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Fotobiomodulação em úlceras de pressão: revisão integrativa

Low-Level Light Therapy in pressure ulcers: integrative review

Fotobiomodulación en úlceras por presión: revisión integradora

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RESUMO

Objetivo: Identificar, a partir de publicações científicas, a utilização do Laser de Baixa Intensidade para o tratamento de úlcera. **Métodos:** Revisão integrativa com levantamento bibliográfico nas bases de dados Medline, LILACS, BDEnf e SciELO, entre 2011 e 2021, utilizando os descritores Low Level Light Therapy, Pressure Ulcer. Foram incluídos artigos em português, inglês e espanhol, com os resumos disponíveis nas bases de dados selecionadas e disponíveis na íntegra sem custos. Para análise dos artigos, aplicou-se a ferramenta CASP adaptada. **Resultados:** A amostra final foi composta por 05 artigos. Foram descritas que cicatrização da úlcera ocorreu após 30 dias de tratamento e observou-se epitelização total. A combinação de terapia fotodinâmica, laserterapia e revestimento com membrana de celulose é um tratamento promissor para a cicatrização de UP em pacientes diabéticos. **Considerações Finais:** A maioria dos resultados aponta que a cicatrização efetiva das úlceras por pressão está relacionada com a irradiação do laser no comprimento de onda de 658nm.

Palavras-chave: Laser de baixa intensidade, Úlcera por pressão, Enfermagem.

ABSTRACT

Objective: to identify, from scientific publications, the use of Low Level Laser Therapy for ulcer treatment. **Methods:** integrative review with bibliographic survey in Medline, LILACS, BDEnf and SciELO databases, between 2011 and 2021, using the descriptors Low Level Light Therapy,

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Pressure Ulcer. Articles in Portuguese, English and Spanish were included, with abstracts available in the selected databases and available in full at no cost. The adapted CASP tool was used to analyze the articles. **Results:** The final sample consisted of 05 articles. It has been described that healing of the ulcer occurred after 30 days of treatment and complete epithelialization was observed. The combination of photodynamic therapy, laser therapy and cellulose membrane coating is a promising treatment for PU healing in diabetic patients. **Final considerations:** The majority of the results indicate that the effective healing of pressure ulcers is related to laser irradiation at a wavelength of 658nm.

Descriptors: Low-intensity laser, Pressure ulcer, Nursing.

RESUMEN

Objetivo: identificar, a partir de publicaciones científicas, el uso de la Terapia con Láser de Baja Intensidad para el tratamiento de úlceras. **Métodos:** revisión integrativa con levantamiento bibliográfico en las bases de datos Medline, LILACS, BDEnf y SciELO, entre 2011 y 2021, utilizando los descriptores Low Level Light Therapy, Pressure Ulcer. Se incluyeron artículos en portugués, inglés y español, con resúmenes disponibles en las bases de datos seleccionadas y disponibles en su totalidad sin costo. Para el análisis de los artículos se utilizó la herramienta CASP adaptada. **Resultados:** La muestra final estuvo conformada por 05 artículos. Se ha descrito que la curación de la úlcera se produjo después de 30 días de tratamiento y se observó una epitelización completa. La combinación de terapia fotodinámica, terapia con láser y recubrimiento de membrana de celulosa es un tratamiento prometedor para la curación de UPP en pacientes diabéticos. **Consideraciones finales:** La mayoría de los resultados indican que la curación efectiva de las úlceras por presión está relacionada con la irradiación láser a una longitud de onda de 658 nm.

Descriptores: Láser de baja intensidad, Úlcera por presión, Enfermería.

INTRODUÇÃO

The Intensive Care Unit (ICU) is a special treatment unit designed to care for critically ill patients who require complex care and constant monitoring, including technological support. This unit is staffed by a specialized multi-professional team (BRASIL, 2010). Patients in need of intensive care have significant impairment of their vital functions, often require sedation, are bedridden and have been hospitalized for a long time (BRASIL, 2010).

