



The Use of Laser Therapy for Patients with Fibromyalgia: A Critical Literary Review

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Abstract

The management of pain – despite many anaesthetic drugs – remains to be an urgent task. If the goal is to achieve permanent pain relief – and not to temporarily mask the pain (masking pathology) – then this goal can only be achieved by treating pain with physiotherapeutic methods, the most universal and effective of which, is low level laser therapy (LLLT).

The treatment methods vary fundamentally in the case of neuropathic (nonspecific, primary) pain, which includes pain with the localization of the trigger points (TP) and nociceptive (specific, secondary), which includes all types of pain resulting from trauma, inflammation, etc. When treating patients with fibromyalgia (FM), a comprehensive approach is required, using different methods of laser therapy and guided by well-known rules. These rules include setting all the correct parameters of the laser exposure (wavelength, operating mode, power, exposure, etc), limiting exposure and power to optimal values and limiting the total time of the procedure and the number of procedures per course.

Keywords: Pain; Fibromyalgia; Low level laser therapy.

Introduction

Pain is a concept that is clinically and pathogenetically complex and heterogeneous. It differs in intensity, localization and subjective manifestations (shooting, pressing, pulsating, pricking, cutting, whining, etc) and can be permanent or periodic. All the existing varieties of the characteristics of pain are largely related to localization and what caused it. For pain management, an educated choice is made when administered appropriate medicines and effective treatment methods, particularly like laser therapy. To make these choices, it is essentially important to distinguish the two variants based on pathophysiological mechanisms: neuropathic (nonspecific, primary) and nociceptive (specific, secondary) pain.^{1,2}

A striking example of the widespread muscle or joint-muscle pain is fibromyalgia (FM) - rheumatic disease of unclear etiology, characterized by generalized muscle weakness (a fatigue sensation) and painful palpations of characteristic areas of the body, considered to be *tender points* by some authors,³ and *trigger points* by others.⁴

According to studies about FM, around 6 million Americans suffer from it, while 4 million of them are women. Although there is no distinct pathophysiological basis of the disease, such patients are easily recognized

by the characteristic prevalence and localization of pain in their bodies. Over long periods of observation, specialists came to the unequivocal conclusion that the treatment of patients with FM should be individual, and requires a holistic approach; they need time, empathy, and interaction with other professionals. Ensuring the effective management of these patients is often a real test of the professionalism of the physician.⁵

It is necessary to discuss some of the words and terms used, which are extremely important in our case. Initially, the term *tender points* was used for FM,⁶ and *trigger points* for myofascial pain syndrome (MPS),⁷ all the while emphasizing the differences in the pathogenesis of the diseases themselves and the differences in the local painful areas.^{8,9} In recent years, however, the situation has changed, and most experts tend to the fact that the "points" defined by the Moscow International AIDS Foundation are virtually impossible to distinguish clinically or pathophysiological from those characteristic of FM, and the disease itself represents the stages of a single process of chronic muscle pain.¹⁰ Therefore, it is logical to combine two variants of definition of points and call them "TP", especially since the initial letters of word combinations are identical.

But the most important thing is that the TP's (*tender points* or *trigger points*) are the result of the nonspecific response of the central nervous system (CNS) in its interaction with the autonomic nervous system (ANS), which manifests itself in both FM and MPS. That is, the pain occurs in TP is neuropathic (nonspecific, primary), and explains the recommended integrated approach to solve the problem of the management of the pain syndrome in FM.

Sometimes, quite typically TP is confused with any local painful zone (PZ), when the pain induced by a pathological process (trauma, inflammation, etc), and has a nociceptive nature. Pathophysiological differences in the causes of 2 types of pain warrant two different types of approaches for its elimination. On the other hand, it is quite difficult to distinguish them, since there are no reliable objective methods of differentiation. Therefore, creates additional difficulties in the correct interpretation and systematization of scientific data.

