Journal of Novel Physiotherapies
ISSN: 2165-7025

Case Report Open Access

Synergistic Action of Photobiomodulation and Ultrasound in the Treatment of Fibromyalgia and Childhood Autism: Case Report

Nikolly Struziatto Duarte[1], Antonio Eduardo de Aquino Junior[1,3]*, Nathália Gonçalves de Oliveira[2], Díulia Estéfane Santos Barbosa[2], Gabriel Oliveira Borba[2], Maria Julia de Melo Matuck[2], Fernanda Mansano Carbinatto[1,3], Esther Angélica Luiz Ferreira[4] and Vanderlei Salvador Bagnato[1,3,5]

[1]*Physics Institute of São Carlos, University of São Paulo, São Paulo, Brazil*
[2]*College of Sete Lagoas, Minas Gerais, Brazil*
[3]*Pos-graduation Program of Biotechnology, Federal University of São Carlos, São Paulo, Brazil*
[4]*Department of Medicine, Federal University of São Carlos, São Paulo, Brazil*
[5]*Department of Biomedical Enginnering, Texas A&M University, Texas, USA*

Abstract

Fibromyalgia, a chronic disease, manifests itself through diffuse pain and sensitivity in various parts of the body, in addition to other symptoms, and is a pathology that can affect children and adolescents. Another clinical condition that can be diagnosed in childhood is Autism Spectrum Disorder, a complex neurological condition characterized by persistent challenges in communication and social interaction, as well as by the presence of repetitive and restricted patterns of behavior, interests, and activities. The objective of this study was to promote intervention in a clinical case of a child with fibromyalgia and autism spectrum disorder using synergistic photobiomodulation and ultrasound on the palms of the hands, evaluating possible benefits for fibromyalgia and autism. Female patient, 9 years old, diagnosed with juvenile fibromyalgia and autism spectrum disorder level 1. The patient underwent 10 treatment sessions using equipment with synergistic photobiomodulation and ultrasound capabilities, applied to the palms of the hands. Assessments were performed together with the patient's guardian using the Fibromyalgia Impact Questionnaire, Visual Analogue Scale for pain and Hospital Anxiety and Depression Scale. The results showed that the clinical intervention was effective in controlling the symptoms of fibromyalgia, reducing pain. Anxiety and depression showed a small reduction according to the questionnaire. Thus, we can conclude that the clinical intervention provided an improvement in quality of life and reduced pain in the fibromyalgia condition. Regarding Autism Spectrum Disorder, a longer intervention period is necessary.

Keywords: Fibromyalgia; Fotobiomodulation; Ultrasound; Autism; Pain; Life quality

Introduction

Marked by intense learning, childhood is a phase that brings psychic development through socialization, exploratory instinct and understanding of cultural values [1]. Developed capabilities and lived experiences can directly influence future development and well-being because it is the moment in which beliefs, orientations and expectations are created [2]. Thus, the environment in which the child is inserted during childhood is a definitive factor in the child's physical, cognitive, social, emotional and linguistic progress and development, all of which have a profound impact on the individual's current and future general well-being [3].

Fibromyalgia

Fibromyalgia is a chronic disease that manifests itself through diffuse pain and sensitivity in various parts of the body, accompanied by symptoms such as fatigue, muscle stiffness, sleep disorders, and cognitive and memory difficulties, among other symptoms. The number of diagnoses has increased because the signs and symptoms are considered exclusive to this definition [4,5].

Fibromyalgia syndrome in children and adolescents is a chronic non- inflammatory painful condition that occurs mainly in girls between the ages of nine and 15, and is called Juvenile Fibromyalgia Syndrome [6].

Through an estimated prevalence in the pediatric population of 1.2% and 6.2%, juvenile fibromyalgia has a higher incidence in females (4:1), with onset between 11.4 and 13.7 years and is more common in the Caucasian population, in women and in adolescents [7,8]. In many cases, there is a family history of fibromyalgia or other central sensitization processes [8].

