Chapter 9

The Use of Photomedicine in Musculoskeletal Pain

Abdullah M. Al-Shenqiti

Additional information is available at the end of the chapter

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Abstract

Musculoskeletal pain is a major cause of disability. Myofascial trigger points (MTrPs) in particular are a common source of pain in a substantial number of patients presenting at a pain clinic. Many different invasive and non-invasive forms have been advocated to the treatment of MTrPs. However, favourable outcome rates are inconsistent and some of these treatment forms described are often painful and have potentially dangerous side effects. Photomedicine including the coherent light sources (lasers) and more recently, non-coherent light sources have been reported to be beneficial in soft tissue lesions including MTrPs. Their beneficial therapeutic effects can be obtained without undesired effects. The main intentions of this chapter are to bring the attention of the doctors and physical therapists to the scientific approach of photomedicine, in particular laser therapy for the relief of pain arising from MTrPs, and to demonstrate how this type of therapy can be utilized in a rational manner for the relief of musculoskeletal pain. In addition, it has been found necessary to include or to start with an overview of the recently recognized diagnostic and therapeutic importance of MTrPs. Attention will therefore first be drawn mainly to incidence, types, aetiology, clinical diagnostic criteria and conventional forms of MTrPs.

Keywords: photomedicine, myofascial pain, trigger points, laser therapy, phototherapy

1. Introduction

Skeletal muscle contractile tissues are subject to constant wear and tear, which makes them prone to development of myofascial trigger points (MTrPs) that result in referred pain and motor dysfunction [1]. MTrPs are extremely common and a major source of musculoskeletal pain and dysfunction that can affect anyone at one time or another [1–3].

MTrPs are one of the profound reasons of pain in clinical practice [4, 5]. They are the source of pain in 30% of patients seeking treatment or medical advices for pain in primary care and the greatly noticeable cause of pain in 85% of patients presenting at a pain centre [6, 7].

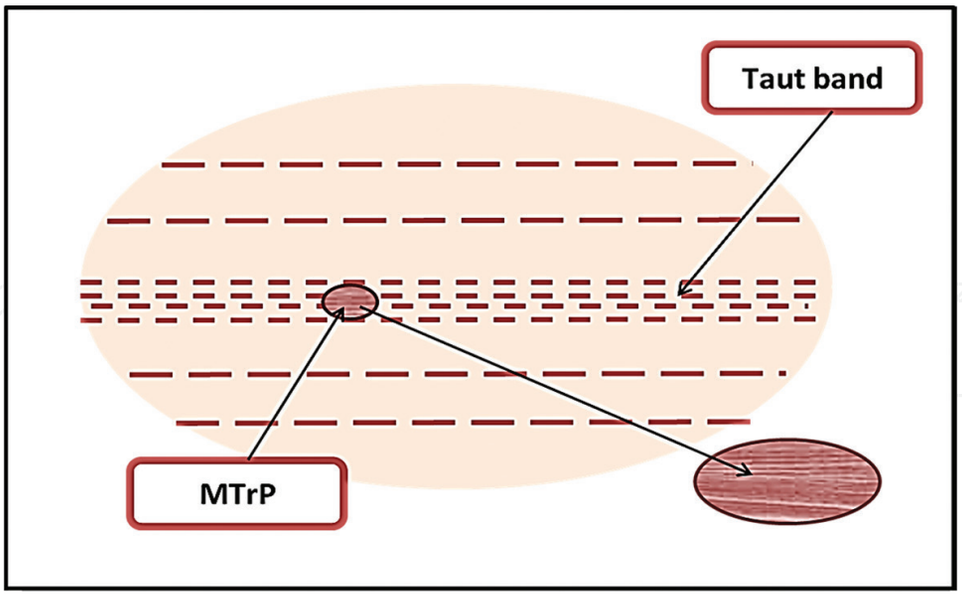

Figure 1. Simplified schematic of taut band and myofascial trigger point (MTrP).

Myofascial pain syndromes are common conditions that, by definition, result from trigger points (TrPs). Unfortunately, practitioners often do not recognise the myofascial pain syndrome [7, 8]. Unrecognised myofascial headaches, low back pain and shoulder pain have been considered to be one of the major causes of chronic pain, disability and industrial time lost, which plays a factor in most worker's compensation claims [1, 9].

Musculoskeletal pain originating from muscle has concerned the medical community for more than a century [10]. The subject has been appointed by multiple terms that emphasize various signs and symptoms representing basically the same phenomenon [11].

