

LOW-INTENSITY LASER THERAPY IN THE TREATMENT OF WOUNDS: an integrative literature review**TERAPIA LÁSER DE BAIXA INTENSIDADE EN EL TRATAMIENTO DE HERIDAS: una revisión integrativa de la literatura****LASERTERAPIA DE BAIXA INTENSIDADE NO TRATAMENTO DE FERIDAS: uma revisão integrativa de literatura**Eliézer Bueno-Silva¹Fabíola Iohan²Gisele Cassão³Claudia Capellari⁴

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Authors' contribution

^{1,2} Conception, design of the study

³ Final review and critical participation

⁴ Analysis and interpretation of data

Submission: 06-12-2022**Approval:** 20-12-2022**RESUMO**

Objetivo: Identificar, com base nas publicações científicas, os resultados do uso da laserterapia de baixa intensidade no tratamento de feridas. **Método:** Trata-se de uma pesquisa descritiva tipo revisão integrativa da literatura (RIL). A pesquisa foi realizada por meio de busca eletrônica nas bases de dados: Banco de Dados em Enfermagem (BDENF), Scientific Electronic Library Online (SciELO), Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS), US National Library of Medicine (PUBMED) e Biblioteca Virtual em Saúde (BVS), considerando o recorte temporal de 2007 a 2022. **Resultados e Conclusão:** A maioria dos estudos avaliados, mostraram resultados estatisticamente significativos em variáveis como tempo de cicatrização e fechamento da ferida $p < 0,002$. Outro desfecho significativo foi para o alívio da dor $p < 0,001$, mostrando efeitos analgésicos.

Palavras-chave: Laserterapia; Feridas e Lesões.

ABSTRACT

Objective: To identify, based on scientific publications, the results of the use of low-intensity laser therapy in the treatment of wounds. **Method:** This is research descriptive of the integrative literature review (ILR) type. The research was carried out through an electronic search in the databases: Database in Nursing (BDENF), Scientific Electronic Library Online (SciELO), Latin American and Caribbean Literature in Health Sciences (LILACS), US National Library of Medicine (PUBMED) and Virtual Health Library (BVS), considering the time frame from 2007 to 2022. **Results and Conclusion:** Most of the evaluated studies showed statistically significant results in variables such as healing time and wound closure $p < 0.002$. Another significant outcome was for pain relief $p < 0.001$, showing analgesic effects.

Keywords: Wounds and Injuries; Laser Therapy.

RESUMEN

Objetivo: Identificar, con base en publicaciones científicas, los resultados del uso de la terapia con láser de baja intensidad en el tratamiento de heridas. **Método:** Se trata de una investigación descriptiva del tipo revisión integrativa de la literatura (ILR). La investigación se realizó a través de una búsqueda electrónica en las bases de datos: Database in Nursing (BDENF), Scientific Electronic Library Online (SciELO), Latin American and Caribbean Literature in Health Sciences (LILACS), US National Library of Medicine (PUBMED) y Virtual Biblioteca de Salud (BVS), considerando el período de 2007 a 2022. **Resultados y Conclusión:** La mayoría de los estudios evaluados mostraron resultados estadísticamente significativos en variables como tiempo de cicatrización y cierre de heridas $p < 0,002$. Otro resultado significativo fue para el alivio del dolor $p < 0,001$, mostrando efectos analgésicos.

Palabras clave: Heridas y Lesiones; Terapia por láser.

INTRODUCTION

Wound healing is a complex and dynamic process, comprising overlapping phases of inflammation, granulation tissue formation, and tissue remodeling, and must result in restoring the integrity of the tissue structure, and correcting the damage. ⁽¹⁾

Among the various treatments for wound recovery, there is the application of photobiomodulation or low-intensity laser therapy. The wavelength of these lasers targets the skin's chromophores – structures that act as receptors for heat and energy emitted by the laser's light – such as hemoglobin and melanin, based on the principle of selective photothermolysis. ⁽²⁾

