Effects of photobiomodulation in the treatment of pressure sores

Efeitos da fotobiomodulação no tratamento de lesões por pressão

Efectos de la fotobiomodulación en el tratamiento de las lesiones por presión

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Abstract
Pressure ulcers (PUs) are a cause of concern in health care institutions due to the negative effects they cause to patients, such as pain, infection, and delayed functional recovery. From this perspective, in order to accelerate wound healing, more current treatments are being explored. Among these treatments, the photobiomodulation (FBM) offered by low power laser therapy (LBP) stands out. Given the above, this paper aims to analyze the effects of photobiomodulation in the treatment of PUs. This is an integrative literature review, with searches carried out in MEDLINE, SCIELO and BDENF databases, in which complete papers were included, in Portuguese and English, available electronically and free of charge, published from 2015 to 2021 and that addressed the proposed theme. Studies that did not address the subject of interest or did not answer the guiding question were excluded, as well as duplicate publications in more than one database. The study was composed of the analysis of 8 publications. The findings showed that this therapy contributes to pain reduction, increases local vascularization and accelerates the process of tissue healing, favoring a positive evolution during the treatment of injuries. Thus, it is emphasized that the use of MBP is of paramount importance for the treatment of PUs, because when used in the correct manner, with a qualified professional, it presents positive results in the healing period of the lesion, regardless of the type of associated dressing.

Keywords: Pressure ulcer; Laser therapy; Wound healing; Treatment outcome.

Resumen
Las lesiones por presión (LPs) son motivo de preocupación en las instituciones de salud debido a los efectos negativos que causan en los pacientes, como dolor, infecciones y demora en la recuperación funcional. De esta perspectiva, en el intento de acelerar la cicatrización de las heridas, se están explorando tratamientos actuales. Entre estos tratamientos, se destaca la fotobiomodulación (FBM) ofrecida por la terapia láser de baja potencia (LBP). A partir de la exposición, este trabajo tiene como objetivo analizar los efectos de la fotobiomodulación en el tratamiento de lesiones por presión. Se trata de una revisión integrativa de la literatura, en la que se incluyeron trabajos completos, en portugués e inglés, disponibles en formato electrónico gratuito, publicados entre 2015 y 2021 y que abordaban el tema propuesto. Se excluyeron los estudios que no abordaban el tema o no respondían a la pregunta guía, así como las publicaciones duplicadas en más de una base de datos. El estudio se compone del análisis de 8 publicaciones. Los resultados mostraron que esta terapéutica contribuye a la reducción del dolor, aumenta la vascularización local y acelera el proceso de curación de las lesiones. Así, se destaca que el uso de la FBM es de suma importancia para el tratamiento de las LPs, ya que, cuando se utiliza de forma correcta, con un profesional cualificado, presenta resultados positivos en el periodo de curación de la lesión, independientemente del tipo de apósito asociado.

Palabras clave: Úlceras por presión; Terapia a laser; Cicatrización de heridas; Resultado del tratamiento.
1. Introduction

In 2016, the National Pressure Ulcer Advisory Panel (NPUAP) changed the terminology from pressure ulcer (PU) to pressure ulcer injury (PLI). Thus, throughout the text both terms are applied in order to respect the title of the selected papers. Pressure ulcers (PUs) are defined as an injury to the skin and/or underlying soft tissue that is usually over a bony prominence or associated with medical devices or other artifacts (National pressure ulcer advisory and pan pacific pressure injury alliance, 2015).

These injuries generate concern in health care units because of the negative effects they cause in patients, such as pain, infections and delay in functional recovery. In addition, they cause increased morbidity and mortality, prolonged hospitalizations and, consequently, higher costs for institutions (Galetto et al., 2019).

Macedo et al., (2021) emphasize that this type of injury has a multifactorial cause, and may be related to intrinsic and/or extrinsic factors. Intrinsic factors include age, malnutrition, changes in body mass, obesity, vasomotor insufficiency, peripheral vasoconstriction, existence of chronic diseases, and urinary and fecal incontinence; and extrinsic factors include high temperature, increased humidity, friction, and shear.

As for the LPs classification, they may vary from stages 1 to 4, and may still be considered as unclassifiable pressure ulcers and deep tissue pressure ulcers. Such categorization will depend on the damage and tissues affected, and may compromise skin, muscles, and even bones. It is emphasized that depending on the depth and degree of the LP, several problems may arise, such as: sepsis, osteomyelitis, social isolation and reduced quality of life of the patient (Galetto et al., 2019; Loudet et al., 2017; Nogueira; Caliri & Santos, 2002).