History has introduced terms such as fibrositis, myalgia, rheumatic myalgia and non-articular rheumatism. However, it should be noted that all of these terms and many others that are used for myofascial trigger points (primary cause of muscle pain) and fibromyalgia (central cause of muscle pain) are now no longer utilized [1, 10, 12].

The entity of MTrP has now been widely acknowledged on the basis of clinical observation and basic scientific research [13, 14]. A myofascial trigger point (MTrP) has been defined as a highly localised, sensitive, hyperirritable spot in a palpable taut band of skeletal muscle fibres [1, 15] (**Figure 1**). MTrPs are frequently found at or near to a muscle's origin and insertion, as well as along the belly of a muscle particularly at the motor points [2, 12].

2. Types of MTrPs

There are two main types of MTrPs active and latent. An active MTrP is one associated with spontaneous pain or occurring in response to movement [16–18]. It has also been defined as one whose nociceptors have undergone sufficient activation and sensitisation to cause pain to be referred to a site some distance from it (the zone of pain referral) [12].

A latent MTrP is a sensitive spot with pain or discomfort, which occurs in response to compression only [16, 17]. It may also be defined as one in which its nociceptors have undergone a limited amount of trauma-induced activation and sensitisation, but not sufficient to cause the development of pain [12].

Active TrPs might cause agonising incapacitating pain particularly when associated with active satellite TrPs in another muscles [1]. By contrast, despite the fact that, latent TrPs do not produce spontaneous pain, they can cause some increased muscle tension, limitation of passive range motion and may also cause some muscle shortening [1, 17]. Both active and latent TrPs can therefore cause motor dysfunction [1].

MTrPs may become activated either through a primary or through a secondary event [12, 18]. Primary activation of the TrPs usually takes place as a result of direct trauma to a muscle, sudden strain, or when there is excessive or unusual exercise. The activation might also be the result of cumulative effects due to long-standing repetitive minor trauma or overloading [1, 12, 17, 18].

Secondary activation of TrPs usually takes place in synergistic and antagonistic muscles. This may be due to compensatory actions or by counteracting tension in the primary muscles. Referral from visceral sources such as in a myocardial infarction or connective tissue disorder such as osteoarthritis, rheumatoid arthritis may also contribute to this secondary phenomenon [1, 19].

3. Clinical diagnostic criteria of MTrPs

There are certain clinical characteristics that should be looked for during the examination in order to confirm the presence of MTrPs. These include:

3.1. Taut band

Muscles sometimes contain taut cord-like bands. Palpable taut band is considered to be a basic diagnostic criterion of an MTrP [20].

3.2. Local twitch response

The local twitch response (LTR) is a transient contraction of the palpable taut band of muscles comprising MTrPs. It can be visualised, or palpated through the skin of the patient, or seen by ultrasound imaging [1, 15, 18].

The LTR is elicited mechanically, usually by a vigorous snapping palpation of the TrP in a direction opposite to the muscle fibres, or by needle penetration of the TrP [1, 18].

3.3. Spot tenderness or jump sign

Spot tenderness is an essential diagnostic criterion in the MTrP examination. However, spot tenderness alone has a limited value because it might be due to other reasons such as fibromyalgia.

The jump sign is a characteristic behavioural response to pressure on a MTrP. Patients often withdraw and sometimes complain of pain particularly with active MTrPs [1].

3.4. Pain recognition

Digital pressure on an MTrP can be used to elicit referred pain patterns characteristic of that muscle and the patient symptoms. This is considered as one of the most important diagnostic criteria particularly when accompanied by other signs [1, 20, 21].

3.5. Limited range of motion

Restricted range of motion is more severe in more active MTrPs and is a fundamental characteristic of MTrPs [1]. A muscle containing an MTrP restricts range of motion due to pain [1, 12, 22]. When MTrPs are treated, range of motion increases and often returns to normal [1].

3.6. Referred pain

Pain is often felt a considerable distance from the MTrPs and as a consequence, most patients are unaware of the presence of the TrP despite its exquisite tenderness. The referred pain either occurs spontaneously, particularly when the MTrP is very active [1, 2] or through palpation [15].

Referred pain by itself is not considered a diagnostic criterion of an MTrP unless accompanied by other findings [1, 20, 23]. However, the referred pain patterns play an important role in the initial examination as they direct the examiner to the muscle that harbours the MTrPs. In addition, knowledge of referral patterns minimises the chances of missing some TrPs [12] (**Figure 2**).

