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Multiwave Locked System LASER photobiomodulation in the multidisciplinary team approach/ management of a 3rd degree burn on the posterior thorax in an 82-year-old woman – a case study

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Abstract: Introduction: In the current study, we aim to demonstrate the efficacy and significance of MLS LASER therapy in the context of post-combustion injuries, through the expeditious improvement of a harmonious healing process for the lesions. A burn is recognized as a significant concern in the medical field [1], as the majority of them are profoundly disabling [2] and negatively impact crucial facets of daily existence, as well as overall quality of life [3]. Material and methods: We hereby present the case of an 82-year-old female patient admitted to our Neuromuscular Rehabilitation Clinic Division following a post-burn incident that occurred in January 2023, characterized by flame burns of IIA-IIB-III degrees on the posterior thorax, bilateral arms, and sacral regions. Initially, the patient received care in the Plastic Surgery Clinic Division of our hospital, and after three weeks, she was transferred to our division. Here, she underwent a tailored rehabilitation program and received notable Multiwave Locked System (MLS) LASER treatment on the posterior thoracic region over ten sessions. The patient's progress was comprehensively and objectively quantified using assessment scales. Results: Remarkable results were obtained, consisting a significant reduction in the size of the lesion on the posterior thoracic region after 10 sessions of MLS LASER photobiomodulation, along with a related improvement in locomotor and self-care dysfunctions. Conclusions: Since references in the literature regarding the use of this type of phototherapeutic intervention are relatively scarce, we consider this case study to contribute to a better understanding and appreciation of it. At the same time, an efficient multidisciplinary collaboration proves advantageous not only for the patient's well-being, but also for the development of current therapeutic interventions, contributing to the enrichment of this complex domain.

Keywords: Burns, Multiwave Locked System (MLS) LASER photobiomodulation, Multidisciplinary team, Burn rehabilitation program.

1. Introduction

Burns are described as a "global public health problem" [4] causing significant morbidity and mortality [5], with approximately "180,000 deaths annually", predominantly in low-income countries [4]. They rank among the conditions with high costs, mainly when referring to severe burns, as they require extended hospitalization and long-term treatment for wound and scar management and potential complications [5].

Burns can be caused by "thermal, electrical, chemical, or radiant factors"[6]. A crucial stage in burn management involves classifying of injury to assess its severity relative to the total body surface area, often using the "Rule of 9" [7,8].

When the body undergoes the trauma known as a burn, there is a sudden release of "vasoactive mediators" from the burn injuries ("kinins, prostaglandins, catecholamines, and glucocorticoids"), causing a drop in body temperature and, consequent, an obligatory increase in energy consumption [9]. Dysfunctions in capillary integrity, also known as the "capillary leak syndrome", lead to volume redistribution into the extravascular space [9].

Complications constitute a particularly crucial aspect in the context of post-burn pathology, manifesting in various ways and profoundly impacting patients' "quality of life (QOL)" [10]. These consequences, both from aesthetic and mental health perspectives, can result in diminished self-perception and, in some cases, may precipitate depressive states. Regarding the complexity of complications, we can highlight contractures and deformities that may occur following severe burns, imposing significant mobility restrictions and revealing pronounced stiffness, ultimately leaving a challenging imprint for the patient to endure [8,11].

In the case of first and second-degree burns, the primary therapeutic intervention involves maintaining local hygiene, applying creams, including antibiotics in certain circumstances, and using dressings [12]. Conversely, severe third-degree burns necessitate surgical intervention, as their prolonged healing process may lead to the development of severe scarring. The most commonly employed approach involves the "application of a split-thickness skin graft harvested from an unaffected donor site" [13]. In cases where a donor site is not available, patients with "extensive burns often require temporary coverage with an allograft, xenograft, skin substitute, or dermal analog" [13]. Regarding the healing period, standardization is not feasible, as small-sized third-degree burns may require at least "three weeks for recovery", while extensive third-degree burns may even entail several years to achieve complete recovery. It is crucial to emphasize that the temporal variability in the healing process depends on the size and severity of the respective burn [9].