Therefore, it is important that during the evaluation of LPs, pain, pulse, exudate characteristics, size and depth of the wound, as well as signs indicating infection are taken into consideration. Therefore, these factors are relevant for an appropriate treatment approach, in which the wound healing process is considered an ongoing and, in some cases, prolonged treatment. It should be noted that the healing process, in most cases, is complex, with the appearance of cellular and vascular modifications, production and deposition of collagen, synthesis of elastin, cell proliferation, revascularization, until the reduction of the wound (Lucio & Paula, 2020).

One of the most implemented treatments is dressing with different coverings, however, the advantage of healing in the medium and long term will depend on the size and depth of the lesion, as well as the clinical condition of the patient. From this point of view, in order to accelerate wound healing, more current treatments are being explored. Among these treatments, photobiomodulation (FBM) offered by low-power laser therapy (LBP) stands out (Macedo et al., 2021).

Photobiomodulation with LBP has been employed in treatments of traumatic ulcers and chronic wounds with positive results. Due to its photochemical, photophysical and otobiological effects, the behavior of cells can be changed and, consequently, contributing to tissue repair, reduction of pain and edema, as well as anti-inflammatory effects, formation of new blood vessels, immune response and increase of fibroblasts (Macedo et al., 2021; Ribeiro & Marangoni, 2020).

Given the above, this study aims to analyze the effects of photobiomodulation in the treatment of PUs.

2. Methodology

This is an integrative review of literature, qualitative in nature, developed from qualitative data from studies through a systematic search on the effects of photobiomodulation in the treatment of PUs. The review followed the steps described by Mendes et al., (2008): 1) Choice of the theme and elaboration of the guiding question; 2) Definition of the inclusion and exclusion criteria; 3) Characterization of the information to be obtained from the selected articles; 4) Analysis of the chosen articles; 5) Interpretation of the collected results; 6) Presentation of the review and summary of knowledge. For Pereira et al.,
(2018), qualitative methods are essential for the researcher to know how to interpret with their opinions regarding the studied phenomenon.

At first, the theme established was the effects of photobiomodulation in the treatment of pressure injuries. Subsequently, the guiding question was elaborated: What are the effects of photobiomodulation in the treatment of pressure sores? Next, data collection was carried out in the Medical Literature Analysis and Retrieval System Online (MEDLINE), Scientific Electronic Library Online (SCIELO) and Nursing Database (BDENF) databases.

The terms used for the search were selected using the Descriptors in Health Sciences (DECS): “pressure ulcers” and “laser therapy” and “wound healing” and “treatment outcome”, in order to carry out an integrated search, the connective “and” was used, bringing together the descriptors.

In addition, the PICO strategy was used, where the Population (P) was defined: individuals with PUs; Intervention (I): use of photobiomodulation; Comparison (C): treatment of PUs by photobiomodulation; Outcomes (O): to reduce the healing time of the lesions. This is a strategy used to elaborate the guiding question and to search for scientific evidence in the literature (Santos et al., 2007).

Regarding the inclusion criteria, we included complete papers, in Portuguese and English, available electronically and free of charge, published between 2015 and 2021 and that addressed the proposed theme. Studies that did not address the subject of interest or did not answer the guiding question were excluded, as well as duplicate publications in more than one database.

**Figure 1.** Flowchart of the papers found in the researched databases.

![Flowchart](source: Authors (2021)).

After a thorough reading of all complete articles, a data collection tool was applied, containing the following topics:
title, authors, year of publication, type of study, objectives, and conclusion (Souza, Silva & Carvalho (2010)).

3. Results and Discussion

After selecting and reading the articles resulting from the search in the databases through the associated descriptors, a table was produced to display the research covering information such as title, authors, year, type of study, objectives, and conclusion. It is worth mentioning that the articles were selected and analyzed aiming to answer the study's guiding question. A total of eight articles were identified and selected from an extensive review following the methodological steps mentioned above. Subsequently, a discussion was held about the theme addressed in this research, in order to bring evidence on the use of photobiomodulation in the treatment of LPP, and how this method influences the healing process.