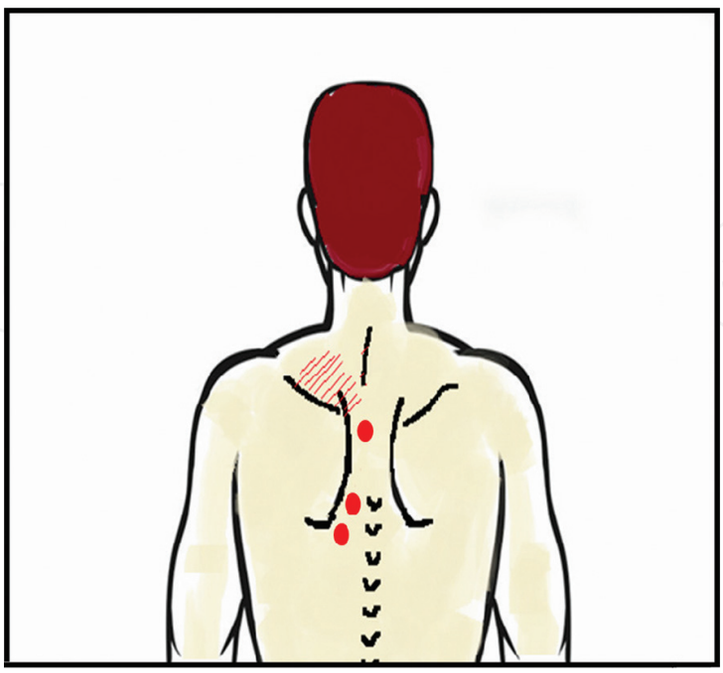

Figure 2. The pattern of pain referral from myofascial trigger points (●) in the rhomboid muscles.

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4. Diagnosis of MTrPs

The diagnosis of MTrPs primarily relies on manual palpation and clinical judgment. However, manual palpation may be imprecise and not a reliable [24]. Therefore, specific training coupled with clinical experience is needed to obtain good reliability for the MTrP diagnosis. It has been showed that a combination of "spot tenderness," "taut band" and "pain recognition" are the basic clinical criteria to diagnose a MTrP, while "referred pain" and "local twitch response" are considered to be confirmatory signs [20, 21].

More recently, detection of biochemicals related to pain and inflammation in MTrP site [25], the sonographic methods of MTrPs [26] and the magnetic resonance elastography for taut band image [27] are potential objective outcome assessment tools in the MTrPs diagnosis.

5. Conventional forms of MTrPs treatment

There are several forms that are conventionally used to treat the MTrPs, which include:

5.1. Dry needling

The possibility of treating the MTrPs by dry needling techniques has been noted as early as 1952 [28], but Lewit [29] was the first investigator to employ dry needling techniques.

More recently, the effectiveness of dry needing in reducing the tenderness of MTrPs has been reported by a number of authors (e.g. [30–32]). However, dry needling is occasionally associated with adverse events such as post-needling soreness, bruising, dizziness and infection [32–34].

5.2. The injection of a local anaesthetic into an MTrP

The use of local anaesthetics such as Procaine Lidocaine has been reported to be an effective method for reducing post-injection soreness [1, 30, 32]. However, the use of them may occasionally give rise to toxic, allergic and anaphylactic reactions [15].

5.3. Botulinum toxin A injection

Botulinum toxin A injection (BTA) has been utilized in treatment for MTrPs [35–38]. However, it is rare clinically indicated, as it may be associated with possible local and systemic side effects such as muscle weakness and serious respiratory compromise [38, 39].

5.4. The injection of non-steroidal and steroidal anti-inflammatory drugs into MTrPs

The injection of non-steroidal anti-inflammatory drugs into the MTrPs has been used successfully to treat them [40, 41]. However, repeated injection of it into muscle might lead to skin necrosis [40]. The injection of steroids has also been used to treat the MTrP, and a good result has been reported [40, 42]. However, the use of steroids should be discouraged because of the risk of inducing local myopathy and the possible muscle fibre damage that is frequently associated with repeated injections [40].

5.5. Therapeutic ultrasound

The literature advocates therapeutic ultrasound as an effective modality for MTrP treatment in the clinical practice [1, 43]. In a study by Hong et al. [44] revealed that pain pressure threshold of MTrPs was increased immediately after ultrasound therapy with intensities of (1.2–1.5 W/cm^2) as compared to placebo therapy. However, Lee et al. [45] could not obtain similar finding at a lower intensity of ultrasound (0.5 W/cm^2).

More recently, two studies conducted by Srbely et al. [46] and Srbely and Dickey [47] revealed improvement in pressure pain threshold value (less tenderness). However, the study of Srbely and Dickey [47] was not blinded and did not address the long-term benefit.