Symptoms include widespread musculoskeletal pain, fatigue, and sleep and mood disturbances, often resulting in a deterioration of depressive symptoms and a reduction in physical functioning in affected patients [9]. Despite the great similarities between juvenile fibromyalgia and adult fibromyalgia, the reduction in physical activity, school absenteeism and reduced coping resources in children and adolescents justify the differentiated analysis of fibromyalgia in young people [6].

There are several treatment approaches available for fibromyalgia, which vary in effectiveness and can be both pharmacological and non-pharmacological. Pharmacological interventions include anti-inflammatories, antidepressants and anticonvulsants, which have shown significant to moderate benefits. Non- pharmacological options

***Corresponding author:** Antonio Eduardo de Aquino Junior, Physics Institute of São Carlos, University of São Paulo, São Paulo, Brazil, E-mail: antonioaquino@ifsc.usp.br

Received: 02-Nov-2024, Manuscript No: jnp-24-151631; **Editor assigned:** 04-Nov-2024, Pre-QC No: jnp-24- 151631(PQ); **Reviewed:** 18-Nov-2024, QC No: jnp-24-151631; **Revised:** 23-Nov-2024, Manuscript No: jnp-24-151631(R); **Published:** 30-Nov-2024, DOI: 10.4172/2165-7025.1000763

Citation: Duarte NS, Junior NEA, Oliveira NG, Barbosa DES, Borba GO, et al. (2024) Synergistic Action of Photobiomodulation and Ultrasound in the Treatment of Fibromyalgia and Childhood Autism: Case Report. J Nov Physiother 14: 763.

include acupuncture, cognitive-behavioral therapies, exercise and hydrotherapy as some of the most effective in treating the condition [10]. Furthermore, the use of low-intensity laser (through the photobiomodulation process) and ultrasound has become a potential non-pharmacological treatment for the disease, especially for pain [11].

A link between pain and anxiety has also been established, showing that the higher the anxiety scores, the worse an individual's perception of pain, and that patients with lower levels of the disorder demonstrate greater tolerance to pain [1]. Both emotional and cognitive factors have an important influence on pain perception [12,13]. Self-reporting, the gold standard for measuring pain, since it is a private experience [14]. The presentation of anxiety varies with age and is among the most common psychiatric disorders among children and adolescents, being frequently associated with the impairment of young people's social, personal and academic functions [15].

Autism spectrum disorder

According to the Diagnostic and Statistical Manual of Mental Disorders, in its fifth edition (DSM-5), Autism Spectrum Disorder (ASD) is defined as a complex neurological condition, which is characterized by persistent challenges in communication and social interaction, as well as by the presence of repetitive and restricted patterns of behaviors, interests and activities [12].

According to the Centers for Disease Control and Prevention's Autism and Developmental Disabilities Monitoring Network, 1 in 44 children is diagnosed with Autism Spectrum Disorder (ASD). It is more prevalent in males, four times more so than in females. In addition to having the spectrum, individuals may also have associations with other conditions, such as depression, anxiety, and attention deficit disorder [13].

The etiology of the disorder is multifactorial, including genetic, environmental and immunological factors, as well as perinatal, neuroanatomical and biochemical factors. Patients with ASD present deficits in interaction, verbal and non- verbal communication, as well as limitations in their motor functions. The presence of the disorder can lead to increased levels of anxiety, stress and isolation of individuals and family members. Therefore, these patients require special care, which will demand significant financial resources [14].

Individuals may present spectrum characteristics in early childhood, therefore, early diagnosis requires a multidisciplinary evaluation, where behavioral and pharmacological therapies are indicated [13]. Pharmacological therapies may be beneficial for treating symptoms identified in individuals with ASD, and it is important to consider the benefits and risks of each case. Among the pharmacological interventions used, the use of stimulants, alpha-2 agonists, antipsychotics, anticonvulsants and antidepressants stands out [15,16].