MLS LASER Therapy can be characterized as an innovative and modern treatment modality [14] derived from the scientific research of the "American Society of Anesthesiologists (ASA)" [8,15]. Build up in compliance with the related "European Community/European Union (EC/EU)" regulations [16], ensuring safety, quality, and efficacy. It has been officially tested and validated also by the "U.S. Food and Drug Administration (FDA)" - (scientifically and clinically) [8], starting in 2003 in the United States of America (USA), where it gained extensive available, and later in Europe [8], becoming famous in terms of utilization.

The device powers 6 LASER sources: "3 continuous (808 nm) and 3 pulsed (905 nm)" [17] and it is endowed with a "multidiode optical group performing a robotic multitarget movement" [8]. Hence, the robotic head, moves independently and automatically over the lesion area to be treated once the desired zone has been established.

MLS LASER Therapy represents a valuable, "non-invasive" [18], and well-tolerated treatment for patients [19] due to its painlessness, offering high performance. It allows spatial overlap of two different wavelengths: "continuous emission at 808 nm and pulsed emission at 905 nm" [17], resulting in a single homogeneous pulse with a minimum diameter of 5 cm [18], precisely delimited by a red LED light. Enables effects such as "analgesic, anti-inflammatory, anti-edematous", and "tissue repair effects in superficial and deep tissues" [20].

Studies have shown that MLS emission can stimulate "neoangiogenesis, improve cellular energy metabolism, modulate inflammation, and, consequently, regulate fibroblast activation" [20]. This method illustrates additional advantages due to its easy application procedure and short treatment periods [8], contributing to faster rehabilitation.

Currently, considering the existing literature, research on the use of MLS LASER therapy is abundant in the context of pressure injuries and various body pain, but there is a limited coverage regarding burns. Predominant information regarding post-burn injuries is found in very few case studies conducted abroad, especially in the USA, presentations and e-books advocating for this therapy. Given these evident gaps, we identify an opportunity to contribute to the expansion of the current scientific knowledge in this field by providing our own contribution.

2. Materials and Methods

We present a case of an 82-year-old female who sustained flame burns in an open space, affecting 9% of her total body surface area. The burns ranged from second-degree (IIA-IIB) to third-degree (III), and they were located on the posterior thorax, bilateral arms, and sacral region.

She was initially admitted to the Plastic Surgery Clinic Division within our hospital. A burn lesion with necrosis on approximately 7%, "Total Body Surface Area (TBSA)" [21] was identified in the right posterior hemithorax and sacral right region. The pink dermis was evident on approximately 1%. The lesion exhibited an irregular contour. The patient underwent daily dressings, after which a portion of the necrotic areas was debrided and partially removed. On the posterior sites of both arms, serial surgical interventions were performed for excisional debridement of necrotic tissue, and five days later was followed by split-thickness skin grafting.

The patient was transferred to our Neuro-Muscular Rehabilitation Clinic Division within the TEHBA for self-care dysfunction and mild locomotor impairment as well as for stage-specific rehabilitation treatment, including with related psycho-cognitive status assessment and approach within the overall post-burn incident context.

Regarding the general clinical examination at admission, we observed a relatively stable overall condition. The patient was afebrile, with pale and dehydrated skin (persistent skin tenting - within its aging-specific biological modification), with a geographical map-like appearance at the level of the post-burn lesion on the posterior thorax (approximately 42x37cm in size), bilateral arms (around 10x15 cm in size), sacral (about 8x5 cm in size), accompanied by intense itching. The muscular system was characterized as hypokinetic, normotonic, and normotrophic. Blood pressure (BP) was recorded at 120/70 mmHg, and the heart rate (HR) was 82 beats per minute, maintaining a rhythmic pattern. Pulmonary auscultation revealed normal findings with no bronchial rales, SpO2 saturation was at 97%, and bilateral vesicular murmur was present, with a chest demonstrating a tendency toward kyphosis. The venter was spontaneously painless, mobile with respiratory movements, devoid of signs of peritoneal irritation, and exhibited affirmatively slow bowel transit. Liver and spleen clinical examinations were within normal limits. The patient used adult diapers for micturition, and the Giordano test yielded negative results bilaterally.