5.6. Electric stimulation

Electrotherapy has been advocated as an effective therapeutic modality to alleviate pain emanating from MTrPs [43, 48, 49]. Graff-Radford et al. [50] showed that high frequency transcutaneous electrical nerve stimulation (TENS) could alleviate pain but they did not succeed to show any improvement in the MTrP sensitivity. More recently, Lee et al. [45] utilised electrical muscle stimulation and they concluded that pain was significantly decreased compared to the placebo group, but no significant improvement in pressure threshold or range of motion was found. The long-term influence of the electrical stimulation on MTrP was not addressed in the methodology of the above two trials.

6. Photomedicine

Photomedicine has progressed and come to be one of the most inspiring fields in the medical research in the past 50 years. The coherent light sources (lasers) and more recently, non-coherent light sources, e.g. light emitting diodes (LEDs) and superluminous diodes (SLDs) used in the musculoskeletal disorders are those with an athermic effect. Frequently used lasers include the helium-neon (HeNe gas) and infrared lasers with gallium arsenide (GaAs) or gallium aluminium arsenide (GaA1As) diodes [51–53].

Laser therapy (coherent sources) or low reactive-level laser therapy (LLLT) has been reported to be beneficial in soft tissue lesions including MTrPs [54–60]. Its beneficial therapeutic effect can be obtained without undesired effects. The below section of this chapter considers mainly the background of laser and characteristics of laser light, laser treatment parameters, treatment approaches and the possible mechanisms of action of laser in MTrPs.

7. Background and historical perspectives of laser

While laser is a relatively new form of treatment, the therapeutic benefits of light energy are not a new concept [51, 61, 62]. The sun was the first source of light that was employed in the treatment of several conditions.

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Laser was not developed until 1960; however, the concept behind it was described at the beginning of the century by Albert Einstein in his 'quantum theory' [62, 63]. The development of LASER—Light Amplification by stimulated Emission of Radiation—then arose when Theodore Maiman in 1960 amplified light (using a ruby crystal as a lasing media) [51, 62].

In the 1960s, rapid development took place and variety of laser types appeared, based on different lasing media and resulting in different wavelengths. For example, Johnson in 1961 developed the neodymium YAG (Nd:YAG) laser followed by the Argon laser developed by Bennet in 1962. This was followed by the carbon dioxide (CO_2) laser 2 years later by Patel and colleagues [64]. These kinds of laser in their medical applications relied upon the photothermal and photoablative interactions with the tissues at relatively high power and energy densities [62, 63].

In contrast, other types of laser were developed by Professor Master's group in Budapest during the late 1960s and early 1970. These types of laser relied upon the non-thermal interactions of laser irradiation with tissues at low power and energy densities had a photobiostimulation effect on experimental wounds, which increased the rate of healing [62–65].

Another possible biological effect of low power laser was described in 1973 by Friedrich Plog in Canada, who presented his work on the use of HeNe laser as an alternative to metal needles for acupuncture treatments [51, 66, 67].

After these initial successful reports of Professor Mester's group at Budapest and Dr. Plog in Canada, low power laser treatment has become more frequently utilized by physicians and physical therapists for the alleviation of pain [68–70]. More recently, low power laser has got approval of Food and Drug Administration (FDA), as a pain reliever for soft tissue lesion in 2005 in the USA [71]. Furthermore, the appearance of a number of clinical research papers with very promising results particularly for MTrPs treatment have led to the popularity of laser therapy (e.g. [54–58]).

8. Principal components of a laser system

The laser device consists of three essential components.

8.1. Lasing medium

A lasing medium is a material that can absorb the energy generated by an external source. It can be gaseous, liquid, solid, crystal or a semiconductor [51, 62, 65, 72–74].

8.2. Energy source

Energy laser device must have an energy source to excite the lasing medium in order to emit laser radiation [51, 62, 65, 73, 74].

