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Low-Level Laser Therapy Protocols for Dentistry: an integrative review

Protocolos de Laserterapia de Baixa Potência para Odontologia: uma revisão integrativa

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ABSTRACT

The interest in the uses and effects of low-level laser therapy has significantly increased in dentistry. This study aimed to indicate the ways of use, dosimetric parameters, and modes of application of laser therapy. An integrative review of the literature was conducted on scientific articles and publications of interest regarding the use of laser therapy and protocols for the treatment of oral conditions. From the analysis of the selected articles, it is concluded that low-level laser therapy is a safe and effective alternative in the treatment of oral lesions. It is worth noting that none of the analyzed articles presented all the necessary dosimetric parameters for future experimental studies to be clinically reproducible, thus posing an obstacle in the formulation of a universal dosimetric protocol.

Keywords: Low-level laser therapy; Photobiomodulation; Antimicrobial photodynamic therapy; Dentistry;

RESUMO

O interesse pelos usos e efeitos da laserterapia de baixa potência tem aumentado significativamente na odontologia. O presente trabalho teve por objetivo indicar as formas de uso, os parâmetros dosimétricos e modos de aplicação da laserterapia. Foi realizada uma revisão integrativa da literatura em bases de dados de artigos científicos e publicações de interesse, sobre o uso da laserterapia e protocolos para tratamento de afecções bucais. A partir da análise dos conteúdos dos artigos selecionados, conclui-se que a laserterapia de baixa potência é uma alternativa segura e eficaz no tratamento de lesões bucais. Vale ressaltar, ainda, que nenhum dos artigos analisados apresentou todos os parâmetros dosimétricos indispensáveis para que estudos experimentais futuros consigam ser reproduzidos clinicamente, sendo, então, um obstáculo na formulação de um protocolo dosimétrico universal.

Palavras-chave: Laserterapia de baixa potência; Fotobiomodulação; Terapia fotodinâmica antimicrobiana; Odontologia;

INTRODUCTION

In recent years, the evolution of scientific knowledge has enabled light-based technologies to be present in the clinical routine of various health specialties. One of the observed advances relates to laser therapy, which combines its characteristics and its interaction with the biological system, assisting therapeutically and diagnostically, when light interacts with the tissue and when the tissue affects the light, respectively (SRIVASTAVA & MAHAJAN 2014).

Light therapy, also known as phototherapy, is a widely used resource since ancient times, in which people from ancient civilizations, such as the Egyptians, Greeks, and Aztecs, benefited from exposure to sunlight in association with herbal poultices for the treatment of certain skin conditions. However, it was only in 1960 with the development of the laser that light began to be studied with a therapeutic and diagnostic focus. The word laser is an acronym for "light amplification by stimulated emission of radiation," that is, amplification of light by stimulated emission of radiation. Its use is based on the interaction of light with biological cells and tissues in the generation of clinically relevant phenomena, and its applications can be divided into two aspects: high-power lasers, generally used for cutting, removal, and tissue coagulation, and low-power lasers, commonly used in tissue repair processes and analgesic action (NADHREEN, ALAMOUDI & ELKHODARY, 2019; NUNEZ, GARCEZ & RIBEIRO, 2022).

In dentistry, the use of low-level laser therapy (LLLT) encompasses photobiomodulation (PBM) and photodynamic therapy (PDT), which use visible light

and infrared (IR) to induce biological responses through non-thermal effects (photophysical, photochemical, and/or photobiological). In PBM, red or infrared light is used at wavelengths of 600-700 nm and 700-1000 nm, respectively, with the aim of precipitating wound healing processes, modulating inflammation, and generating analgesia.

PDT uses photosensitizers (0.01% or 0.005% aqueous solution of methylene blue and 1.5% curcumin) to absorb light and induce chemical reactions in the target tissues, producing a bactericidal effect through oxidative stress. Thus, PDT presents itself as an alternative to conventional treatment methods for orofacial infections, in which the infections are mostly localized and shallow, facilitating the action of light and the arrival of the photosensitizer (NUNEZ, GARCEZ & RIBEIRO, 2022).

In clinical practice, these therapeutic modalities find an important place in the prevention and treatment of oral conditions, such as mucositis, canker sores, paresthesia, temporomandibular joint dysfunction, neuralgia, xerostomia, pericoronitis, alveolitis, trismus, osteoradionecrosis, and post-surgical treatment through their analgesic, anti-inflammatory, and tissue biomodulation effects, in addition to being a non-traumatic, low-risk, cost-effective, broad-spectrum therapy without drug interactions or adverse reactions (SANTOS; SANTOS & GUEDES, 2021).

Faced with new technologies that enable more comfortable, less invasive, and painful procedures, laser therapy gains ground in Dentistry as an alternative treatment option with numerous documented benefits for the irradiated tissues, such as activation of local microcirculation through stimulation for the formation of new blood vessels, analgesic and anti-inflammatory effects, and cellular regeneration and growth (GOMES, 2013; DE AQUINO, 2020).