Treatment

There is broad consensus in the literature that treatment for fibromyalgia should be multidisciplinary [6,8].

Changes in pain transmission have been described at the level of the ascending spinothalamic pathways and descending modulatory pathways [17,18]. Chronic pain would induce hypersensitization and persistent stimulation in the posterior horn of the spinal cord, causing an exaggerated response to non-painful stimuli (allodynia) or mildly painful stimuli (hyperalgesia), characteristic of both fibromyalgia and other pain amplification syndromes. This increase in central sensitization to pain determines an inability to attenuate pain resulting from repeated exposure to a noxious stimulus through descending pathways (endogenous inhibition) of the cortical areas of the brain. The increase in neurotransmitters in the pronociceptive pathways, such as substance P or glutamate, and the decrease in serotonin and norepinephrine in the descending pathways may contribute to the increased sensitivity to pain [6].

The adaptive stress response, specifically the hypothalamic-pituitary response that results in decreased production of adrenocorticotropic hormone (ACTH) and cortisol, is decreased in patients with fibromyalgia. There may also be low levels of growth hormone, which is important for tissue repair, given the sleep disturbances in these patients [6]. Associations with HLA-DR4 and polymorphisms in genes associated with serotonin (serotonin transporter SLC4), dopamine (D2 and D4 receptors), and catecholamine (catechol-o-methyltransferase [COMT]) metabolism have been described [6].

Synergistic photobiomodulation and ultrasound therapies are considered the best approaches in certain cases because they present anti-inflammatory and analgesic responses, since when used together, tissue stimulation becomes greater, and consequently presents significant therapeutic responses [19].

Red and infrared wavelengths are the most widely used in healthcare as therapeutic tools, through modulation of mitochondrial respiration, inducing the production of ATP through red light. For the control of pain and inflammation, low- intensity laser has been increasingly used, as it induces responses in therapeutic procedures in which the gain has been shown to be significant [20,21].

Therapeutic ultrasound is a technology used for various treatments of musculoskeletal disorders. The use of this therapy promotes acoustic microflow and cavitations, increases cell membrane permeability, promotes healing and increased blood flow, while cavitation is responsible for the agitation of gas microbubbles that promote the fragmentation of necrotic tissues [20,22].

The objective of this study is to evaluate the intervention model using laser and ultrasound combined in an intervention model for fibromyalgia, through application to the palms of the hands, evaluating possible benefits in a case of autism.

Case Report

The study was submitted to the Human Ethics Committee of Santa Casa de São Carlos (CAAE 83748624.0.0000.8148), in accordance with resolution 466/2012. A 9-year-old female patient diagnosed with juvenile dementia (based on palpation criteria, with a score of 15) and level 1 autism spectrum disorder (ASD) was evaluated at our clinical research center (Photodynamic Therapy Unit). The guardian reported that the child had intense pain in her hands, feet, and body after activities such as walking and playing, which prevented her from participating in activities such as dancing and having fun. She uses the following medications: antidepressants, anticonvulsants, antipsychotics, and hormonal supplements, and also reports pain relief whenever she uses a hot compress and rests. Regarding the evaluation mechanism, the FIQ (Fibromyalgia Impact Questionnaire) was used, which, although limited (it can provide diagnosis and further studies) [6,8], can generate real conditions of interference in pain and quality of life, VAS (Visual Analogue Scale) for pain and HADS (Hospital Anxiety and Depression Scale). All questionnaires were answered with the help of the person in charge.

Equipment

The equipment used in the study was developed at the Technological Support Laboratory (LAT) of the Physics Institute of São Carlos, University of São Paulo (USP) and produced by MMOptics, São Carlos, São Paulo, Brazil, patent number BR102014007397-3 A2, named RECUPERO®. The equipment allows for the simultaneous application of fotobiomodulation (low-level laser therapy) and ultrasound, providing the combined application of resources, allowing the overlapping of therapeutic fields (Figure 1).