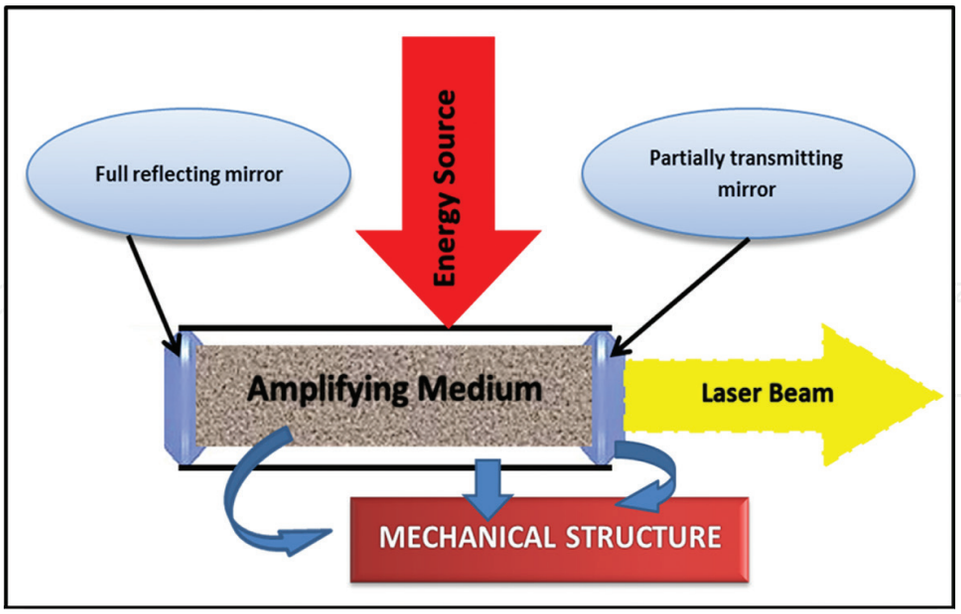

Figure 3. Simplified schematic of laser basic components.

8.3. Mechanical structure

The mechanical structure consists of the lasing medium within a central chamber located between two parallel mirrors. Reflection of photons of light back and forth between the two mirrors an across the chamber takes place, which lead to an intense photon production [51, 62, 72, 73].

The reflective extent of the two mirrors is not the same. While one of them is 100%, the other one is slightly less reflective to allow a small amount of the laser beam to pass through as irradiation output of the device [51, 62, 72, 73] (**Figure 3**). However, in the semiconductor devices, the ends of the diodes can be polished or coated with a highly reflective material to work as an alternative to the mirrors. Similarly, one end of the diode is slightly less reflective to allow a certain amount of the laser beam to pass as an output of irradiation [51, 73, 75].

9. Characteristics of laser light

Laser light differs from the ordinary light in terms of its monochromaticity, collimation and coherence. The biological and clinical significance of these characteristics is still relatively questionable and under investigations:

9.1. Monochromaticity

Monochromaticity indicates to single, defined wavelength, which consequently gives (mono) single colour [51, 73, 76–78]. Research evident showed that biological process possibly altered within a very narrow bandwidth, as distinct from the board spectrum of natural light [79].

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9.2. Collimation

Collimation indicates to the minimal divergence of the laser beam. Compare to, the emitted radiation of non-laser light sources radiates in various directions [51, 72, 75].

9.3. Coherence

Coherence indicates to the inherent 'synchronicity' of the light emitted by laser devices, which means that all energy waves are in phase [51, 63, 75, 77, 78] (**Figure 4**).

Some in-vitro studies have found that it is substantially critical to use a coherent laser source to attain photobiological modulations (e.g. [80, 81]), whilst others have found that coherence is not necessary [79, 82, 83]. Therefore, some of manufacturers have presented a cheaper phototherapy units, e.g. superluminous diodes (SLDs) and light-emitting diodes (LEDs), which are non-coherent [51, 63].

Clinically, researchers have disputed over the possible loss of coherency when subjecting laser light to human tissues and recently have shown positive outcomes when using light-emitting diodes (LEDs) (non-coherent light sources) in experimental muscle injury [84, 85].

Conversely, it has been reported that the photon density of coherent laser beam ensures a greater and more efficient penetration [67, 86, 87]. Simunovic [88] has also shown that coherency possibly maintained when passing through tissue. The significance of coherency has been also stressed by Antipa [89], as one of the characteristics that are necessary to obtain a higher clinical efficacy of laser therapy [89].