The skin, or integumentary system, is the largest organ in the human body, accounting for approximately 10% of body weight. Its thickness, elasticity and distensibility vary according to age, degree of nutrition and hydration. In this context, caring for the skin is fundamental, since its possible lesions are a gateway for microorganisms that can worsen the patient's clinical condition, thus prolonging the length of hospitalization or even leading to the patient's death. Pressure ulcers are among the main skin lesions that affect patients who have difficulty mobilizing in bed and/or walking, especially those who are neurologically affected. A pressure ulcer is localized damage to the skin and soft tissues and can cause pain, cell necrosis and impaired local circulation, as well as physical and psycho-spiritual discomfort (BRASIL, 2010).

Its cause is attributed to prolonged intense pressure together with shear, potentiated by nutrition, microclimate, perfusion, comorbidities, and the patient's clinical conditions. It is a constant problem for the nursing and multidisciplinary team in an Intensive Care Unit (BERNARDES LO, 2018).

Pressure ulcers are a quality indicator in the ICU and the sixth goal of the National Patient Safety Plan, which aims to minimize and reduce the risks to which patients are exposed. Therefore, the healthcare team should carry out a daily assessment of the risks of developing a pressure ulcer, change the patient's position and moisturize the skin. Despite greater attention to patient care, the incidence and prevalence of pressure injuries in ICUs remains high (BRASIL, 2010).

One study points out that 58.8% of pressure injuries begin during the first fourteen days of hospitalization; the highest incidence of pressure injuries is in the sacral region with 46.4%, followed by the calcaneus with 29.7% (LIMA NEP, et al., 2018). In turn, another study corroborates this by stating that nursing plays an important role in the assessment, diagnosis and daily care plan, thus achieving the desired results in tissue recovery and promoting comfort through relief, tranquility and transcendence (MENEGUZZO DT, et al., 2015).

One of the alternatives for treating pressure ulcers is photobiomodulation or low-intensity laser. This technology has been used in various areas of health and its effects are to accelerate tissue healing, modulate inflammation and promote analgesia (MENEGUZZO DT, et al., 2015).

These effects are associated with the stimulation of microcirculation, antioxidant effects, and reactivation of cellular respiratory potential, promoted by low-intensity laser radiation, which is little known and used in medicine and even more so in dentistry and physiotherapy (MENEGUZZO DT, et al., 2015).

The hypothesis that supports the use of laser in the treatment of pressure ulcers is the interaction with tissue leading to modulation of inflammation, biostimulation of tissue repair, analgesia and activation of the immune response (MENEGUZZO DT, et al., 2015).

A pressure ulcer is a lesion located on the skin and/or underlying tissue, usually on a bony prominence, as a result of pressure or a combination of pressure and torsional forces - National Pressure Ulcer Advisory Panel.5 Critically ill patients admitted to the ICU are at greater risk of developing pressure injuries, since they are hemodynamically unstable and severe, thus restricted to bed (ARAÚJO ID, 1997; THULER SR and PAULA MAB, 2016).

Pressure damage is formed as a result of prolonged internal pressure combined with shear. The intensity of the pressure, the prolonged duration on the tissue, friction and shear associated with humidity, loss of sensation, incontinence, hyperemia, protein malnutrition, anemia, smoking, advanced age are all risk factors for pressure injury. The main risk factor for pressure ulcers is pressure (SIBBALD RG, et al., 2006).

MÉTODOS

This is a bibliographic, descriptive study, an integrative literature review, a specific method whose aim is to analyze the knowledge already built up in previous research on a given topic. It therefore enables the synthesis of various publications and allows the generation of new knowledge, based on the results presented by previous research. Thus, the methodological path was defined in six stages (BOTELHO LLR, 2011).

In the first, the acronym PICo was used to construct the guiding question, with P: the population (patients with pressure ulcers), I: the phenomenon of interest (photobiomodulation) and Co: the context (adult intensive care unit). The following question was then asked: what are

the main experimental and non-experimental studies that can support the use of photobiomodulation in pressure ulcer healing? The search strategies and databases were then defined (ARAÚJO WCO, 2020).