Low-intensity laser therapy is a non-ionizing, collimable, polarized, monochromatic, coherent light that can modify cell behavior to facilitate tissue repair. Its mechanism of action begins during photoreception (during irradiation) and remains until a photoresponse is achieved – at which point light energy is transformed into chemical energy. This, in turn, stimulates the irradiated cells, which can multiply, regenerate or secrete mediators necessary to achieve homeostasis. This therapy also promotes photochemical effects on irradiated tissues, thus helping in wound healing to biostimulate or inhibit processes involved in tissue repair. ⁽³⁾

In addition, photobiomodulation by low-intensity laser therapy has the effect of a photochemical action, which stimulates the production of ATP and suppresses the production of prostaglandins, leading to a

reduction in the inflammatory process. There are also photobiophysical and photobiological effects that stimulate macrophages to release the epidermal growth factor, promoting the proliferation and migration of epithelial cells and keratinocytes. In burn patients, local laser irradiation accelerates the healing process in the graft donor area. ⁽⁴⁾

There is also biostimulation with laser irradiation at the edges of the wound, synthesizing fibronectin, which forms a temporary matrix to which cells can migrate and regenerate, favoring neovascularization. ⁽⁵⁾ These lasers are considered non-ablative, that is, they induce thermal lesions in the microvasculature of the scar, leading to thrombosis and ischemia that results in collagen denaturation and collagen fiber realignment, as in cases of keloids or hypertrophic scars. ⁽⁶⁾ In cases of venous ulcers, there is evidence that this therapy can facilitate the re-epithelialization of chronic wounds, accelerate healing and reduce pain levels. ⁽⁷⁾

Proper assessment of wounds and their healing process is essential in nurses' clinical practice. ⁽⁸⁾ Based on a detailed assessment of the lesions, it is possible to use laser therapy as an adjunct to the healing process.

Therefore, this study aims to identify the effectiveness of treatment with low-intensity laser therapy in the treatment of wounds and what are the possible outcomes for the patient, with the following research question: What were the main results of using low-intensity laser therapy in the treatment of injuries?

OBJECTIVE

To identify the results of the use of low-intensity laser therapy in the treatment of wounds.

METHOD

This is a descriptive research, integrative literature review (RIL) type. The delimitation of the theme refers to low-intensity laser therapy in the treatment of wounds.

The research was carried out through an electronic search in the following databases: Database in Nursing (BDENF), Scientific Electronic Library Online (SciELO), Latin American and Caribbean Literature in Health Sciences (LILACS), US National Library of Medicine (PUBMED) and Virtual Health Library (VHL), considering the time frame from 2007 to 2022.

To search, descriptors were used, registered in the DeCS/MeSH (Descriptors in Health Sciences), in Portuguese, and their correspondents in English, according to the language of the repository. Additionally, the Boolean and connector were used, as follows: “Wounds and Injuries” and “Laser therapy”; “Wounds and Injuries” and “Laser therapy”. As filters in Pubmed, it was used: Free full text, Clinical trial, published in the period of 15 years (2007 to 2022).

As inclusion criteria, it was considered: articles published in Portuguese and English, research available in full and online, articles

written in the period from 2007 to 2022 and, as exclusion criteria: works involving children or adolescents, review articles bibliography, articles involving education for formal teaching in the health area, validation studies of instruments/scales, articles that evaluated only the individuals' knowledge about the disease, editorials, opinion of authorities, reports of committees or specialties.