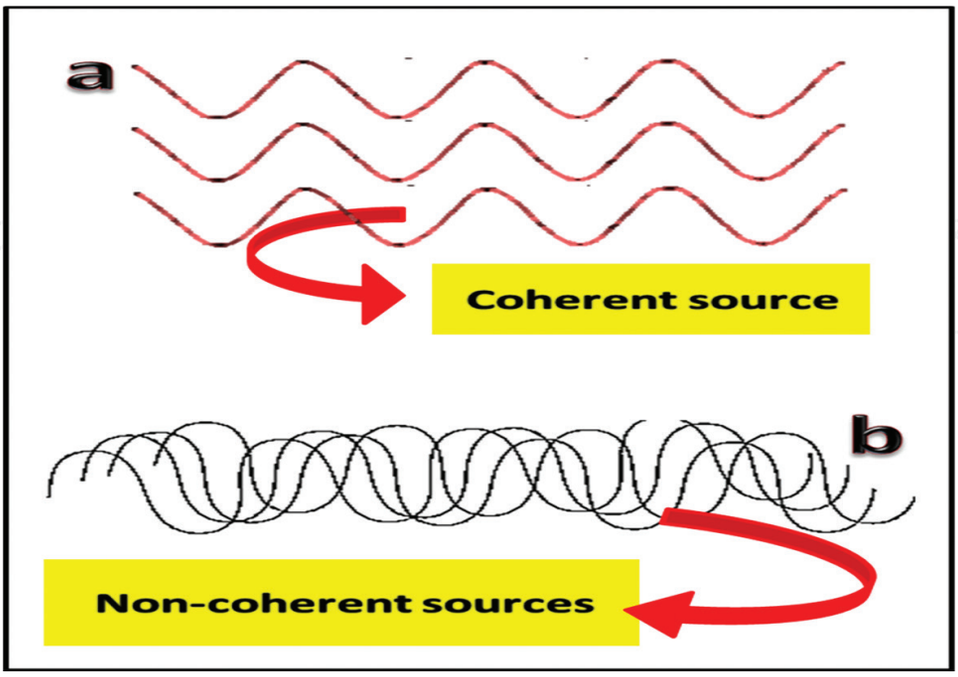

Figure 4. (a) Coherent light and (b) incoherent light.

9.4. Laser therapy treatment approaches

Laser therapy usually involves two main types of treatment approaches.

9.4.1. Contact approach

In the contact approach, the probe or the treatment head is applied perpendicular to the treated tissue. This technique greatly intensifies the irradiance on the tissue surface and consequently a greater proportion of laser energy can be directed to the target tissue [51, 63, 72, 75] (**Figure 5**).

The contact approach has been reported to be the most efficient treatment approach and must be used whenever it is possible [51, 62]. The treatment is also relatively safe as it reduces the potential hazard that comes from accidental intrabeam viewing [51, 62, 63].

A contact approach is commonly utilized in treating MTrPs. Beneficial effects have been shown in a number of clinical trials adopting this approach [54, 56, 90] while others failed to reveal any successful effects [91, 92]. However, in the latter two studies, no treatment parameters details and/or poor treatment parameters were evident.

9.4.2. Non-contact approach

In the non-contact approach, the probe or the treatment head is used out of contact with the tissue (**Figure 5**). This technique attenuates the irradiance on the irradiated tissue according to the 'inverse square law', thus more reflection of the incident photons will occur [51, 62, 63].

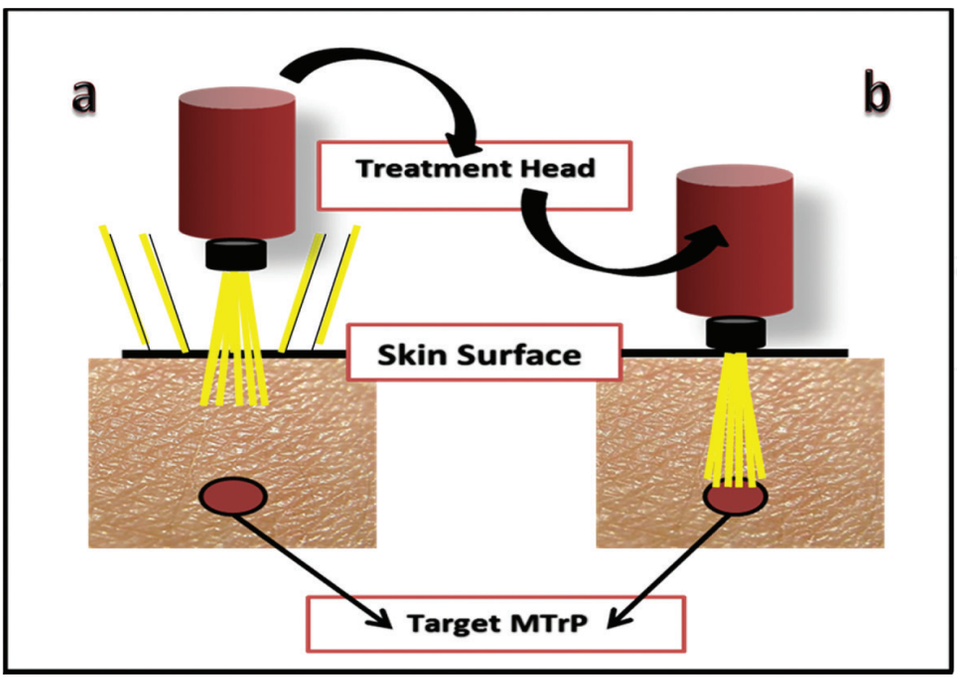

Figure 5. (a) Non-contact approach and (b) contact approach.