Intervention

Combined laser and ultrasound therapy was applied to each of the patient's hands, totaling 10 sessions performed twice a week. A frequency of 1MHz, intensity of 0.5W/cm², lasting 5 minutes for each hand, and a pulse of 48Hz were used. The red laser used had a wavelength of 660nm and power of 1.30W (Figure 2).

The application was performed on the palms of the hands due to the high innervation of the region, with the application area occurring in the muscles of the Hypothenar, Thenar and Palmar Aponeurosis regions [11].

Results

Figure 3 shows the evolution of quality of life according to the Fibromyalgia Impact Questionnaire, considering the 10 intervention sessions, measured before and after treatment. A reduction in values is observed when evaluating the questionnaire, with an initial value of 81 and a final value of 28 (Figure 3).

Figure 4, which shows the visual analogue scale that illustrates the intensity of the patient's pain, according to the Visual Analogue Scale, which quantifies pain by questioning the patient, considering 10 intervention sessions. A reduction in values is observed through the evaluation of the questionnaire, with an initial value of 10 and a final value of 1 (Figure 4).

Table 1 shows the evolution of depression and anxiety measured according to the Hospital Anxiety and Depression Scale Questionnaire, considering 10 intervention sessions. A reduction in values is observed upon evaluation of the questionnaire, with an initial value of 20 to 18 for anxiety and 8 to 5 for depression (Table 1).

Figure 1: Shows the use of laser combined with ultrasound (RECUPERO®) on the palms of the hands.

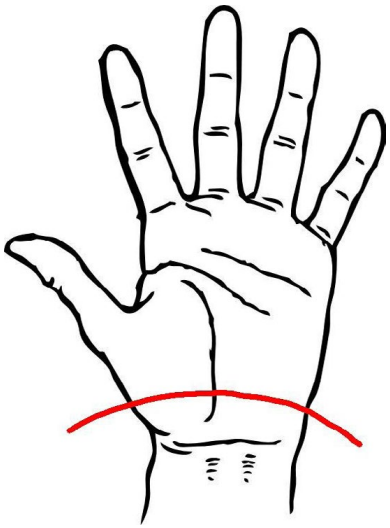

Figure 2: Illustration of the area of application of the hand preserving the growth area of the long bones.

Discussion

According to previous studies [11], the use of combined technology has been widely used in treatments for improving sleep and anxiety [23], rheumatoid arthritis [24], psoriatic arthritis [25], osteoarthritis [26] e fibromyalgia [11], promoting an improvement in the conditions. The treatment of fibromyalgia with this new technology that combines laser and ultrasound, through the overlapping of therapeutic fields, allows the simultaneous association of these resources in a single approach, presenting greater efficiency in the organism of the patient with fibromyalgia by modulating the nervous system and peripheral

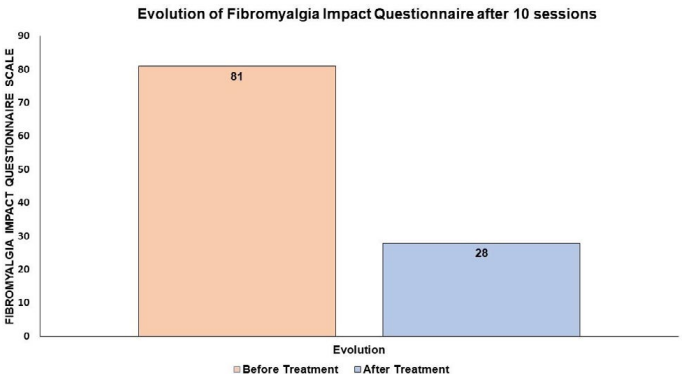

Figure 3: Fibromyalgia impact questionnaire scale, quantified before treatment (81) and after treatment (28), with a percentage reduction of 65.4%.