Despite a significant number of drug and non-pharmacological methods of treatment for patients with FM, their effectiveness is not good enough. In addition, long-term use of analgesics, sedatives and non-steroidal anti-inflammatory drugs (NSAIDs) - commonly used for treatment - lead to the development of side effects, the aggravation and the severity of the patients' condition.¹¹

Low-level laser therapy (LLLT) is the most universal therapeutic factor, which has no side effects or absolute contraindications, while unlike analgesics, it does not target only one link in the painful reception, but targets essentially the whole hierarchy of mechanisms of its origin and regulation.⁹

The use of the integrated approach, which involves a wide range of LLLT methods, allows restoring any abnormalities in the functioning of various organs and systems of the human body, which, in addition to directly blocking pain, ensures the elimination of the causes of the disease. This "universality" predetermines the exceptional effectiveness of LLLT in the reliable elimination of pain syndromes of different types, provided by varying the parameters of the techniques. Equally importantly, after a well-organized and methodized course of laser therapy, the healing effect persists for long periods of time, i.e. months and years. It is even possible to talk about this treatment in such a way that suggests the patient will forget out their pain, if not forever, then for a very long time.^{2,9}

In this article, we are not looking at the "analgesic" mechanisms of biomodulatory action (BA) of low-intensity laser illumination (LLLI), however, a lot of work is devoted to this topic, we recommend you to read the latest published works on this issue.^{12,13} But it is necessary to note the fact that practically none of the works deal with "laser pain management", considering one important circumstance - what type of pain, primary or secondary, i.e. they do not show the differences in the reasons of its occurrence when choosing the laser exposure technique. This is fundamentally important in this case. The

methods of laser therapy are quite simple and absolutely safe. This follows directly from the known mechanisms of the LILI database, the illumination that causes the body's response through the initiation of Ca^{2+} -dependent processes at a cellular level, after which the disturbed homeostasis is restored through the development of the secondary response of various regulatory systems and organs, resulting in the patient's recovery.¹⁴⁻¹⁶

However, it is necessary to understand that the safety and effectiveness of any method of treatment, including laser therapy, is achieved only if it is applied correctly. There are several common methods of laser therapy (methods of laser illumination).^{9,16}

- external illumination;
- projection of the internal organs;
- on immunocompetent organs;
- on large blood vessels: intravenous laser blood illumination (ILBI) and non-invasive laser blood illumination (NLBI);
- paravertebral;
- at the acupuncture points (AP);
- at trigger points (TP), painful points (PP) and painful areas (PA).

There are some very strict rules for the use of these techniques¹⁷:

- limiting of the exposure time,
- determination and use of the optimal power density (PD) and the wavelength of LLLT,
- preferred use of pulse mode, which is especially important for pain management, etc.

Unfortunately, in most works which use laser therapy as the main method of treatment for patients with FM and other pain syndromes, the parameters of the method are far from effective, so often the results are not impressive. The purpose of the review is to analyze various methodologies and methodological errors made by many researchers, and to develop recommendations based on the available scientific data, and to develop a correct understanding of the mechanisms of the LILI database and its own clinical experience.

We compiled a table with the most accurate indication of all parameters of the method of treatment of patients with FM, and in some pain syndromes, paying attention to those works in which the result was not obtained, while using the same parameters of the procedure (Table 1). We have maintained the authentic terminology in terms of diseases (FM and MPS).

Unlike other reviews, which mainly focus on the reliability of the obtained results (which is extremely important), the errors are analyzed below, and the pros and cons of each are listed, also it is suggested to more independently understand the various methods of influence.

Uncertainty in relation to TP (*trigger points*, *tender points*) and generally PZs, clear and unambiguous division of them, often leads to mistakes in the choice of tactics of treatment and methodology. In many works these