The electronic bibliographic survey was carried out using the descriptors: Low-Level Light Therapy, Pressure Ulcer. These descriptors were taken from the Health Sciences Descriptors Portal (DeCS). The result of using these descriptors was an extensive mapping of the databases of the Regional Portal of the Virtual Health Library (VHL), the main structures of which were the Medical Literature Analysis and Retrieval System online (Medline), Latin American and Caribbean Health Sciences Literature (LILACS), Nursing Database (BDEnf) and Scientific Electronic Library Online (SciELO) databases. For each database, the Boolean operator AND was used (to intersect the terms in the search strategy), with the aim of associating the descriptors in the databases. Medline used the strategy (Low-Level Light Therapy) AND (Pressure Ulcer). The same limits were repeated for LILACS and BDEnf, and for SciELO (Low-Level Light Therapy) AND (Pressure Ulcer).

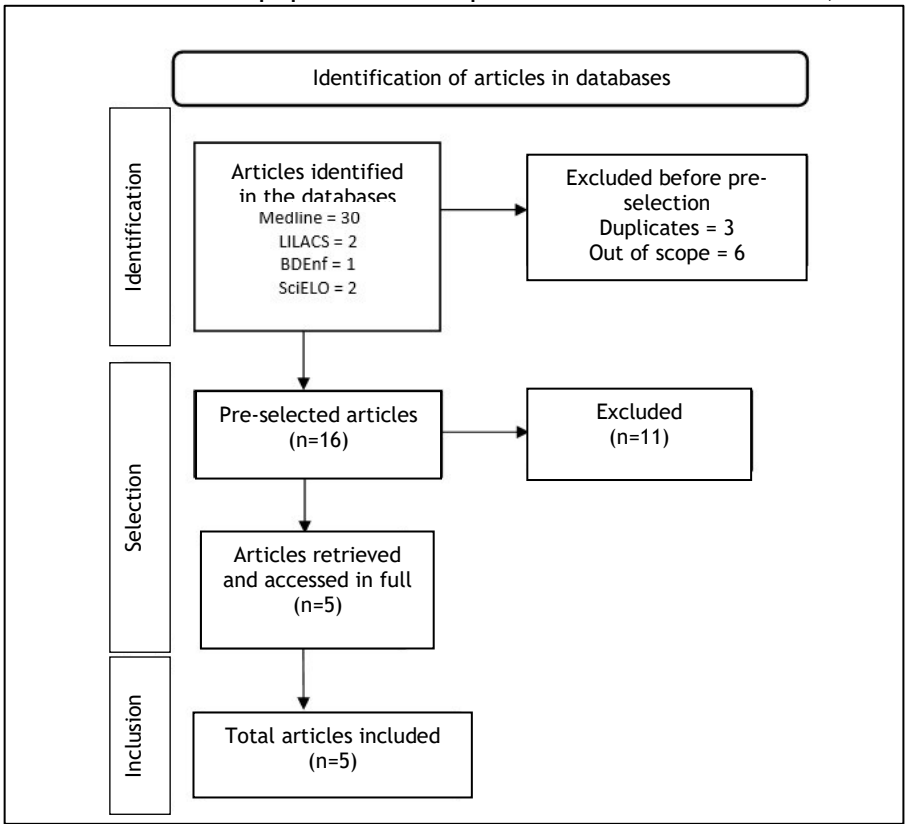
For analysis, articles were included that met the following criteria: published in Portuguese, English and Spanish, with abstracts available in the selected databases, in the period between 2013 and 2022, available in full, online in the selected databases, free of charge to obtain and that addressed the use of photobiomodulation in the treatment of pressure ulcers. The exclusion criteria were dissertations, theses and monographs, abstracts in event proceedings and expanded abstracts. Duplicate articles were also excluded. Information was retrieved from the databases independently by the researchers in March 2023.

In the search, the proposed period of 2013 to 2023 was used, considering that this investigation would not retrieve information, concepts or ideas that could, perhaps, be obsolete or inaccurate, negatively affecting validity and judgments. Obsolete knowledge can even affect the external validity of future studies that use it as a reference (CRITICAL APPRAISAL SKILLS PROGRAMME, 2021).

The articles were then pre-selected by reading the title and abstract, according to the guiding question and the previously defined inclusion and exclusion criteria, and the instrument adapted from the Critical Appraisal Skills Program (CENTER FOR EVIDENCE-BASED MEDICINE, 2009) was used to assess the methodological quality of the articles included. At the end of the evaluation, only publications classified as having good methodological quality and reduced bias remained.