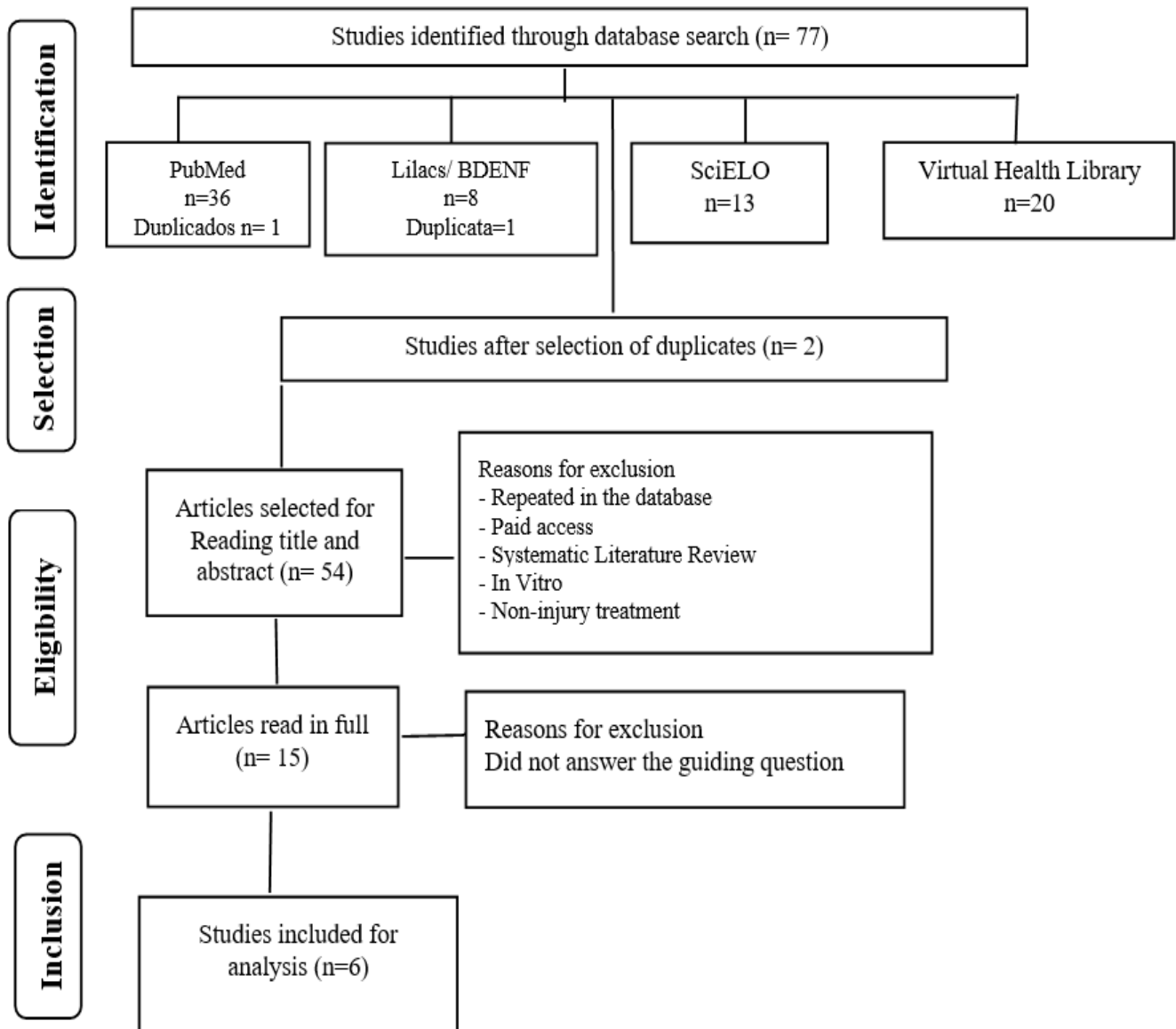
The selection of articles was performed firstly by reading the title, and those selected underwent reading of the abstract. Afterward, the complete reading was carried out.

Because it is a literature review, this work is exempt from submission to the research ethics committee.

RESULTS

The first search performed by reading the title resulted in 77 articles. From the reading of the abstracts, 06 resulted in full reading. Descriptors in Portuguese were used for filtering Scielo, with laser therapy and wounds. The first search performed by reading the title resulted in 13 articles. From the reading of the abstracts, 03 resulted in full reading. In the Lilacs filtering, the descriptors Wounds and Injuries, Laser therapy, Bdenf database, controlled clinical trial, and published in the last 15 years were used. The first search performed by reading the title resulted in 3 articles. After reading the abstracts, they were discarded for not meeting the inclusion criteria. According to the flowchart:

Figure 1 - Flowchart representing the identification, selection and inclusion of studies



From the complete reading of the selected articles, the synoptic table was elaborated (Table 1), which summarizes the information of the studies.