Table 1. LLLT for Fibromyalgia and Some Pain Syndromes

Peculiarities (localization)	Research methods, results	Technique and Location of Exposure	Wavelength (nm), Laser Mode	Power, (Pulse Duration, ns)	Frequency ^b , Hz	Exposure Per Zone, min	No. of Procedures	Ref.
Cervical MP	Pain (the VAS and 5-point scales), tenderness (algometer), taut bands, cervical lateral flexion. No result was shown.	Over the 3 trigger points and one point in the taut bands in trapezius muscle bilaterally	904 nm, pulsed	27 W, 50 W, or 27×4 W (not specified)	1000	2	Once daily, 10 weekdays for 2 weeks	Altan et al ¹⁸
Widespread pain along both body's sides in the waist area	Number of tender points, morning stiffness, FIQ, verbal scale of global evaluation by the patient concerning her well-being (VSGI), total myalgia score. LLLT has both short- and long-term effectiveness.	11 tender points	830 nm, continuous	50 mW, 2 J, the diameter of the laser beam – 1 mm	–	1	Once a day, 5 days a week, for a total duration of 10 days	Armagan et al ¹⁹
MPS	Pain (VAS, urinary excretion) IR laser increases an important mediator of pain inhibition, serotonin, LLLT is effective.	4-5 trigger points	904 nm	13.5 W (200), 1.44 J/cm ²	4000	3	Once a day for 10 consecutive days	Ceylan et al ²⁰
MP	The masticatory performance, pressure pain threshold, pain (VAS). LLLT improved MP and PPT of the masticatory muscles.	At 5 trigger points of the anterior temporal and masseter muscles: 4 forming a cross and one a central point.	808 nm, continuous	100 mW	–	19s	Two times per week for 1 month	de Moraes Maia et al ²¹
TMD disorders characterized with MP	Pain (VAS). LLLT has shown the same effectiveness as occlusal splint for pain management.	Onto the trigger points of the masseter (the number is not specified), in a scanner manner	1064 nm, continuous	250 mW, 8 J/cm ²	–	20s	Five times a week, 10 sessions	Demirkol et al ²²
Cervical MPS	Pain (VAS). Inclinator and goniometer; the NDI. LLLT is not superior to placebo.	Over 3 trigger points bilaterally (6 TP)	830 nm, modulated	450 mW, 58 mW/cm ²	1000	2	Daily for 3 weeks (15 sessions)	Dundar et al ²³
Fibromyalgia (FM)	FIQ, VAS. LLLT was not effective in pain reduction.	Application of six frequencies on seven anatomical zones of the body (anal region, hipogastro, epigastric region, left pectoral region, previous vertical region, crista galli, between bregma and vertex). At a distance of 1cm from the skin drawing a circle of 10 cm in diameter with the laser.	905 nm, pulsed	1W (70 ns)	1) 292 Hz; 2) 594 Hz; 3) 1168 Hz; 4) 2336 Hz; 5) 4672 Hz; 6) 73 Hz; 7) 146 Hz	42 min, 1 min for each frequency	6 weeks	Fernández García et al ²⁴
TMD disorder	The maximum bite force, occlusal contact area and pressure. LLLT has shown effectiveness for pain relief but not for physical improvement.	On trigger points (the number is not specified), from a 2-mm distance	820 nm, continuous	300 mW	–	10 s	Three times a week, 10 sessions	Gökçen-Röhlig et al ²⁵
MPS	Pain (VAS), PMSS and evaluation by anesthesiometer. LLLT was not superior.	On trigger points (the number is not specified)	830 nm modulated	450 mW, 60 mW/cm ²	1000	2	20 sessions for 1 month	Gül and Onal ²⁶
FM	The Likert scale scoring system. LLLT is effective.	At 12-13 tender points	904 nm	20 W (200 ns)	2800	3	Daily for 2 weeks, except weekends	Gür et al ³
FM	The Likert scoring system, the HDRS and DSM IV criteria. FIQ. LLLT is effective.	At 12-14 tender points	904 nm	20W (200 ns)	2800	3	Daily for 2 weeks, except weekends	Gür et al ¹⁰²⁷