To collect data from the articles, the reviewers themselves prepared an instrument based on one validated by Page MJ, et al. (2021) containing the following items: author/year, study design, synthesis of the study in question and classification of the level of evidence according to Oxford (DORNELLES C, et al., 2012). The selection flowchart is shown (Figure 1).

Figure 1 - Flowchart of the paper selection process. Rio de Janeiro- RJ, Brazil, 2023.



Source: Survey results. Rio de Janeiro, 2023

The bibliographic survey in the databases resulted in the identification of 35 potentially relevant articles, 6 (six) of which were excluded due to their language and 3 (three) due to duplicates. After pre-selection and application of the inclusion criteria, 16 articles were retrieved, of which 5 (five) were accessed after reading the titles and abstracts. Thus, the final sample consisted of 5 (five) publications which were analyzed in full.

To facilitate the analysis and synthesis of the studies, a summary table was constructed consisting of the following items: authors, year of publication, country in which the research was conducted, study objectives, method and results achieved.

From this extraction, the central elements, and units of analysis of each article were evaluated, generating categorization by similarity of the subjects discussed. These categories are presented in a narrative summary.

RESULTADOS e DISCUSSÃO

The results are available in the summary table, as well as the discussion, developed in a descriptive manner, enabling the reader to evaluate the applicability of the integrative review prepared to achieve the objective based on the proposed method, that is, to identify, from scientific publications, the use of Low Intensity Laser for ulcer treatment, providing subsidies for the treatment of pressure ulcers (Figure 2).

As for the year of publication, in 2004 one article (20%), 2017 one article (20%), 2018 two articles (40%) and 2020 one article (20%). The average annual publication for the period studied is 1.25 articles per year. All the articles were published in international journals, highlighting the scarcity of publications on the subject in Brazilian journals.

The results show that effective healing of pressure ulcers is related to laser irradiation at a wavelength of 658nm. Perhaps this effect is related to the inhibition of inflammatory processes in the wound and stimulation of angiogenesis and fibroblast proliferation at this specific radiation (based on both the concentration of interleukins and the serum level of TNF-α and the activities of VEGF, TGFβ1, TNF-α in wound biopsies). Laser therapy at wavelengths of 940 and 808nm does not significantly affect the repair processes, which explains its low effectiveness in treating pressure ulcers. These results demonstrate that the salutary effects of low-intensity laser on wound healing are independent of temperature in this model.

It was also described that the ulcer healed after 30 days of treatment and total epithelialization was observed. Based on the results obtained in this case report, we conclude that the combination of photodynamic therapy, laser therapy and cellulose membrane coating is a promising treatment for PU healing in diabetic patients.

Figure 2 - Summary table of selected articles. Rio de Janeiro- RJ, Brazil, 2023.

Authors/Year	Study design	Applied intervention	Level of evidence
Ruh AC, et al., 2018	Research quantitative	The PUs were irradiated with a low-level laser (InGaAlP, 100 mW, 660 nm), energy density 2 J/cm2 , once a day, at 24-hour intervals, totaling 12 applications. Analysis of the lesion area revealed an average improvement in granulation tissue size of up to 50% from pre- to post-treatment.https://doiorg.ez39.periodicos.capes.gov.br/10.1007/s10103-017-2384-6	4
Lima AMCT, et al., 2020	Research quantitative	Cycles of ischemia-reperfusion were used to cause the formation of PU by the external application of magnetic plates. Immediately after wounding, a suspension of Pantoea agglomerans was applied to the base of all the wounds in the infected groups using a calibrated pipette. PBM (simultaneous emission at 660 and 808 nm, 142.8 J/cm 2, in continuous wave emission mode) was applied to the PUs for 14 sessions. https://doiorg.ez39.periodicos.capes.gov.br/10.1007/s10103-019-02862-w	4
Taradaj J, et al, 2018	Randomized study	The patients received basic treatment, repositioning and mobilization, air pressure mattress and bed support surfaces, wound cleaning and drug therapy. They received laser therapy once a day, 5 times a week for 1 month using semiconductor lasers (GaAlAs) that emitted a	2C