From the perspective of the neuro-myo-arthro-kinetic and psychocognitive examination, we can describe a conscious and cooperative patient without signs of meningeal irritation. The cranial nerve inspection revealed normal findings. There was a reduction of osteotendinous reflexes in the upper and lower limbs, with the plantar reflex indifferent bilaterally. Minimal sensory disturbances and coordination disorders were noted. Still, there were no signs of sphincter disorders (the use of diapers being required by the overall mobility thereof/difficulties including the capability to go to the toilet) or difficulties with swallowing. Functionally, the patient proved the ability to move on short distances but with assistive support (either by a person or the walker). The muscle strength assessment revealed that according to the "Medical Research Council (MRC) scale" [22], the patient exhibited a strength of 4/5 in all the upper and lower limbs.

From a paraclinical perspective, the patient exhibited mild hypoalbuminemia, mild hyperchloremia, moderate hypochromic microcytic anemia, and a mild inflammatory

biological syndrome, values that have been attempted to be corrected to aid a proper healing of the lesion.

The patient followed an individualized rehabilitation program, which included general rehabilitative nursing, post-burn wound treatment, and care of the donor site - by the consultations and instructions provided by the Plastic Surgery Clinic Division – Kinesiology and Physical Therapy: MLS LASER phototherapy on the posterior thoracic lesions for biotrophic effect and acceleration of healing.

The therapeutic sessions with MLS LASER photobiomodulation were conducted within our Neuro-Muscular Rehabilitation Clinic Division at the TEHBA. The inclusion of the patient occurred after she gave her formal acceptance by signing the Patient's Informed Consent. Due to the patient's limited mobility and the fact that she was alone in the room, she received the therapeutic procedures by the bed. During the therapy sessions, the patient and the physician wore protective goggles to prevent any potential eye injury, and the therapy provider wore gloves.

A total of 10 treatment sessions were conducted at a 2-day interval [23,24]. In the first phase (the initial 5 sessions), the adjusted parameters included the area of the lesion plus an adjacent zone of 2-3 cm of healthy tissue at an intensity of 50%, a frequency of 700 Hz, and a power density of 4J/cm^2. In the second phase (the last 5 therapy sessions), the area of the lesion plus 2-3 cm of healthy tissue around was maintained, the intensity was increased to 100%, the frequency to 1000 Hz, and the power density of 4J/cm^2 was retained [23,24].

The patient underwent continuous monitoring through (semi-)quantitative instruments assessing both the severity and concomitant clinical-functional progress at the onset of MLS LASER therapy sessions and the end of the respective 10 sessions. These instruments included the "VSS - Vancouver Scar Scale" [25], "VAS - Visual Analogue Scale" [26], "5-D ITCH Scale" [27], "MMT - Manual Muscle Test Scale" [28], "The Barthel Index" [29], "Katz Index of Independence in Activities of Daily Living (ADL)" [30], "Timed Up and go test" [31], as well as "10 meters walking test" [32].

3. Results

The outcomes of MLS LASER therapy, administered to the post-burn lesion on the posterior right hemithorax, demonstrated a significant improvement from session to session. The most notable aspect was the reduction in size of the lesion. During the initial intervention, presented in Figure 1, the patient's lesion had an irregular contour, measuring a maximum length of 42 cm and a maximum width of 37 cm. A necrotic area measuring 5 x 9 cm accompanied by present secretions and the patient reporting an intense itching sensation were noted.

Figure 1. The post-burn lesion appearance upon admission to the Neuromuscular Rehabilitation Clinic Division at the first MLS LASER therapy session

In Figure 2, still within the framework of the first therapy session, the measurement of the diameter upon which the LASER was applied is depicted, extending by 2 cm into healthy tissue. The therapeutic process lasted for 18 minutes (automated steeled by the apparatus' soft fitting to the lesion's area) [23,24], during which the patient reported only a mild sensation of warmth without experiencing any discomfort throughout the entire treatment session.

Figure 2. The targeted area for which the MLS LASER treatment was applied.

During the third session of MLS LASER therapy, as depicted in Figure 3, the centripetal lesion reduction within the healing phenomenon was already apparent, highlighting an epithelialized margin of approximately 2 cm. We noted the nearly complete elimination of the necrotic area and the visible augmentation of regenerative buds across the entire lesion surface. The patient reported a significant reduction in itching. (see further, too)

Figure 3. Session number 3 within the MLS LASER therapy

The results of the fifth therapeutic session were prompt, as emphasized in Figure 4, demonstrating complete epithelialization of the lesion in the right paravertebral lumbar region, measuring 8 x 10 cm. The extension of the epithelialization contour across the entire lesion was noteworthy, ranging from 2.5 to 3 cm, particularly on the right lateral side.