In view of the above, it is necessary for Dentists to have constant theoretical and practical training to absorb and use such complementary therapy in their routine in a safe manner, based on appropriate and effective protocols. Therefore, this study aims to evaluate the uses and applications of low-level laser therapy in order to contribute to the updating and improvement of the laser therapy protocol of the Health Department of the Federal District (SES/DF) and for general Dentistry.

The general objective of this study is to indicate the contexts and forms of use of low-level laser in dental routine. The specific objectives are to describe the mode of application of low-level laser in dentistry; to indicate the parameters for the use of PDT and PBM and their applications in dentistry; to update the laser therapy protocol of SES/DF based on the most recent results involving the theme of laser in dental practice.

METHODOLOGY

This is an integrative review in databases that will serve as the basis for the elaboration of a laser therapy protocol. This research was conducted through a bibliographic search in the Medline, PubMed, and Lilacs databases, using the following descriptors: "Low-Level Light Therapy" OR "Photobiomodulation Therapy" OR "Laser Phototherapy" OR "Laser Biostimulation" and their respective translations into English, between September 2021 and September 2022.

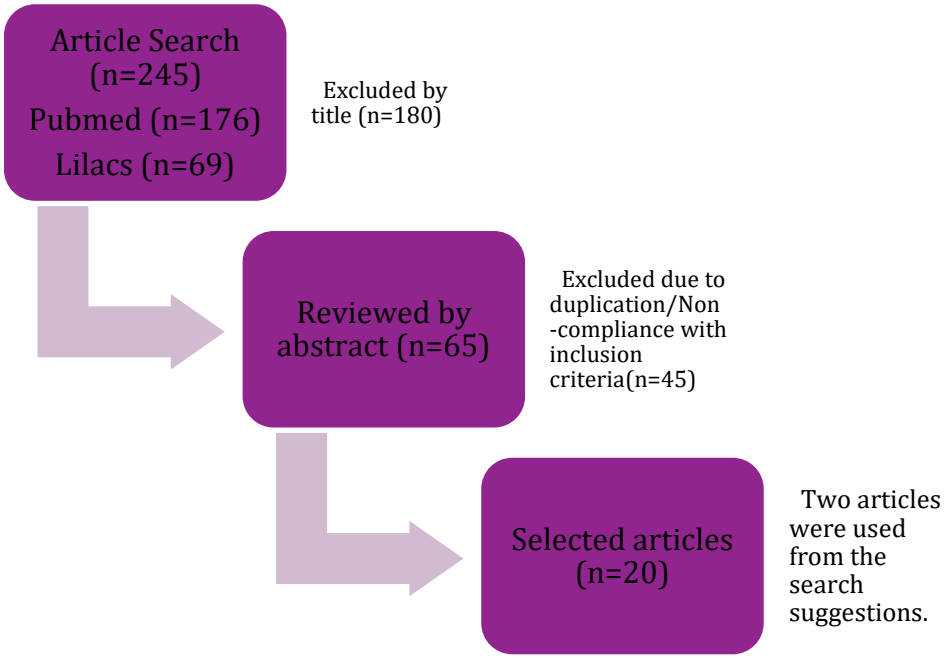
For the selection of studies, the following inclusion criteria were considered: full articles available, publication date from September 1, 2021, to September 30, 2022, text in English or Portuguese, containing methods and experimental data within the study on laser therapy in dentistry. As exclusion criteria: duplicate articles, articles outside the theme, animal studies, conference abstracts and systematic reviews.

Based on the results found in the databases, the studies that met the inclusion criteria were subjected to title and abstract analysis. Works containing incomplete information were read in full. Finally, a manual search was conducted in the bibliographic references suggested in the article search to include relevant studies on the topic of this review. After the conclusion of the selection, the data were tabulated by creating an independent table containing information such as: authors/year of publication, type of injury/condition, laser parameters, and results.

Given the variability of studies regarding the parameters used in laser therapy, Almeida-Lopes & Massini (2002) described a standardization of energy density (ΔE) to be applied at the treatment site, ranging from 25 to 130 J/cm². They suggest that in situations where the application occurs in soft tissue, the energy density/fluence should range from 25 to 45 J/cm²; in bone tissue ranging from 90 to 120 J/cm²; in dental tissue with a range between 80 to 110 J/cm²; and in nervous tissue with a range between 100

to 130 J/cm². Thus, for the elaboration of this protocol, studies that presented ΔE was applied within the variations described above or close to the aforementioned values were considered. Additionally, books and other laser therapy protocols were consulted for the composition of this work (Clinical applications of laser in dentistry – Nunez, Garcez and Ribeiro, Practical manual for the use of lasers in dentistry UFG – Francine Moreira, Clinical manual of duo laser for dentists – Rosane Lizarelli, DMC® protocols).

Figure 1. Article Selection Diagram



Source: own authorship (2023)

RESULTS AND DISCUSSION

The table below (Table 1) briefly describes the content contained in the selected studies.