Chart 1 - Synoptic Chart of the Integrative Literature Review on the Use of Low-Intensity Laser Therapy in the Treatment of Injuries.

No.	Country/Author / Journal / Year of publication / Doi	Type of study and approach	Objective	Participants	Interventions	Summary of Results
01	Brazil Osmarin et al., 2021. SciElo https://doi.org/10.1590/0034-7167-2020-1117 (9)	Prospective cohort study, nested within a randomized, quantitative clinical trial.	To evaluate the effects of venous ulcer healing in patients after six months of conventional treatment and adjuvant therapy with low-intensity laser.	38 male and female patients, 19 from GI with 40 VUs and 19 from GC group with 38 VUs. The patients from GI, CG, and RCT were blindly separated by the researchers, using a lottery, and each one of the participants took a card indicating which group they belonged to.	Outpatient follow-up during 16 weeks or until lesion healing. CG - Conventional treatment: removal of the dressing, cleaning with warm 0.9% saline solution in jet, application of different topical products, and technological dressings recommended and available at the institution according to the VU characteristic. Afterward, high compression therapy with a specific elastic bandage was applied. Participants received guidance on diet, hydration, specific calf strengthening exercises, and lower limb elevation during each visit. IG - In addition to the conventional treatment, a weekly application was performed using the Aluminum Gallium Indium Phosphorus Laser - AlGaInP (Po - 30mW), with 660 nm length and 30mW power, by a qualified nurse.	Of the group's GI and CG, there was statistically significant differentiation about gender $p=0.038$, BMI $p=0.049$, and use of analgesics $p=0.038$. At the end of the RCT, the patients in GI had 22 (55%) wounds healed, and the patients in CG had 13 (34.2%) wounds healed, but there was no significance between them. In the evaluation of the follow-up period, 20 (50%) healed wounds were identified in the patients from GI, while in the patients from CG, there were 10 (26.3%), with significance $p = 0.030$. In GI outcome – a decrease in wound size ($p = 0.010$) and scar formation ($p = 0.002$) - was significant between the groups, with better results in GI.
02	Brazil, Bavaresco, Lucena, 2022. SciElo https://doi.org/10.1590/0034-7167-2021-0396 (8)	Prospective cohort study	To compare the effect of adjuvant low-power laser therapy versus conventional treatment alone on venous ulcer healing.	Adult patients (aged 18 years or older) who had active VU and who were available to attend weekly follow-up appointments at the outpatient clinic for 16 weeks or until wound healing.	Both groups received standard treatment according to the institutional protocol, which included cleaning the lesion with warm 0.9% saline in a jet and applying different topical products and technological dressings to correct the humid environment, exudate absorption, and control microbial indicated according	Forty patients participated in the study, of which 20 were allocated to the IG (with 43 UV) and 20 to the CG (with 39 UV). There were 1,066 weekly nursing consultations, 551 for patients in the CG and 515 for patients in the IG, during a follow-up period of up to 16 weeks. Healing of the first GI ulcer was observed in the second