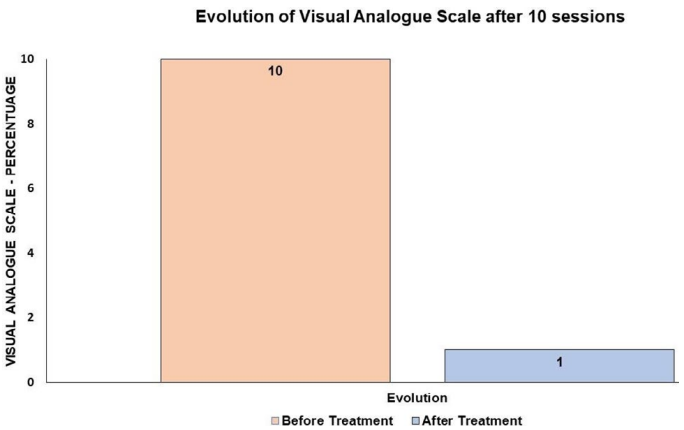

Figure 4: Visual analogue scale, quantified before treatment (10) and after treatment (1), with a percentage reduction of 90%.

Table 1: Hospital Anxiety and Depression Scale (HADS) questionnaire. Anxiety quantified before treatment (20) and after treatment (18), with a percentage reduction of 10%. Depressio n quantified before treatment (8) and after treatment (5), with a percentage reduction of 37.5%.

Anxiety			Depression		
Before	After	%	Before	After	%
20	18	10	8	5	37.5

blood flow, causing severe changes in the pain threshold and improving quality of life. In the present study, the case report initially indicated intense pain and limitations in activities and participation restrictions [11]. Regarding the treatment methodology with application in the palms of the hands, a structural difference was indicated in a biopsy performed by Albrecht et al 2013 [26], which supported the entire treatment methodology of synergistic use of resources for systemic pain control [26].

A significant improvement was observed in the patient after treatment with combined laser and ultrasound intervention. The results obtained were measured using the Fibromyalgia Impact Questionnaire (figure 3), which indicates an improvement in quality of life (65.4% improvement). Figure 4, which shows the Visual Analog Scale, allows the analysis of pain intensity, which indicates a reduction in pain (90% reduction).

When observing the patient, Autism Spectrum Disorder (ASD) is also reported, in this case, mild autism, classified as level 1, according to the DMS-5. Assuming that in relation to ASD it is the main concern, anxiety and depression can directly impact the well-being of the individual with this spectrum [27]. Comorbidities commonly associated with autism include psychiatric disorders and unfavorable behaviors when performing certain activities [26,27]. However, depression is a disorder that presents a sad, empty or irritable mood, which is added to cognitive changes that shake the individual, which can also be observed when it comes to anxiety, as the disorder tends to persist even when developed in childhood, whether induced by stress or fear [12,27,28]. Thus, associated therapies can be impactful alternatives for a comprehensive approach to treating anxiety, depression and autism [24,28,29]. Thus, the use of combined laser and ultrasound therapy may have an influence on the evolution of these behaviors, given the improvement in carrying out daily activities considered uncomfortable, such as cutting hair and trimming nails, as reported by the person in charge.

As observed in previous studies [11], the combined action of fotobiomodulation and ultrasound shows a systemic action with its activity beginning when applied to the palms of the hands, targeting the peripheral nerve endings of the thenar, hypothenar and palmar aponeurosis areas, acting on the nerve cells present near blood vessels (anomaly observed in the study), as observed by Albrecht PJ, et al. [26]. The use of ultrasound allows the action of cellular cavitation, facilitating the transition of sodium, potassium and calcium ions, possibly improving nerve conductivity. In addition, there is the analgesic and anti-inflammatory action of the ultrasound resource. Low-intensity laser, in addition to its analgesic, anti-inflammatory and enzymatic modulation action, also produces ATP. Through afferent nerve pathways, the stimulus is conducted to the central nervous system, where a brief modulation of intracranial compliance occurs in the brain [30], allowing an adjustment of the pain center present in the prefrontal cortex and, as a consequence, a decrease in hypersensitivity. Also in an observed case report and in a related study on sleep disorders a reduction in anxiety and depression levels was observed with the same treatment methodology. Although the present study had results on the quality of life and pain present in the fibromyalgia condition, where the standard use of 10 intervention sessions has been shown to be effective, even in the anxiety and depression issues observed previously [11,30], a new model with a longer intervention time may be more effective on issues relevant to Autism Spectrum Disorder.