		continuous emission of radiation at separate wavelengths of 940 nm (group A), 808 nm (group B) and 658 nm (group C). In group D (simulated therapy), laser therapy was applied in the same way, but the device was switched off during each session (only the applicator was switched on to scan pressure ulcers using non-coherent red visible light). https://doi-org.ez39.periodicos.capes.gov.br/10.7150/ijms.25651	
Lanzafame RJ, et al., 2004	Randomized study	Pressure ulcers were created in C57BL mice by placing the dorsal skin between two round ceramic magnetic plates (12.0 x 5.0 mm, 2.4 g, 1 K Gauss) for three 12-hour cycles. The animals were divided into three groups (n = 9) for daily phototherapy (830 nm, CW, 5.0 J/cm(2)) on days 3-13 after ulceration in both groups A and B. A special heat exchange device was applied in Group B to maintain a constant skin surface temperature (30 degrees C). Group C served as a control, with irradiation of 5.0 J/cm(2) with an incandescent light source. Skin surface temperature and temperature changes during treatment were monitored. The wound area was measured and the rate and time to complete healing were recorded.https://doiorg.ez39.periodicos.capes.gov.br/10.1089/pho.2004.22.483	2C

Rosa LP, et al., 2017	Case studies	The patient was treated with photodynamic therapy with curcumin and blue light-emitting diodes (LEDs), laser therapy and the application of a cellulose membrane with the aim of promoting local decontamination of the ulcer, accelerating wound healing and maintaining favorable conditions of asepsis and humidity, respectively. https://doiorg.ez39.periodicos.capes.gov.br/10.1016/j.pdpdt.2017.06.011	4

Source: Survey results.

The presence of infection in wounds can lead to increased healing time due to the "paralysis" of epithelial cell repair mechanisms (ANDRADE MC, et al., 2013).

The first studies involving the use of low-intensity lasers to treat ulcers took place between the 1960s and 1970s. Their results with the use of the HeNe laser, with doses of up to 4 J/cm2, were satisfactory for reducing pain and improving healing (ARAÚJO AR, et al., 2008).

After 1970, this technology showed promise in the treatment of various types of ulcerated lesions, especially those that were chronic and had a complex resolution. Despite the evidence shown by studies, there is still no consensus on the type of laser and its most effective wavelength in healing PU (CORRÊA FI, et al., 2019; CAETANO AM, 2019).

In one study, the AlGaInP laser was used to treat PU, all with a wavelength of 660 nm. This study consisted of a randomized clinical trial and had a sample of 8 adult individuals with PU. In this study, eight volunteers, patients from the Santa Casa de Misericórdia Hospital in Ponta Grossa (SCMPG), met the following inclusion criteria: age between 30 and 75, diabetic and pressure ulcer (PU) grade II, III or IV according to the NPUAP (RUH AC, et al., 2017).

The parameters used were a wavelength of 660 nm (InGaAlP), an output power of 100 mW and an energy density of 2 J/cm 2. The Low Intensity Laser was applied around the area of the lesion; a plastic holder attached to the laser tip was used to keep the laser emitter positioned perpendicularly and 0.5 cm away from the tissue, to avoid contact between the laser

probe and the irradiated points. The points were 2 cm apart. The irradiation time at each point was 12 s ((RUH AC, et al., 2017).

The results of this study showed that, macroscopically, there was a reduction in wound size after the Low Intensity Laser. This reduction in wound size was accompanied by an improvement in the biochemical markers involved in the regeneration process which were assessed by qRT- PCR, indicating that vascular endothelial growth factor (VEGF) levels increased after treatment, IL6 levels did not change after treatment, TNF-α levels decreased after treatment and TGF-ß levels increased after treatment.

The AlGaInP laser has a wavelength of 685 nm, operates in the visible light spectrum and its output mode is continuous. Compared to the HeNe laser, the AlGaInP laser penetrates the tissue more deeply (PROCKT AP, et al., 2008).

Another study using male Swiss mice (8-12 weeks old) were housed in a room with controlled temperature (20-24°C) and humidity (45-55%) on a 12-hour light/dark cycle with free access to food and water (LIMA AMCT, et al., 2019).