					to the characteristics of the UV bed, border, and perilesional skin. Compression therapy with a standardized elastic bandage and non-pharmacological interventions, such as guidance to alternate isometric exercises and rest, elevate lower limbs, and maintain a healthy diet and lifestyle habits were also evaluation methods. In addition to conventional treatment, GI received adjuvant TLBP. The Aluminum Gallium Indium Phosphorus – AlGaInP (Po – 30 mW) laser was applied, with a length of 660 nm and a power of 30 mW, with an energy variation of 1–3 joules/cm ² . of the wound and occasionally on the perilesional skin of the wound.	week of treatment, with 25 ulcers (58.1%) healed at the end of the study. In the CG, the first ulcer healed only in the seventh week and 13 ulcers (35.8%) healed at the end of the study period. This difference between groups was statistically significant p=0.031. GI had a significant improvement in the overall mean score after Wound Healing: Secondary Intent (1103) compared to CG p1=0.018. In an individual analysis of the indicators of this outcome, statistically, significant differences were observed between groups in four of them, all in favor of GI: decrease in wound size p=0.010, scar formation p=0.034, granulation p=0.010, and exudate p=0.011.
03	Brazil, Carvalho, et al, 2016. SciElo http://dx.doi.org/10.1590/S0080-623420160000500013 (10)	Clinical, experimental, controlled, randomized, prospective, interventional, quantitative case study	To evaluate the effects of Low-Intensity Laser Therapy alone and associated with Calendula officinalis oil in the repair of diabetic foot ulcers.	Consisting of 32 patients. The eligibility criteria were decompensated type II diabetic patients, of both genders, aged between 40-70 years, with fasting blood glucose between 150 and 350 mg/dL, with lower limb ulcers, and being followed up at the diabetic foot outpatient clinic.	They were randomly distributed into four groups: 1. Control (C) 2. Low-Level Laser Therapy (LTBI) (L) 3. Essential fatty acids (AGE) and 4. TLBI associated with AGE (LAGE). They underwent an evaluation with the angiologist who characterized the ulcer through clinical evaluation, Doppler Ultrasonography (US), and Ankle-Brachial Index (ABI). They passed through the physiotherapist consisting of personal and historical data regarding Diabetes and lower limb ulcers through a specific evaluation form. After 30 days, they returned to the physiotherapy service for reassessment with US Doppler, ITB, pain	Data related to the quantitative perception of pain by the participants based on the application of the Brief Pain Inventory and the VAS analog scale show that there was a significant reduction in pain in groups L (p<0.001) and LAGE (p<0.001), corroborating that laser therapy it has an analgesic effect when isolated or associated with Calendula officinalis oil. There was a significant reduction in the wound area in the LAGE group (p=0.0032) and in the L group (p=0.0428). Group C showed significance contrary to the objective (p=0.3402) due to intervention absenteeism. There was a