Table 1. Continued

Chronic MP in the neck	Pain at rest and at movement, self-assessed improvement of pain, number of TP, the NPDS, BDI, NHP. LLLT provides pain relief and improves quality of life and functional ability.	At 2-8 trigger points	904 nm	20W (200 ns)	2800	3	Daily for 2 weeks, except weekends	Gur et al ²⁸
MPS	VAS measurement, algometric evaluation thermographic evaluation. LLLT is beneficial for pain in MPS.	At one trigger point (trapezius or levator scapulae muscle)	780 nm, continuous	10 mW	-	3 min 16 s	10 daily sessions	Hakgüder et al ²⁹
MPS	Pain assessment, (VAS, analgesic usage and algometer), cervical range of motion (goniometer), functional assessment (the Nottingham Health Profile). LLLT is effective.	To the 3 TPs in the upper trapezius muscles on both sides	633 nm, continuous	2 J	-	-	3 times a week for 12 sessions	Ilbuldu et al ³⁰
MP of the masticatory muscles	Pain (VAS and verbal scale). Laser acupuncture can be effective, but it is not clearly defined.	Eight of the acupuncture points (ST6, SI18, SI3, LI4 on both sides in the body) were treated at the same time	690 nm, continuous	40 mW	-	15	Two 15 min sessions per week, total 6 sessions over 3 weeks	Katsoulis et al ³¹
Myofascial trigger points of the neck, shoulders and upper thoracic regions	Pain (VAS), questionnaire about side effects. Significant reduction in pain when 820 nm (1 and 5 J/cm ²) and 670 nm (1 J/cm ²) laser therapy is applied.	Three most painful trigger points, laser probe resting on the skin within the circle marking the trigger point	670 nm, modulated 820 nm, modulated	10 mW, 1 and 5 J/cm ² 25 mW, 1 and 5 J/cm ²	5000	100 s and 500 s 40 s and 200 s	Five treatment sessions over a 2 week period	Laakso et al ³²
Tendinitis and MP	Pain (VAS and a pain threshold meter). Laser treatment was most effective on acute tendinitis.	On 3 trigger points, over muscle origins and over insertions	904 nm, pulsed	10 W (180), 0.5 and 1 J/cm ²	4000	-	Six treatments during a period of 3-4 weeks	Logdberg-Andersson et al ³³
Fibromyositic rheumatisms	Spontaneous and caused pain (Ritchie's scale), spontaneous and caused motility (arthrogoniometer), other signs of phlogosis (clinically evaluated). Approximately 2/3 of 846 patients benefited from the treatment.	Contact, on 1-14 trigger points and points corresponding to well-defined anatomic structures, like radicular nerves, ligament and tendon insertions as well as synovial sacs At a distance of 20cm, the whole site of anatomic and functional lesions. (2-7 zones)	904 nm, pulsed 10600 nm, pulsed	54 W (200) 100 W (200)	3000 1000 (half time of irradiation) and 10 Hz	1-10	10-15 sessions	Longo et al ³⁴
Myofascial trigger points of uTM (upper trapezius muscle)	Pressure pain (algometer), NRS, upper lateral cervical flexion (goniometer). LLLT and ultrasound were effective in pain relief and muscle extensibility.	Contact, without pressure, on active trigger points (or the most painful one) within the uTM.	904 nm, pulsed	90 W pulsed, 30 mW average, 22,5 mW/cm ² (200)	1953	10	Five times a week for 2 weeks.	Manca et al ³⁵

Table 1. Continued

FM	Pain (VAS), dolorimetry of pain threshold, FIQ, SF-36. LLLT was not effective.	At a right angle to the skin at 18 tender points	830 nm, continuous	30 mW average, 3 J/cm ²	–	10 sessions, twice a week	Matsutani et al ³⁶
FM	FIQ, CS-PEP test. LLLT may be effective in pain relief and range of motion.	At seven tender points	Dual wavelength laser with 20% 810 nm and 80% 980 nm.	10W	–	Twice-weekly sessions for 4 weeks for a total of 8 sessions.	Panton et al ³⁷
FM	FIQ, McGill Pain Questionnaire, VAS. LLLT provided relief of fibromyalgia symptoms.	At 18 fibromyalgia tender points	670 nm, continuous	20 mW	–	Three times a week over 4 weeks	Ruaro et al ³⁸
MP in the masticatory muscles	Pain (VAS). LLLT was effective for pain relief.	Two lasers to the painful point.	660 nm, continuous 890 nm, pulsed	17.3 mW 9.8 W (100 ns)	– 1500	Twice a week, 3 consecutive weeks	Shirani et al ³⁹
MPS	Pain (VAS, VRS, pressure threshold meter, functional disability, e.g., hand dynamometer, patient's pain diary—for daily protocol of pain presence. LLLT is effective for pain relief.	Direct skin contact technique (the number of TP is not specified). Bilateral treatment was initially applied: one side received laser irradiation and the contralateral side received sham irradiation. When significant results were achieved (usually 6-12 sessions) the other side was irradiated with a real laser.	830 nm, continuous	120 mW, 2.5–8 J	–	Five daily sessions per week and if improvement was observed the frequency was reduced to every second day or 3 times a week. 6-24 sessions	Simunovic ⁴⁰
MP in the neck and shoulder girdle	Pain (VAS). There is no beneficial effect of LLLT.	Contact to skin, at tender points (up to 10).	830 nm, continuous (some of the patients) and modulated (the rest)	30 mW	–	Six sessions during a 5-week period	Thorsen et al ⁴¹
FM	Pain (VAS), flexibility, FIQ. Kinesiotape application and LLLT had a similar effect.	At 17 painful points on the back	850 nm, continuous	40 mW, 2J/cm ²	–	15 sessions of treatment 5 days a week for 3 weeks	Vayvay et al ⁴²