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10. Treatment parameters

Treatment parameters are extremely important and their detailed specification can allow replication of experimental or clinical findings.

10.1. Wavelength

Wavelength is the most important treatment parameters that determine the depth of penetration of laser irradiation [93]. Laser therapy units are usually with single wavelength sources. However, more recently, laser therapy units with a broad spectrum of wavelengths are available.

Therapeutic lasers have commonly wavelengths of approximately 602–1064 nm and give visible (red) or invisible (near infra-red) radiation (HeNe laser) [51, 65, 94].

10.2. HeNe lasers (632.8 nm)

The insufficient of penetration of this visible short wavelength laser source (HeNe laser) [51, 65, 94] might be one the justifications for its ineffectiveness. However, positive outcomes were evident with this type of laser in some MTrP clinical studies (e.g. [54, 95]).

10.3. CO_2 Lasers (10,600 nm)

The CO_2 lasers produce infrared radiation at 10.600 nm and such devices have been used successfully as pain relief modalities by some researchers (e.g. [96–98]). However, this type of laser is almost totally absorbed by water, thus reducing great proportion of light penetration in biological tissue [67].

10.4. Diode lasers (820–950 nm)

Wavelengths that are in the range of 820–950 nm (diode lasers) are known as near infrared radiation in the electromagnetic spectrum [51]. Their tissue penetration ability is quite high compared to other sources with different wavelengths [67].

Most of myofascial trigger point clinical studies utilized lasers with longer wavelength, ranging from 780 to 904, because it can transmit light energy with greater penetration and, therefore, they are the most appropriate to treated trigger points that particularly located in deep muscles [99].

10.5. Radiant power output

The radiant power output of laser systems is generally measured in watts (W), but as a result of the relatively low power output employed in LLLT systems, it is more frequently measured in milliwatts (mW = thousands of a watt) [63, 65, 100].

It has also been reported that more penetration can be gained with greater average output power, as a greater number of photons will be presented at deeper depths [72]. However,

radiant power output was greatly variable between studies with possible pain reduction when irradiating painful MTrPs with a range of radiant power outputs of 0.95–120 mW.

10.6. Irradiance

Irradiance is defined as the incident photon density of laser irradiation at the target tissue and utilized to express to the intensity of light [67]. The significance of irradiance has been stressed by a number of researchers as one of the most influential treatment parameters [101, 102]. However, unfortunately, quite few numbers of researchers reported this treatment parameter [99].

Some literature reported positive results for tissue repair and anti-inflammatory effects when the range of 5–55 mW/cm2 was employed [103–105], while higher irradiances of 300–1730 mW/cm2 was recommended for analgesic purposes [106].

The irradiance can be obtained from the following equation:

$$\text{Irradiance} = \frac{\text{Output power (W)}}{\text{Irradiated area (cm}^2\text{)}} \tag{1}$$

From the above equation, it can be seen that the value of the irradiance (measured in watts) will be profoundly affected by the spot size (measured in square centimetre) of the laser beam [67].

10.7. Radiant energy

The radiant energy delivered to a region of the target tissue over a period of time is commonly expressed in joules (J) and can be calculated by the following equation:

$$\text{Radiant Energy (J)} = \text{power output (W)} \times \text{time (s)} \tag{2}$$

From the above equation, if a certain energy is required in a treatment session, the time (in seconds) needed to obtain that energy can be obtained, by dividing the energy by the radiant power output [51, 63].

The total radiant energy is one of critical treatment parameters [107]. The energy employed in the MTrPs clinical trials ranged from 0.275 to 8 J/point [99].

10.8. Radiant exposure

Radiant exposure is a critical factor in ascertaining whether the laser light will influence photobiological modulation process [108, 109]. A recent study also revealed that the radiant exposure provided by laser therapy is one of the factors that can influence biochemicals related to pain in the treatment of MTrPs [60].

It is worth noting, energy density is not a fixed parameter as it is dependent on time and can be manipulated by the operator [110]. The radiant exposure can be obtained from the following equation:

$$\text{Energy density (J/cm}^2\text{)} = \frac{\text{Power (W)} \times \text{times (s)}}{\text{area (cm}^2\text{)}} \tag{3}$$

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Treatment exposure is usually in a range between 1.44 and 12 J/cm^2 in the treatment of MTrPs. However, radiant exposures of up to 32 J/cm^2 have been employed also [75, 99].

10.9. Pulse repetition rate

Generally, the laser devices that are available in research or clinical applications deliver a continuous wave or allow some form of pulsing of their output [63, 65, 72, 73].