					<p>scales, and macroscopic images.</p> <p>Participants in Group L underwent the following protocol: 658 nm, 30mW power, 80s application time (4 J/cm²), continuous wave, and visible beam, in an area equivalent to 12,566 mm². For LLLT purposes, the pen was held straight to the wound with point contact and at points the same distance around and on the wound bed. The wound was protected with transparent film. Initially, the wound was cleaned with sodium chloride solution (0.9% saline solution), removing excess with sterile gauze. A total of 12 meetings were held, corresponding to 3 weekly sessions, on alternate days. For the AGE group, the therapeutic protocol implemented was: wound washed daily with sodium chloride solution (0.9% saline solution), removing the excess with the aid of sterile gauze. Subsequently, 5 mL of calendula oil was applied once a day for 30 days.</p> <p>For the LAGE group, LLLT* was applied first according to the protocol mentioned in the L group, and subsequently, calendula oil was applied as described for the AGE group, followed by dressing. The oil was applied during the 30 days of the therapeutic protocol for this group; oil was eventually applied on days when LLLT was not applied.</p>	<p>decrease in pain in the Low-Intensity Laser Therapy and Low-Intensity Laser Therapy associated with Essential Fatty Acids groups, with p<0.01. Regarding ABI and US Doppler, all groups remained unaltered. In the analysis of the decrease in the area of the lesion, the Low-Intensity Laser group associated with Essential Fatty Acids, the sample was significant p=0.0032, and the Low-Intensity Laser group was significant, being p=0.0428.</p>
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04	<p>Brazil, Shim, et al. 2015. PubMed https://doi.org/10.1155/2015/825309 (11)</p>	Prospective cohort	<p>Fractional laser treatment in the early postoperative period has been used to reduce scarring in many institutions, but the most effective energy parameters have yet to be established. This study sought to determine effective parameters in the treatment of facial laceration scars.</p>	<p>57 patients with Fitzpatrick skin types III–V were enrolled. All patients with facial lacerations sutured primarily in the emergency room by the same senior chair of the plastic surgery department were considered candidates. Patients aged between 15 and 50 years were included. The facial laceration was defined as a laceration within a limited area bounded by the forehead hairline, the preauricular area, and the mandibular angle to the chin. Patients with a subcutaneous facial laceration uniformly deep along the length within 6 cm representing a relatively clean cut without maceration were included.</p>	<p>Laser treatment began approximately 4 weeks after primary closure. The surface was cleaned with chlorhexidine solution and EMLA cream (a lidocaine-based topical anesthetic cream) was applied for 30 minutes before treatment. After removing the anesthetic cream, the scar was treated with a 1,550 nm fractionated erbium-glass laser. All patients underwent 4 sessions at 4-week intervals. In each session, the laceration was divided in half and each half was treated with different parameters: low energy portion (L portion), fluence of 10 mJ/point and density of 200 points/cm, and high energy portion (H portion).) 50mJ/point 40 points/cm², the laser starts automatically upon contact with the skin and stops at the end of each session after delivering a set of energy; therefore, the applicator does not need to control the repetition rate or pulse duration.</p>	<p>In all patients, the change observed in the H portion was significantly greater than that observed in the L portion, which suggests that the most effective scar management was achieved in the H portion. P=0.038. Complications included erythema, inflammation, discharge, and thermal or radiation burn. However, all complications were resolved with conservative treatment. Portions treated with a high fluency parameter showed a greater difference in pre-treatment VSS* scores and overall assessment values, indicating positive esthetic results.</p>
05	<p>Brazil, Dogan, Evcik, Ay, 2010. PubMed https://doi.org/10.1590/S1807-59322010001000016 (12)</p>	Randomized clinical trial	<p>To investigate the effectiveness of 850 nm gallium aluminum arsenide (Ga-As-Al) laser therapy on pain, range of motion, and disability in subacromial impingement syndrome.</p>	<p>A total of 52 patients (33 women, 19 men) with a mean age of 53.59±11.34 years with SAIS* were included in the study. The diagnosis of SAIS was made according to a detailed physical and neurological examination. After physical examination, magnetic resonance imaging (MRI) was performed to exclude rotator cuff injuries. Complete blood count, biochemical markers, erythrocyte sedimentation rate,</p>	<p>The gallium-aluminum-arsenide diode laser (GaAlAs, infrared laser) with a wavelength of 850nm, power of 100 mV, continuous wave, and laser spot area of 0.07 cm² was used for laser therapy. The laser was applied at a dosage of 5 joule/cm² (15–20 joule in total) on a maximum of 5–6 painful points for 1 minute at each point on the subacromial region of the shoulder. The placebo laser was applied in</p>	<p>In group I, after therapy, statistically significant improvements were observed in pain severity, ROM* except internal and external rotation, and SPADI* scores compared to baseline scores p < 0.05. In Group II, all parameters except external rotation ROM have improved p<0.05. However, no significant differences were recorded between groups p>0.05.</p>



				and C-reactive protein were also evaluated.	the same way, but the device was turned off during the treatment sessions. Patients and the physiotherapist were asked to wear protective eyewear during therapy for safety. Cold compress therapy for 10 minutes was applied to all patients in both groups. Patients also received an exercise program that included a range of motion, stretching, and progressive resistance exercises. Each exercise was performed once a day with 10-15 repetitions. The therapy program was applied 5 times a week, once a day for 14 sessions.	
06	Brazil, Alvarenga, 2016 id: biblio-1150390	Randomized, parallel, triple-blind clinical trial	To evaluate the effects of low-intensity laser on the healing of the perineal region, and on the frequency and magnitude of perineal pain, after right mediolateral episiotomy.	A sample of 54 puerperal women, was divided into an experimental group (received laser irradiation) and a control group (received irradiation simulation). The puerperal women were included in the study between 6 and 10 hours after delivery in the Rooming-in Room of the University Hospital of the University of São Paulo. Inclusion criteria were: age 18 years, gestational age 37 and <42 weeks; no previous vaginal delivery; spontaneous delivery of a single fetus, live and in cephalic presentation, with right mediolateral episiotomy; absence of infectious process, hemorrhoids, hematomas or varicose veins in the vulvoperineal region; not having prepared the perineal region during pregnancy; not	The laser consisted of three irradiations (1st: from 6 to 10 hours after delivery, 2nd: 20 to 24 hours, and 3rd: 40 to 48 hours after the first application), with an infrared diode laser, active semiconductor medium Gallium-Aluminum-Arsenide (GaALAs), spot size 0.04 cm ² , energy density 5J/cm ² , power 20mW, irradiation duration 10 seconds per spot. In each session, the episiotomy was irradiated at nine different points, with 0.2J per point and total energy of 1.8J per session.	As for healing, the groups did not differ on the REEDA scale in any of the assessments. As for the means of perineal pain, the groups differed on the following occasions: the experimental group presented higher means of pain in the evaluation before (experimental group 4.5; control group 2.0; p=0.002), after the first irradiation (experimental group 4, 1; control group 2.0; p=0.008), and after the third irradiation (experimental group 1.5; control group 0.6; p=0.019). As for the presence of pain, there was no significance between the groups at different evaluation times.



