound waves. Parameters set up for the treatment are described on Table 1.

Ultrasound	
Mode	Pulsed, 1 MHz
Frequency	100 Hz
Duty cycle	50%
Spatial-peak temporal-average intensity	0.5 w/cm <sup>2</sup>
Photobiomodulation (Low-level laser therapy)	
Wavelength	808 nm
Mode	Continuous
Power	100 mW
Irradiance	60 W/cm <sup>2</sup>

**Table 1:** Parameters set up of the therapeutic ultrasound and low-level laser on ultra-laser prototype.

## Results and Discussion

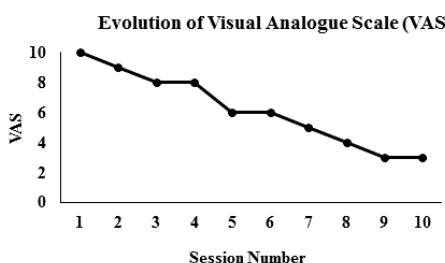
Fibromyalgia is a chronic pain disorder combined to an inflammatory clinical condition that results in the decrease of life quality. We proposed in a previous study a new treatment approach by applying simultaneously therapeutic ultrasound and low-level laser therapy [13] to the palm of hands of women. However, this is the first time this new treatment proposal is reported on treatment of a fibromyalgic man.

Table 2 shows the comparative analyses of Quality Life Questionnaire (SF-36) and Visual Analogue Scale (VAS) variables before and after treatment. In addition, delta ( $\Delta$ ) value shows the percentage variation of patient's response to treatment, where  $\Delta>0$  indicates efficacy of the treatment and  $\Delta<0$  is related to patient's aggravation of clinical condition. By the results shown, it is possible to verify an improvement on general patient's clinical condition, with a delta value of  $\Delta=43.45$  for functional capacity evolution,  $\Delta=100$  for physical limitations,  $\Delta=100$  for pain,  $\Delta=19.35$  for general clinical condition,  $\Delta=62.5$  for vitality,  $\Delta=85.7$  for social impact,  $\Delta=33.4$  for emotional impact and  $\Delta=65$  for mental health. It is important to emphasize that a greater score points out to improvement in the clinical condition of the patient.

	Evaluation Before Treatment	Evaluation After Treatment	Delta value ( $\Delta$ )
Functional capacity	45	80	43.75
Physical limitations	20	40	100
Pain	0	31	100
General clinical condition	50	62	19.35
Social impact	12.5	87.5	85.7
Emotional impact	66.6	100	33.4
Mental health	35	100	65

**Table 2:** Quality life questionnaire (SF-36).

In all treatment sessions, the patient was asked to use the Visual Analogue Scale to quantify pain before ultra-laser therapy. Figure 2 shows the patient's pain evolution, in the initial session and final session.



**Figure 2:** Evolution of the patient's clinical condition through treatment sessions, considering pain relief quantified by Visual Analogue Scale (VAS). The evaluation was performed before each session.

The new protocol proposed to treat fibromyalgia with therapeutic ultrasound and low-level laser therapy succeeded in improving patient's health condition. The clinical approach at the palm of hands showed to be a harmless and painless approach with systemic action [16], and the main hypothesis to these results was related to a higher nerve supply to the palm of hands of fibromyalgic patients when compared to health population [19].

Systemically, fibromyalgia clinical condition can modulate brain and peripheral blood flow, resulting in hyperalgesia. Similarly, abnormal blood flow and temperature might modulate the autonomic nervous system, reflecting in metabolic response or in pain threshold modulation, what could explain fatigue as a response to metabolic stress of the body [15,16].

By analyzing the patient's report, it seems that the ultra-laser therapy promoted systemic homeostasis. The synergic action of the ultrasound and laser resulted in improvement of quality of life, as well as pain reduction, having a great impact on the patient's social and public relations. Therapeutic ultrasound is widely used in physiotherapy to promote analgesia and anti-inflammatory response, apart from favoring ionic permeation into the cells due to cavitation effect. The photobiomodulation also promotes analgesia and anti-inflammatory response, but the light interaction with the mitochondrial respiratory chain also results in ATP generation [22,23]. The main hypothesis to the observed results is that both therapeutic approaches to treat fibromyalgic patients could reestablish blood flow through the body and brain [21,24] and contribute to homeostasis of metabolic anomalies, gradually minimizing fatigue apart from contributing to thermoregulation and modulation of the pain threshold.

Thus, the new ultra-laser therapeutic approach for fibromyalgia treatment is effective not only in female, but also in male patients, reducing pain and allowing patients to return to activities that had been abandoned due to fatigue or pain crisis.

## Conclusion

The present study showed the beneficial effect of simultaneous application of ultrasound and low-level laser therapy at the palm of

hands of a male fibromyalgic patient, resulting in pain decrease and contributing not only to pain relief, but also to the improvement of the patient's quality of life.

## Ethical Approval

The study was approved by the Hospital Ethical Committee (resolution 466/2012).