Thus, the proposed intervention allowed a reduction in pain and an improvement in quality of life, enabling the patient to perform actions not previously performed, such as playing, but showed low effectiveness in assessing anxiety.

Conclusion

This study shows an improvement in quality of life and a reduction in pain in fibromyalgia, through the technological support of laser and ultrasound used on the palms of the hands, indicating the efficiency of the protocol used. However, when observing Autism Spectrum Disorder, a longer intervention period is suggested for better evaluation and possible difference in the observation of the patient, allowing greater reliability in the therapeutic action of this spectrum.

Acknowledgement

This work was supported by São Paulo Research Foundation (FAPESP-grants n◦2013/07276-1 and 2014/50857-8), by National Council for Scientific and Technological Development (CNPq-grantn◦ 465360/2014-9) and Department of Biomedical Engineering, Texas A&M University, Texas, USA.

References

1. Shonkoff JP, Garner AS, Committee on Psychosocial Aspects of Child and Family Health, Committee on Early Childhood, Adoption, and Dependent Care (20212) The lifelong effects of early childhood adversity and toxic stress. Pediatrics 129: e232-e246.
2. MacLean K (2003) The impact of institutionalization on child development. Dev Psychopathol 15: 853-884.
3. Likhar A, Baghel P, Patil M (2022) Early Childhood Development and Social Determinants. Cureus 14: e29500.
4. Brosseau L, Wells GA, Tugwell P, Egan M, Wilson KG, et al. (2008) Ottawa Panel evidence-based clinical practice guidelines for aerobic fitness exercises in the management of fibromyalgia: part 1. Phys Ther 88: 857-871.
5. Gomez-Arguelles JM, Maestu-Unturbe C, Gomez-Aguilera EJ (2018) Neuroimaging in fibromyalgia. Rev Neurol 67: 394-402.
6. Goulart R, Pessoa C, Junior Lombardi I (2016) Psychological aspects of juvenile fibromyalgia syndrome: a literature review. Rev Bras Reumatol Engl Ed 56: 69-74.
7. Malattia C, Chiappe G, Capurro C, Puntoni M, Cadeddu G, et al. (2024) High prevalence of orofacial pain in juvenile fibromyalgia as detected by a novel tool specifically devised for children and adolescents. Clin Exp Rheumatol 42: 1272-1279.
8. Clemente Garulo D (2020) Fibromialgia juvenil y síndrome de fatiga crónica. Protoc diagn ter pediatr 2: 311-323.
9. Suñol M, Pascual-Diaz S, Dudley J, Payne M, Jackson C, et al. (2024) Neurophysiology of Resilience in Juvenile Fibromyalgia. medRxiv
10. Macfarlane GJ, Kronisch C, Dean LE, Atzeni F, Häuser W, et al. (2017) EULAR revised recommendations for the management of fibromyalgia. Ann Rheum Dis 76: 318-328.
11. Aquino Junior AE de, Carbinatto FM, Franco DM, Bruno J da SA, Simão ML de S, Fernandes AC, Canelada ACN, Viviani Junior NA, Bagnato VS. The laser

and ultrasound: the ultra laser like efficient treatment to fibromyalgia by palms of hands - comparative study. J Nov Physiother 11: 2-12.