Table 1 - Characterization of the articles included in the integrative review according to the title, authors, year, type of study, objectives, and conclusion.

| Title | Authors/Year | Type of study | Goals | Conclusion |
|-------|--------------|---------------|-------|------------|
| The effectiveness of laser associated with different types of dressings in the healing of pressure ulcers | De Bortoli, Prato & Kroth (2016) | Randomized Clinical Trial | To verify the effectiveness of laser therapy associated with different types of dressings in patients of a university hospital | Regardless of the type of dressing used, low frequency laser therapy has shown positive results for patients. |
| Evaluation of the effect of photobiomodulation in traumatic ulcer in children: clinical case report | Ribeiro & Marangoni (2020) | Clinical case report | To evaluate the effect of photobiomodulation on a traumatic ulcer in a child patient | Low intensity laser has the potential to treat traumatic injuries, reducing pain and discomfort and accelerating the healing of traumatic ulcers. |
| Effects of photobiomodulation in the treatment of pressure ulcers: an integrative review | Macedo et al., (2021) | Integrative review | To evaluate the effects of photobiomodulation with low power laser in the treatment of pressure ulcers | Photobiomodulation with low power laser in the treatment of pressure ulcers, in association or not with adjuvant therapies are effective in the treatment of lesions. |
| Effects of laser therapy in the treatment of PUs: a systematic review | de Oliveira Bernardes & Jurado (2018) | Systematic review | To study the efficacy of laser therapy in the healing process of PUs | The low power laser shows itself as a favorable treatment for wound healing, because it increases the healing speed, improves the microcirculation and reduces the expenses with conventional coverings |
| Photobiomodulation in the healing process of injuries: a case study | Lucio & Paula (2020) | Case Study | To present the case of a diabetic patient with varicose ulcer, who underwent treatment with laser therapy and high-tech dressings | The laser therapy treatment was effective and applied by a qualified professional was a safe treatment, bringing positive results to the patient. |
| Photobiomodulation in the treatment of pressure ulcers: a review of the literature | de Oliveira et al., (2019) | Literature review | Analyze the effects of photobiomodulation in the treatment of pressure ulcers | Photobiomodulation is shown to be an effective therapy in the treatment of pressure ulcers, being effective in reducing pain, increasing local vascularization, and accelerating the healing process of the tissue. |
Impact of low-level laser therapy on the dynamics of pressure ulcer-induced changes considering an infectious agent and cathelicidin LL-37 concentration: a preliminary study

Brauncajs et al., (2018)

Preliminary Study

Investigate the impact of low-level laser therapy on pressure ulcer dynamics considering an infectious agent and cathelicidin LL-37 concentration

Low-level laser therapy has potential benefits in combating the pathogens that infect pressure ulcers.

Laser therapy in pressure ulcers: assessment by Pressure Ulcer Scale for Healing and Nursing Outcomes Classification

Palagi et al., (2015)

Case Study

To describe the healing process of pressure ulcers in critically ill patients treated with conventional healing therapy plus low intensity laser therapy as assessed by the Pressure Ulcer Scale for Healing (PUSH) and the Wound Healing Score

There was improvement in the pressure ulcer healing process treated with adjuvant Low-Level Laser Therapy (LLLT) and the use of NOC enabled a more thorough and accurate assessment than PUSH

3.1 Morpho-physiological evolution of lesions during laser treatment and associations

The study by Bortoli, Prato and Kroth (2016) was a clinical study, with a sample of six patients with PU. They were divided into two groups, in which group 1 used as therapy the AlGaInP laser, 660 nm 4J/cm² low power pen, along with a essential fatty acid coverings. And group 2 used the same parameters of the laser, but with papain as coverings. During the analysis of the results, it could be observed that the wounds in which the oil lotion based on Essential Fatty Acid (EFA) with laser therapy was used presented a greater reduction in the area and physical aspects of the skin, such as color, vascularization, and absence of devitalized tissue on the edges; when compared to the wounds treated with papain, an improvement in the healing process was noted, however, a regression in the general condition of the skin, with alterations in color and the presence of devitalized tissue on the edges of the wounds.

Palagi et al., (2015), conducted a case study, in which the patient presented LPP, and after 15 days of treatment with Low Intensity Laser (LLLT), it was observed that the dimensions of the lesion reduced from 7 cm to 1.5 cm in length and from 6 cm to 1.1 cm in width, in addition to the reduction of secretion and odor, and significant increase in epithelial and granulation tissue. Concluding, therefore, that the intervention with LLLT accelerated tissue proliferation, besides increasing local vascularization, forming granulation tissue by promoting rapid healing of the lesion. It is noteworthy that the coverings used was in accordance with the protocol of the institution, including the use of heated 0.9% saline solution, used for hygiene of the lesion and specific coverings used according to the evolution of the lesion, such as zinc oxide, medium chain triglycerides, hydrogel and silver alginate, along with LBP.