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## Conflicts of Interest

All authors confirm that there is no conflict of interest.

## References

1. Gomez-Arquelles JM, Maestu-Unturbe C, Gomez-Aguilera EJ (2018) Neuroimaging in fibromyalgia. *Rev Neurol* 67: 394-402.
2. Berber JSS, Kupek E, Berber SC (2005) Prevalence of Depression and its Relationship with Quality of Life in Patients with Fibromyalgia Syndrome. *Rev Bras Reumatol* 45: 47-54.
3. Spaeth M (2009) Epidemiology, costs, and the economic burden of fibromyalgia. *Arthritis Res Ther* 11: 117.
4. Kaplan RM, Schmidt SM, Cronan TA (2000) Quality of Well Being in Patients with Fibromyalgia. *J Rheumatol* 27: 785-789.
5. Martinez J, Ferraz MB, Fontana AM, Atra E (1995) Psychological Aspects of Brazilian Women with Fibromyalgia. *J Psychosom Res* 39: 167-173.
6. Borchers AT, Gershwin ME (2015) Fibromyalgia: A critical and comprehensive review. *Clin Re Allergy Immunol* 49: 100-151.
7. Skaer TL (2014) Fibromyalgia: disease synopsis, medication cost effectiveness and economic burden. *Pharmacoeconomics* 32: 457-466.
8. Higgs JB (2018) Fibromyalgia in Primary Care. *Prim Care* 45: 325-341.
9. Clauw DJ (2014) Fibromyalgia: a clinical review. *JAMA* 311: 1547-1555.
10. Matsutani LA, Marques AP, Ferreira EA, Assumpção A, Lage LV, et al. (2007) Effectiveness of muscle stretching exercises with and without laser therapy at tender points for patients with fibromyalgia. *Clin Exp Rheumatol* 25: 410-415.
11. Kwiatak R (2017) Treatment of fibromyalgia. *Aust Prescr* 40: 179-183.
12. Gur A, Karakoc M, Nas K, Cevik R, Sarac J, et al. (2002) Efficacy of low power laser therapy in fibromyalgia: a single - blind, placebo-controlled trial. *Lasers Med Sc* 17: 57-61.
13. Hamblin MR (2017) Mechanisms and applications of the anti-inflammatory effects of photobiomodulation. *AIMS Biophysics* 4: 337-361.
14. Çitak-Karakaya II, Akbayrak T, Demirtürk F, Ekici G, Bakar Y (2006) Short and Long-Term results of Connive Tissue Manipulation and Combined Ultrasound Therapy in Patients with Fibromyalgia. *J Manipulative Physiol Ther* 29: 524-528.
15. Amaral J, Franco DM, de Aquino E Jr, Bagnato VS (2018) Fibromyalgia Treatment: A New and Efficient Proposal of Technology and Methodological – A Case Report. *J Nov Physiother* 8: 379.
16. Bruno JSA, Franco DM, Ciol H, Zanchin AL, Bagnato VS, et al. (2018) Could Hands be a New Treatment to Fibromyalgia? A Pilot Study. *J Nov Physiother* 8: 393.
17. Jorge AES, Simão MLD, Fernandes AC, Chiari A, de Aquino Jr AE, et al. (2018) Ultrasound conjugated with Laser Therapy in treatment of osteoarthritis: A case study. *J Sports Med Ther* 3: 024-027.
18. Jorge AES, Simão MLS, Fernandes AC, Chiari A, de Aquino Junior AE, et al. (2017) Can Combined Ultrasound and Laser Therapy Potentiate the

Treatment of a Symptomatic Osteoarthritis? A Case Report. *J Nov Physiother* 7: 372.

19. Albrecht PJ, Hou Q, Argoff CE, Storey JR, Wymer JP, et al. (2013) Excessive peptidergic sensory innervation of cutaneous arteriole-venule shunts (AVS) in the palmar glabrous skin of fibromyalgia patients: implications for widespread deep tissue pain and fatigue. *Pain Med* 4: 895-915.

20. Vierck CJA (2012) Mechanism-Based Approach to Prevention of and Therapy for Fibromyalgia. *Pain Res Treat* 2012: 951354.

21. Kaya A, Akgöl G, Gülkesen A, Poyraz AK, Yıldırım T, et al. (2018) Cerebral Blood Flow Volume Using Color Duplex Sonography in Patients With Fibromyalgia Syndrome. *Arch Rheumatol* 33: 66-72.

22. de Aquino Jr AE, Carbinatto FM (2017) The interaction between photonic technology and physical exercise: The action of low-level laser therapy. *New Insights Obes Gene Beyond* 1: 10-13.

23. Azeemi ST, Raza SM, Yasinzai M (2008) Colors as catalysts in enzymatic reactions. *J Acupunct Meridian Stud* 1: 139-142.

24. Rodriguez A, Tembl J, Mesa-Gresa P, Muñoz MA, Montoya P, et al. (2017) Altered cerebral blood flow velocity features in fibromyalgia patients in resting-state conditions. *PLoS One* 12: 1-21.