In this study, for the ischemia and reperfusion-induced injury model, all the animals were anesthetized intraperitoneally with ketamine (150 mg/kg) and xylazine (15 mg/kg), and their dorsums were trichotomized and cleaned. The dorsal skin (epidermis, dermis and hypodermis) was gently pulled upwards and positioned between two circular magnets measuring 8 mm in diameter, 4 mm thick and weighing 1.47 g on average. The compressive pressure generated between the two magnets was greater than 50 mmHg. The magnets were applied for 16 h, followed by a release period of 8 h for 1 cycle, this being considered day 0 (LIMA AMCT, et al., 2019).

Low-intensity laser irradiation of the wound was started 24 hours after the Pantoea agglomerans suspension was applied to the base of all the wounds in the infected + laser group. For the laser group, the irradiation procedure was started 24 hours after wounding. In previous studies, the bacterial suspensions were exposed to single and dual wavelength low-intensity lasers with emission in the red (660 nm; InGaAlP) and infrared (808 nm; AsGaAl) regions and fluence between 35 and 142.8 J/cm2 (Thomé AMC, et al., 2017).

In these studies, PBM with dual-wavelength low-power lasers (808 and 660 nm) at 142.8 J/cm 2 leads to a decrease in bacterial survival rate and biofilm formation ((THOMÉ AMC, et al., 2017; THOMÉ AMC, et al., 2018). In this study, the experiments were carried out using a dual-

wavelength low-power laser with simultaneous emission in the red (660 nm) and infrared (808 nm) wavelengths, a spot size of 0.028 cm 2, an energy of 4 J and a fluence of approximately

142.8 J/cm 2, 20 s per spot, in continuous emission wave mode (power output of 100 mW, power density of 3.571 W/cm 2). Laser irradiation was applied to the central region of the wounds once a day for 14 sessions. The animals were sacrificed by anesthetic overdose 14 days after the injury.

In conclusion, the study suggests that simultaneous exposure to low-intensity red and infrared lasers improves and accelerates wound healing by killing or inhibiting bacteria. Therefore, PBM with simultaneous low-power and wavelength lasers can be considered an option for the treatment of infected pus.

One study recruited sixty-seven patients, treated and analyzed (group A - 940 nm: 17 patients; group B - 808 nm: 18 patients; group C - 658 nm: 16 patients; group D - simulated therapy: 17 patients). All received basic treatment, including repositioning and mobilization, air pressure mattress and bed support surfaces, wound cleaning and drug therapy, as well as receiving laser therapy once a day, 5 times a week for 1 month using semiconductor lasers (GaAlAs) that emitted a continuous emission of radiation at separate wavelengths of 940 nm (group A), 808 nm (group B) and 658 nm (group C). In group D (simulated therapy), laser therapy was applied in the same way, but the device was switched off during each session (only the applicator was switched on to scan pressure ulcers using non-coherent red visible light) (TARADAJ J, et al., 2018).

This study concluded that effective healing of pressure ulcers is related to laser irradiation at a wavelength of 658nm. This effect is believed to be related to the inhibition of inflammatory processes in the wound and stimulation of amphigenesis and fibroblast proliferation at this specific radiation (based on both the concentration of interleukins and the serum level of TNF-α and the activities of VEGF, TGFβ1, TNF-α in wound biopsies). Laser therapy at wavelengths of 940 and 808nm did not significantly affect the aforementioned repair processes, which explains its low efficacy in the treatment of pressure ulcers (TARADAJ J, et al., 2018).

FINAL CONSIDERATIONS

The most relevant findings involve randomized studies. It has also been shown that most of the results show that effective healing of pressure ulcers is related to laser irradiation at a wavelength of 658nm. It is very likely that this effect is related to the inhibition of inflammatory processes in the wound and stimulation of angiogenesis and fibroblast proliferation at this specific radiation (based on both the concentration of interleukins and the serum level of TNF-α and the activities of VEGF, TGFβ1, TNF-α in wound biopsies). Laser therapy at wavelengths of 940 and 808 nm does not significantly affect the aforementioned repair processes, which explains its low efficacy in the treatment of pressure ulcers.

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