Figure 4. The fifth session of MLS LASER therapy

Figure 5 illustrates the implementation of the fifth therapeutic session, wherein the parameters for applying the MLS LASER therapy were increased, as specified in the Materials and Methods section.

Figure 5. Session number 5, in which the MLS LASER acts on the lesion- including the illustration of the light projection of it

During the seventh therapeutic session, as presented in Figure 6, a significant degree of healing is observed, with a contour of approximately 3.5 cm, reaching up to 5 cm, in certain regions (such as the proper lateral site aspect of the right hemithorax).

Figure 6. Session number 7 of MLS LASER therapy

Figure 7 illustrates the application of MLS LASER therapy on our patient, with good tolerance and the absence of discomfort during its activation (the part of the MLS LASER device in action may also be seen).

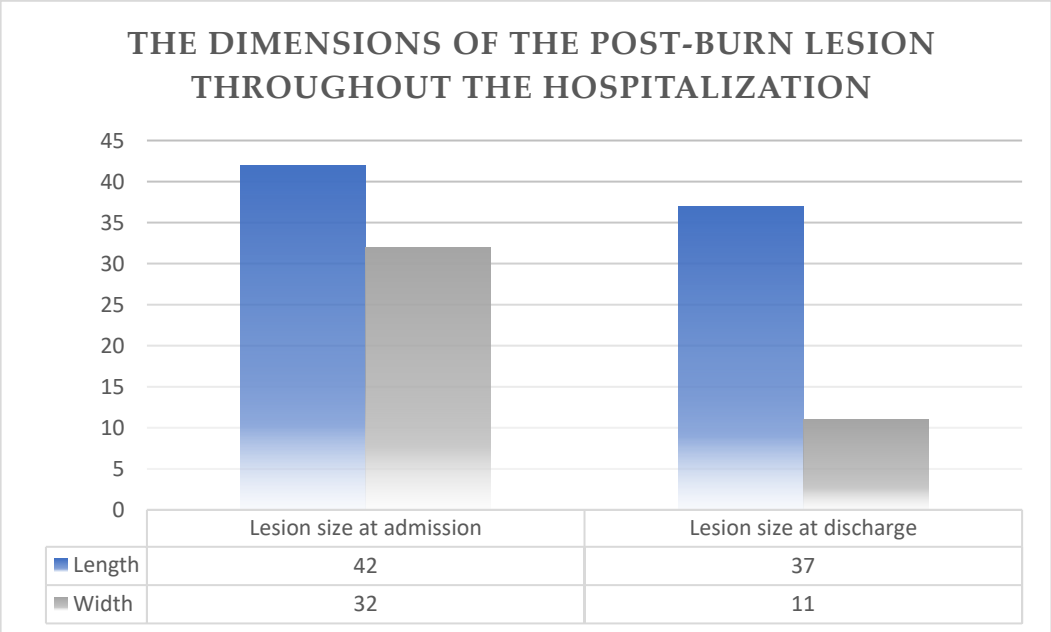
Figure 7. Session number 7 during the application of the MLS LASER photobiomodulation

At the end of the proposed 10-session MLS LASER therapy in our Neuro-muscular Rehabilitation Clinic Division, we observed a remarkable and favorable evolution of the post-burn injuries. There are still in the healing process and present significant epithelialization on the posterior thorax, affecting 4% out of the 7% of the initially concerned TBSA, with a 3% remaining zone undergoing epithelialization. The lesion measured a maximum length of 32 cm and a width of 11 cm, with centripetal healing observed. The outcome was exceptionally satisfactory, as illustrated in Figure 8.

Figure 8. The aspects of the post-burn lesion after the tenth session after applying MLS LASER therapy.

In Chart 1, the progression of the post-burn lesion dimensions is depicted, encompassing both admission and discharge periods.

Chart 1. The dimensions of the post-burn lesion throughout the hospitalization



Using the standardized, clinical-functional evaluation instruments mentioned in the Material and Methods section, a significant and positive evolution of the final scores was noted, as outlined in the information presented in Table 1.