VAS, visual analogue scale; FIQ, Fibromyalgia Impact Questionnaire; LLLT, low level laser therapy; MPS, myofascial pain syndrome; MP, myofascial pain; TMD, Temporomandibular; NDI, neck disability index; PMSS, palpable muscle spasm scoring; HDRS, Hamilton Depression Rate Scale; NPDS, Neck Pain and Disability Scale; BDI, Beck Depression Inventory; NHP, Nottingham Health Profile; VRS, Verbal rating scale.

^a for pulsed lasers.

^b for pulsed lasers or continuous, operating in modulated mode.

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concepts are confused (Table 1). The lack of uniformity and a "standard" of terminology hinder the development of the methodology of treatment of patients with FM.

The table does not include the only experiment in which it was shown that the laser illumination of New Zealand rabbits (contact for 5 myofascial TP and muscle tension zones, 780 nm, continuous mode, 30 mW, 30 seconds (4.5 J/cm^2) or 3 minutes (27 J/cm^2 , 5 consecutive days) affects some biochemical indicators associated with pain (β -endorphin, substance P, tumor necrosis factor TNF- α and cyclooxygenase-2). The conclusion is that the results depend on the energy density (ED), different biochemical parameters vary to different degrees with an increasing or decreasing ED.⁴³

However, in this work, one important fact was neglected, specifically, that the change in the ED was due to arithmetic actions (J/cm^2) – in the case of exposure variation – nonlinearly affects the result (the effect), it is permissible to change only the power and area of influence of essential restrictions. In other words, with formally identical values of ED derived from different exposures, the effect can differ by mirror-image, and both the stimulation and inhibition of some process occur. This is one of the most common mistakes.

A majority of specialists only use the method of illuminating TP's with lasers, which is not always effective. Indeed, it has been shown for a long time that the illumination of TP by a continuous LLLT of the red spectrum (633 nm) causes changes in sympathetic activity, accompanied by an increase of skin resistance at the site of exposure.^{44,45} The latency of peripheral sensory nerve fibers increases, which leads to a decline in the conduction velocity of the nerve impulse, and ultimately, to a decrease in pain.⁴⁶ But this is not enough.

In some studies, the role of metabolic shifts in the etiopathogenesis of FM, particularly energy processes are discussed. This aspect is considered from the position of the analysis of the mechanism of the onset of TP, for example, in tissue biopsies taken from these points, a decrease in the content of high-energy phosphates was detected^{47,48} as well as a change in phosphodiesterase activity.⁴⁹ Data from the spectrographic study of muscles are evidence of local hypoxia.⁵⁰ A study by Bochkova¹¹ showed that after the course of illumination therapy, with the presence of NSAIDs and antidepressants, 82% of patients had a normalization of the isoenzymatic spectrum of lactate dehydrogenase occur, which contributes to the improvement of energy supply to muscle tissue, the number of TP decreased and the morbidity of the surviving tissues reduced. This is a very important conclusion, objectively confirming the influence of LLLT on TP.

However, in addition to the pain syndrome typical for FM, a complex treatment with several RT methods is required, analysis of studies and independent clinical experience allows us to conclude that the effect of continuous LILI

on TP is ineffective, it is necessary to use the pulsed mode and the infrared (IR) spectrum (duration of the light pulse 100-150 ns, pulsed power 10-15 W, wavelength 904 nm).^{11,51}

If you analyse the publications on the topic, including those listed in Table 1, it can be seen that in the vast majority of cases, laser light is used in a continuous mode. In some cases, when using this option, one can get some effects, but it is not very pronounced, not prolonged and not always reliable, even though in Table 1 it shows that it is given positive results. Attempts to increase efficiency by increasing the power of laser light do not always help.^{23,25}

It is known that when the frequency of pulsed lasers varies, the average power proportionally varies, which is actively used to vary the ED and allows optimizing the laser action. For different techniques, different frequencies (read, power) are optimal, but we repeat that this is true only for e LLLI-impulse. The work of Altan et al¹⁸ shows evidence in which the same modes are used for TP and also PZ, which are not related to the TP, and in both cases the frequency of 1000 Hz is not optimal. It would be correct to use LLLT with a varying frequency on TP, starting from 80 Hz (see below), when lighting the PZ, using frequencies above 3000 Hz for the first 1-2 sessions, then reducing to 80 Hz.