The pulse repetition rate in the pulsed devices is expressed in Hertz (Hz, pulses per second) and can vary from 2 to thousands of Hz [63]. However, the pulse rate is restricted in some laser devices.

It has been reported that pulsed light possibly more effective than continuous one, as it allow a potentially much higher peak power densities without causing a significant tissue heating and consequently greater treatment depth [93]. Additionally, different biological effects were obtained, when experiments were conducted to determine the effect of different pulsing frequencies (e.g. [111–115]).

10.10. Frequency of treatment and length of treatment course

Clinical practitioners and researchers advocate multiple treatment sessions for successful laser treatment [51, 65, 94] (**Figure 6**). In MTrPs studies, laser treatment were commonly

Figure 6. Clinical laser session.

utilized 2-3 times per week However, there is no consensus about the optimum frequency of treatment or length of treatment course [56, 99].

11. The possible mechanisms of action of laser in MTrPs

Three possible mechanisms of action were proposed included: stimulation of the local metabolism; modulation of neurotransmitter; anti-inflammatory effect and laser-induced neuronal suppression.

11.1. Stimulation of the local metabolism

In the mechanism of taut band formation, certain muscle fibres react to trauma or abnormal stress by excessive release of calcium ions. This would cause uncontrolled muscle fibres contracture with increase metabolic demands and consequently, MTrPs formation [1]. Laser therapy reported to have the potential to cause rotation and vibration on the membrane molecules that make up the calcium channels that may alter the function of these channels [116]. This might help in removing or minimizing the excessive amount of calcium that may causes uncontrolled shortening activity of the muscle fibres.

The characteristic shortening of muscle fibres associated with MTrPs results in deteriorated local circulation leading to loss of oxygen and nutrient supply. Laser therapy has the ability to enhance the local microcirculation and subsequently decrease the muscular tension and emanate pain in the area [88].

11.2. Modulation of neurotransmitter

Modulation of neurotransmitters has proposed as a mechanism for pain alleviation [117]. For instance, serotonin levels are relatively intensifying when the treatment of MTrPs with laser treatment are employed. A trial carried out by Walker [118] applied laser irradiation on MTrPs patients attributed the analgesic effects to changes in serotonin metabolism.

More recently, a double blind study conducted by Ceylan et al. [57] also found that laser irradiation is an effective method of treatment of MTrPs associated with the elevation of the serotonin. However, more studies may be required in this area.

11.3. Anti-inflammatory effect

The cause of pain in active MTrPs may be as a result of direct trauma to a muscle, sudden strain, or when there is excessive or unusual exercise, a study by Shah et al. [25] also documents a high concentration of nociceptive substances, e.g. protons, bradykinin, calcitonin gene-related peptide, substance p, serotonin and noradrenaline) in the active MTrPs.

As the rise of the above biochemical milieu of substances are usually associated with pain and inflammation and in accordance with the above findings, evidence from the literature

reported that laser therapy inhibits peripheral nerves afferent terminals prohibits peripheral nerve sensitization and hinder further release of the nociceptive substances, thus possible mechanisms of pain relief and anti-inflammatory effect may occur [119, 120].

Research has also clearly revealed anti-inflammatory effects of laser irradiation particularly in acute injury [120]. The tissue repair is associated with the release of prostaglandins $E_{2.}$ Laser irradiation showed the ability to reduce the formation of the inflammatory markers including the prostaglandins E2 [119]. Therefore, laser might be able promote resolution of the inflammatory process vital for the tissue repair.

11.4. Laser-induced neuronal suppression

Laser-induced suppression of neuronal activity is another potential mechanism for pain relieving influences of laser irradiation. In advocate of laser-induced neuronal suppression mechanisms are a number of human trials that showed that laser relatively hinders nerve conduction velocity and augments latency in median [51], radial [121] and sural nerves [122]. However, light-emitting diodes (LEDs) and superluminous diodes (SLDs) more recently failed to act as a direct suppression of neuronal activity [123].

In consistent with the above findings, a number of electrophysiological experiments were carried out, to assess neuronal mediated inhibitory effects of laser irradiation [124–126]. Laser irradiations were able more specifically to influence the nerve conduction of small diameter, thinly myelinated A and unmyelinated C fibres. Therefore, in the light of these encouraging research reports using laser as an alternative to needle in acupuncture for MTrPs treatment might not be excluded.

Author details

Abdullah M. Al-Shenqiti

Address all correspondence to: monuhama@yahoo.co.uk

Faculty of Medical Rehabilitation Sciences, Taibah University, Al-Madinah Al-Munawarah, Saudi Arabia, Centre for Rehabilitation Science, University of Manchester, Manchester, UK

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