In the study by Lucio and Paula (2020) they report the treatment of a lesion in a 67-year-old patient with diabetes mellitus and hypertension. The treatment was the use of LBP together with silver hydrofilm and hydrogel with calcium and sodium alginate. After 55 days of treatment, there was a gradual improvement of the devitalized tissue, and thus total retraction of the lesion, occurring the healing process. Corroborating these findings, de Oliveira Bernardes and Jurado (2018) address that the healing period in elderly individuals is possibly reduced, due to the aging process. Besides being more vulnerable to the emergence of ulcers for other reasons, as in the case of diabetic wounds.

Ribeiro and Marangoni (2020), concluded through a case study carried out in an 8-year-old child with traumatic ulcer, that photobiomodulation is an effective method in the treatment of this ulcer, because after starting treatment by irradiation
with LLLT for analgesia and aid in the healing of the lesion, it was observed an immediate positive result after irradiation, in which the patient reported an improvement in pain. After 9 days, there was total repair of the lesion, and a score of 3 in relation to pain, showing an improvement with regard to the evolution of the traumatic ulcer.

Corroborating with the studies cited, de Oliveira et al., (2019), it was possible to observe several methodological strategies regarding the protocol for treatment with photobiomodulation, however, in all the manuscripts analyzed, it was noted an outcome presenting expressive improvement in the painful picture and in the healing process of the lesions regardless of the therapy used. Complementarily, despite the differences in treatment protocols and strategies, the findings indicate that photobiomodulation contributes to pain reduction, besides increasing local vascularization and accelerating tissue healing, contributing to a positive evolution during the treatment of PUs.

3.2 Multidimensional effectiveness of photobiomodulation in the healing process

In the research conducted by Macedo et al., (2021), concluded that photobiomodulation with LBP in the treatment of PU, associated or not with adjuvant therapies, such as essential fatty acid based coverings and microcurrent are effective in treating lesions. The efficacy was described in all groups evaluated with LBP with a wavelength in the 660 nm range (red) and a dose of 4 J/cm². This shows that the various approaches expose the heterogeneous nature of the studies, and that there is no effective standardization of the type of laser used, as well as the exposure time and periodicity.

The study by Palagi et al. (2015), brings as a possibility the use of LBP in protocols for the treatment of PU, because through this case study, associated with the literature, it could be observed that this method accelerated tissue proliferation, in addition to increasing local vascularization, favoring a rapid healing of the lesion. Through this study, we concluded on the effectiveness of the use of LBP in the process of pressure ulcer healing, and this therapy should be highlighted as an effective alternative in the treatment of PUs in a critically ill patient.

According to Ribeiro and Marangoni (2020), the present study points to photobiomodulation as an analgesic and reparative alternative for the treatment of traumatic ulcers. In agreement with this study, Lucio and Paula (2020), point out that the use of laser therapy is of paramount importance during the wound healing process, because it is a method that through its anti-inflammatory, analgesic and tissue repair action, provides improvement in the patient's well-being and possibly causes a positive impact on their quality of life. In this study, the treatment using laser therapy proved to be an effective resource, and that when performed by a trained professional, it becomes a safe treatment, showing a significant improvement in the patient's condition.

In this same sense, the study by de Oliveira Bernardes and Jurado (2018) shows that the healthcare professional must have knowledge about the theoretical basis of laser therapy, in addition to the purpose of the laser, because this way the treatment will become effective and obtain the maximum therapeutic benefit. It is noteworthy that according to this study, the use of LBP is capable of reducing the number of bacterial colonies present in pressure lesions.

These findings corroborate with Brauncajs et al., (2018) in which they bring in their study that LBP therapy has potential benefits in combating pathogens that infect pressure ulcers. In agreement with these findings, de Oliveira et al., (2019) point out that photobiomodulation is taken as an effective therapy with regard to the treatment of pressure ulcers. Thus, suggesting that it should be considered as a treatment method for these disorders, reducing the length of hospital stays.

4. Conclusion

Therefore, the use of photobiomodulation with LBP is of paramount importance for the treatment of PUs, because when used correctly, by a qualified professional, it presents as a positive result in the healing period of the lesion, regardless of the type of associated dressing. Furthermore, it is important to highlight the need for this therapy to be implemented in the
treatment of this type of disease, as it was observed that it contributes significantly to improving the quality of life of patients, besides possibly reducing the length of hospital stays.

Furthermore, it is necessary to develop irradiation protocols that can elucidate the correct dose for each case, increasing the credibility of this type of therapy. More studies focused on this theme are essential, because through these findings, it is noted that photobiomodulation has been a promising method in the treatment of wounds, considering that it increases the speed of healing, promotes analgesia, improves circulation, and reduces the cost of conventional dressings. Thus, it is recommended that clinical studies be developed in different scenarios, seeking to bring more evidence regarding the treatment using LBP in the healing process of injuries, which would result in a standardization of the indication of this method.

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