As we noted above, in the case of FM, the pain syndrome has its own peculiarities, which is the reason for using only complex laser therapy techniques, when various methods of action directed at different pathogenetic links are involved. One of the examples of the complex approach can be a technique in which the laser action of pulsed IR LLLT (890 nm) is performed in a transcranial manner on the TP and acupuncture points, and the pulse repetition rate is varied, which is extremely important in this case.⁵¹

In the following, a little more about the frequencies for pulsed lasers are discussed. The first to suggest to vary the frequencies of pulsed infrared lasers was Liev et al,⁵² the essence of the technique is a gradual increase in the frequency from 80 Hz in the first procedure, to 3000 Hz in the 7th-8th procedures, then gradually reducing to 80 Hz by the 15th-16th procedures. Later, this technique was improved, and the limiting frequency was increased to 10000 Hz (this makes it possible to use the laser therapeutic apparatus "LASMIK").^{9,15} The logic of this approach is quite understandable to anyone who knows the basics of neurophysiology of pain and the mechanisms of LLLT. But the parameters of exposure to specific PZ's, directly related to the focus of pathology, are fundamentally different, and not always unambiguous. In the management of pain, exposure is extremely important. Most Russian authors recommend exposures from 20 to 60 seconds per one TP, for one procedure no more than 10-12 points, for a course of at least 12-16 procedures.^{11,51} In Table. 1 we see a rather wide range of exposures used in various studies, which is not always justified. When

exposed to specific PZ's, exposure is optimal at 5 minutes per zone, possibly even two mins in case of multiple localization or additional use of other laser therapy methods during the procedure.

Since the total time of the procedure cannot exceed 20 minutes,¹⁷ this replacement (5 minutes instead of two minutes) is justified. The use of other exposures is not allowed in most cases (there are some exceptions). Violation of the rule "the procedure of laser therapy should not last more than 20 minutes" is the reason for the lack of results in a number of studies.^{24,42} In the management of pain, this is especially critical, since the maximum response of the CNS and ANS, including the nociceptive system, occurs exactly 20 minutes from the start of the procedure.

In one of the works (not included in Table 1), with the reference to Russian studies, the possibility of using VLOK-635 (wavelength 633-635 nm, power of 1-2 mW) is justified for the treatment of patients with fibromyalgia.⁵³ The authors motivate their choice by such well-known results of laser illumination as a normalization of the immune system, improvement of the rheological properties of blood and trophic provision of tissues.

Improvement of microcirculation and oxygen supply of various tissues after VLOK-635 is also closely related to the positive influence of LILI on the metabolism: the oxidation of energy materials - glucose, pyruvate, lactate - elevates.⁵⁴ However, quite often (and very successfully) the intravenous version of the laser blood-clarification technique is replaced by a non-invasive (transcutaneous) method, using matrix red pulsed lasers (wavelength 635 nm, pulse power 40 W with eight pieces of laser diodes arranged as four in 2 rows, an area of 8 cm², a pulse duration of 100-150 ns, a frequency of 80-150 Hz).^{2,55}

Thus, we can draw the following conclusions:

1. Methods of pain management are fundamentally different for neuropathic pain (nonspecific, primary), which includes pain with localization in TP, and nociceptive pain (specific, secondary), which includes all types of pain arising from trauma, inflammation, etc.
2. In the treatment of patients with FM, it is necessary to use only complex treatment, including the use of various methods of laser therapy.
3. It is necessary to be guided by some rules for carrying out laser therapy, in particular, to set all parameters of laser exposure (wavelength, operating mode, power, exposure, etc), limit exposure and power to optimal values, limit the total time of the procedure and the number of procedures per course.

Ethical Considerations

Not applicable.

Conflict of Interests

The authors declare no conflict of interest.

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