				<p>having used photosensitizing drugs and without clinical or obstetric interurrences. Women who used any product other than soap and water in the vulvoperineal region were excluded from the study.</p>		
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Source: The authors, 2022. UV: venous ulcer. CG: Control Group. IG: Intervention Group. RCT: Randomized Clinical Trial. REEDA: Redness, Oedema, Ecchymosis, Discharge, Approximation. LLLT: Low-Level Laser Therapy. SAIS: Subacromial Impingement Syndrome. ROM: Range of Motion, VSS: Vancouver Scar Scale. SPADI: Shoulder Pain and Disability Index.



DISCUSSION

According to the articles read in full, it was possible to identify that most of them presented expressive differences when conventional treatments were compared with those that additionally employed low-intensity laser therapy treatment. The results showed that the patients in the intervention groups obtained satisfactory results about conventional therapies such as various dressings and related ones.

In the treatment of wounds, it is necessary to use standardized and reliable evaluation instruments for the tissue repair process, the effect of low-intensity laser therapy in studies with more robust designs, which are capable of evaluating and describing, reliably demonstrating the effects of this therapy to produce high-level evidence in wound care research. ⁽¹⁴⁾

The outcomes that showed statistical significance are related to healing time and wound reduction, as observed in a cohort study, which evaluated venous ulcer healing in patients with adjuvant laser, the Intervention Group (IG) had a $p = <0.002$, compared to the Control Group (CG). It was also observed that the outcomes of scar formation, granulation, and exudate obtained static significance compared to the CG, with $p = <0.034$, $p = <0.010$, and $p = <0.011$, respectively. ⁽⁹⁾

In one study, regarding wound healing, they were satisfactory, even when statistically there was no significance in any of the groups compared, with $p > 0.05$. ⁽¹²⁾ Findings from a study, it was seen that a laser with a high-energy

portion is more effective in lesions, being significantly greater than the low-energy portion, with $p < 0.038$. In the study, there were still some complications, but they were all resolved with conservative treatment. ⁽¹¹⁾

As observed in a study that investigated a significant outcome with low-power laser therapy, it was pain, with $p = <0.001$, showing isolated analgesic effects or associated with herbal medicines. ⁽¹⁰⁾ Thus, studies have shown that low-level laser therapy, in addition to being a promising method of treatment, improves and reduces tissue regeneration time, contributing to advances in the treatment of wounds.

CONCLUSION

Through the evaluated studies, it can be observed that the use of low-intensity laser therapy is effective in the treatment of wounds, and may become one of the main interventions carried out for the treatment of wounds, or used as an adjuvant to the treatment carried out with dressings and correlates, aiming at the improvement of the patient.

The readings carried out brought us points favorable to the use of low-intensity laser therapy in lesions, however, studies involving human beings with these characteristics are still scarce. With this, it is hoped that this review can help clarify and encourage researchers to seek and specialize even more in this study, bringing new research and scientific evidence, and corroborating the treatment of wounds.

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