TABLE 1. Synthesis of the results obtained based on objective clinical-functional quantifications through the related specific evaluation tools/scales used throughout the therapeutic rehabilitative program availed in this case, for the post-combustion lesions

BEFORE THE INITIATION OF MLS LASER THERAPY SESSIONS.	AFTER THE TEN APPOINTMENT OF MLS LASER THERAPY	EVOLUTION
VSS (Vancouver Scar Scale) = 11/13	VSS (Vancouver Scar Scale) = 6/13	VSS (Vancouver Scar Scale) = +5
VAS (Visual Analogue Scale) = 9/10	VAS (Visual Analogue Scale) = 4/10	VAS (Visual Analogue Scale) = +5
5-D ITCH SCALE = 49 / 51	5-D ITCH SCALE = 21 / 51	5-D ITCH SCALE = + 28
MMT = 4/5	MMT = 5/5	MMT = +1
BARTHEL INDEX = 10/90	BARTHEL INDEX = 60/90	BARTHEL INDEX = +50
KATZ INDEX = 2/6	KATZ INDEX = 4/6	KATZ INDEX = +2
TIMED UP AND GO TEST =1/3	TIMED UP AND GO TEST =2/3	TIMED UP AND GO TEST = +1
10-METER WALKING TEST = 0/3	10-METER WALKING TEST = 1/3	10-METER WALKING TEST = +1

Information regarding the long-term follow-up of the patient cannot be detailed, as she resided in a rural area, at a considerable distance from the capital of Romania, where all MLS LASER treatment sessions took place. Additionally, the patient lacked a mobile phone or alternative means of contact, limiting our ability to gather information regarding the progression of the lesion after her discharge from our Rehabilitation Clinic.

4. Discussion

The particularity of this case lies in the visible improvement of the post-burn lesion after the ten therapy sessions and in demonstrating the effectiveness of MLS LASER. The primary discussion we can embark on pertains to the possibility of incorporating MLS LASER photobiomodulation into the therapeutic approach in patients with burns of various degrees. The lapse we found in the literature to start the MLS LASER therapy in post-combustional lesion varies from days to weeks or even months [23,24]. In our case, we have initiated this kind of intervention at 3 weeks after the burns occurred, achieving a remarkable result through the improvement of assessment scales and the patient's overall condition. Comparing one of the few studies we could find in the database, a study that was conducted in the United States by Dr. Tim Brennan, addressing the treatment with "LASER MLS: 700 Hz, 100% intensity" [24], initiated 3 days post-lesion occurrence, where the patient underwent 8 sessions over the course of the 10-day hospitalization. Notably, a reduction in pain was emphasized after the first 2 applications, with a continuous decrease observed. The initial "Visual Analog Scale (VAS)" [26] score was 6/10, and after 7 sessions, it reached 0/10, indicating a significant improvement in painful symptoms. Considering the available bibliographic resources, we can assert that the discussed topic has not been adequately explored. With the desire to make a significant contribution shortly, we aspire that the aim of introducing post-burn MLS LASER therapy into the treatment protocol for patients with burns of different degrees will be achieved.

A consideration arose regarding the potential of MLS LASER therapy to induce similar beneficial effects in the elderly population, too, that this method is safe and efficient, including for a more vulnerable demographic category. Among the highlighted advantages of this treatment, in the apparatus e-book pamphlet [23,24], it is noteworthy that there are "no age-related criteria" [9] limiting the application of this medical approach modality. This assertion is supported by the exceptional results obtained in this study, where the involved patient was 82 years old. Thus, the positive outcomes achieved at an advanced age underscore the effectiveness of MLS LASER photobiomodulation even within the older person.

5. Conclusions

MLS LASER therapy is a valuable method that can be harnessed in the rehabilitation process of patients with burns and beyond. Accelerating the healing process and reducing the recovery period can achieve a more harmonious cure for injuries and more robust rehabilitation and recovery of the needing patients. Thus, we have the opportunity to optimize the comprehensive rehabilitative care of patients with such pathologies and highlight the benefits of a valuable, safe method.

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- This study was approved by the ethics committee of Teaching Emergency Hospital "Bagdasar Arseni" (TEHBA) Bucharest, Romania through the minutes of the meeting number 21858/26.06.2023.

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