12. American Psychiatric Association, DSM-5 Task Force (2013) Diagnostic and statistical manual of mental disorders: DSM-5™ 5th ed. American Psychiatric Publishing, Inc.
13. Wang L, Wang B, Wu C, Wang J, Sun M (2023) Autism Spectrum Disorder: Neurodevelopmental Risk Factors, Biological Mechanism, and Precision Therapy. Int J Mol Sci 24: 1819.
14. Salari N, Rasoulpoor S, Rasoulpoor S, Shohaimi S, Jafarpour S, et al. (2022) The global prevalence of autism spectrum disorder: a comprehensive systematic review and meta-analysis. Ital J Pediatr 48: 112.
15. Genovese A, Butler MG (2020) Clinical Assessment, Genetics, and Treatment Approaches in Autism Spectrum Disorder (ASD). Int J Mol Sci 21: 4726.
16. Bushnell MC, Ceko M, Low LA (2013) Cognitive and emotional control of pain and its disruption in chronic pain. Nat Rev Neurosci 14: 502-511.
17. No authors listed (1986) Classification of chronic pain. Descriptions of chronic pain syndromes and definitions of pain terms. Prepared by the International Association for the Study of Pain, Subcommittee on Taxonomy. Pain Suppl 3: S1-226.
18. Fillingim RB, Loeser JD, Baron R, Edwards RR (2016) Assessment of Chronic Pain: Domains, Methods, and Mechanisms. J Pain 17: T10-20.
19. Crocq MA (2015) A history of anxiety: from Hippocrates to DSM. Dialogues Clin Neurosci 17: 319-325
20. James AC, Reardon T, Soler A, James G, Creswell C (2020) Cognitive behavioural therapy for anxiety disorders in children and adolescents. Cochrane Database Syst Rev 11: CD013162.
21. Mussttaf RA, Jenkins DFL, Jha AN (2019) Assessing the impact of low level laser therapy (LLLT) on biological systems: a review. Int J Radiat Biol 95: 120-143.
22. Rocha WA, Rodrigues KMG, Pereira RRR, Nogueira BV, Gonçalves WLS (2011) Acute effects of therapeutic 1-MHz ultrasound on nasal unblocking of subjects with chronic rhinosinusitis. Braz J Otorhinolaryngol 77: 7-12.
23. Paolillo AR, Paolillo FR, João JP, João HA, Bagnato VS (2015) Synergic effects of ultrasound and laser on the pain relief in women with hand osteoarthritis. Lasers Med Sci 30: 279-286.
24. Bagnato VS, Rodrigues TZ, Garcia V, Vidotti HGM, de Aquino Junior AE (2024) Systemic Effects of Photobiomodulation and Ultrasound as a Potentiating Tool in the Treatment of Sleep Disorders - Pilot Study. J Nov Physiother 14: 2-8.
25. Canelada ACN, Garcia V, Rodrigues TZ, Souza VB de, Panhocá VH, et al. (2022) Effect to the synergistic action of photobiomodulation and therapeutic ultrasound on psoriatic arthritis and fibromyalgia: case report. J Nov Physiother 12: 2-4.
26. 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.
27. Zampieri KR, Panhóca VH, Carbinatto FM, Bagnato VS, Junior AEA (2022) New Methodology to Potentiate the Anti-Algic Effect on the Small Joints of the Hands in Patients Affected by Rheumatoid Arthritis. J Nov Physiother 12: 1-7.
28. Rydzewska E, Hughes-McCormack LA, Gillberg C, Henderson A, MacIntyre C, et al. (2018) Prevalence of long-term health conditions in adults with autism: observational study of a whole country population. BMJ Open 8: e023945.
29. Aquino Junior AE de, Carbinato FM, Tomaz C da SR, Bagnato VS (2022) Photosonic treatment and fibromyalgia: the effect on brain compliance - case report. J Nov Physiother 12: 1-6.
30. Aquino Junior AE de, Carbinatto FM, Franco DM, Bruno J da SA, Simão ML de S, et al. (2021) The laser and ultrasound: the ultra laser like efficient treatment to fibromyalgia by palms of hands - comparative study. J Nov Physiother 11: 2-12.