Author/Year	**Type of injury/condition**	**Parameters**	**Results**
Seabra *et al.*, 2021	Dry mouth and hyposalivation.	Infrared, 808 nm, 100 mW, spot area of 3 mm², 1 J (10 s) per application	Patient reported partial recovery of taste and significant improvement of

		point.	xerostomia and hyposalivation.
Marangoni *et al.*, 2022	Recurrent major aphthous ulcer in an adolescent patient.	808 nm infrared, 4 points around the lesion, 120mW, 35 seconds, 4.2 J per point.	With the irradiation, the healing time decreased to 3 days, and there was no recurrence after 2 years.
El Mobadder *et al.*, 2022	Medication-related osteonecrosis of the jaw at stage II.	Red laser 635 nm (Smart M, Lasotronix, Warsaw, Poland), 4 J/cm²; 50 mW; 8 mm diameter; 40s; continuous contact. 3 points in the exposed bone areas.	A significant reduction in the visual analog scale (VAS) (2/10) was observed, and clinically, there was healing of the soft tissues over the previously exposed bone.
Khalighi *et al.*, 2022	Myofascial Pain Dysfunction Syndrome (MPDS) vs. Acupuncture	Group LLLT: Infrared, 810 nm, 9 mm, 6 and 24 J/cm². Group LAT: 810 nm laser, 150 mW, 5 W/cm², and energy density of 7.5 and 26.25 J/cm² for 5 seconds.	Maximum mouth opening increased. Improvement was observed in both groups.
Dhopte & Bagde, 2022	Recurrent aphthous ulcers.	Group 1 - topical application of triamcinolone acetonide 0.1% (TA). Group 2 - IV laser 810	The pain and the size of the ulcer decreased considerably from the first to the third day.

		nm, 6.3 J/cm², defocused mode, 10 mm from the lesion, 30 s.	
Nejat *et al.*, 2021	Alveolar Osteitis (AO) and postoperative pain after third molar surgery.	660 nm, 200 mW, applied at 4 points in the occlusal area of the extraction socket, 1 cm apart, 0.64 cm², 312.5 mW/cm², 1 J, 1.6 J/cm². 810 nm, 200 mW, applied at three points on the buccal gingiva and three points on the lingual gingiva, 15 s, 400 mW/cm², 3 J, 6 J/cm². For the SHAM treatment: the probe was placed at the same points for the same time intervals. The placebo device emitted no PBM treatment.	Photobiomodulation showed a lower frequency of AO compared to the simulated PBM treatment.
Monteiro *et al.*, 2021	Lenvatinib-associated osteonecrosis.	635 nm diode laser (Lasotronix®, Diode Laser DiodeLX model SMART M, Żytnia, Piaseczno, Poland). 8 mm, continuous mode, 25 s, 10 J/cm².	At the end of 6 months, the patient was recurrence-free.
Ramos-Pinto *et*	Oral mucositis (OM) in patients undergoing	Intraoral group: InGaAlP diode laser, 660nm, 100mW, 33.3 J/cm², 1 J,	The incidence of mucositis in the oral mucosa was

al., 2021	hematopoietic stem cell transplantation (HSCT).	3300 mW/cm², 34 points, daily application. Extraoral group: Diode laser (Gemini ®, Azena Medical, LLC), 810 and 980 nm. 2000 mW, 4.07 J/cm², 20 J, 407mW/cm², 6 application points.	significantly reduced in the extraoral group.
Hadad *et al.*, 2021	Pain, swelling, and trismus after the extraction of impacted third molars.	810 nm infrared diode laser, 6 J, 100 mW, 60 s, on one side (PBM side); and simulated laser irradiation on the other side (SHAM side).	The VAS showed that PBM better controlled the pain than SHAM at 24 h and 48 h, respectively. The visual analog scale (VAS) also showed that PBM better controlled the swelling than SHAM at 24 h and 48 h, respectively.
Sobral *et al*., 2021	Oral lichen planus (OLP) compared to corticosteroid.	Parameters of PBM: GaAlAs diode laser, 660 ± 10 nm, 100mW, 177 J/cm², 5 s, 0.5 J per point.	PBM and corticosteroid significantly improved the quality of life of patients with OLP.
Yüksek & Eroglu, 2021	Postoperative inflammatory response after impacted third molar extractions.	940 nm laser, 0.5 W/cm², 4 J/cm², 50 J, continuous mode, 2.8 cm²; 810 nm, 0.14 W/cm², 4 J/cm², 30 s, continuous mode, 2.1 cm², applied	No significant differences were found between the groups in the evaluated parameters.

		intraorally and extraorally.	
Dias *et al*., 2021	Temporomandibular dysfunction.	830 nm (infrared): the first for analgesia (1st to 5th session) 6 J and 51 J/cm2; the second, 4 J and 34 J/cm2, for biostimulation.	Group 1 showed positive responses to the respective treatment, as did Group 2. A strong positive correlation for VAS was observed in both groups after treatment.
Mohamed *et al*., 2022	Oral mucositis (OM) vs. benzydamine hydrochloride (BHC).	Diodo laser Ga-Al-As (Soft Laser SL-202, 870 nm PETROLASER, Russia) continuous mode (CW), 0.55 cm^2, 60 mW. Laser group: 870 nm laser, 60 mW, 6 J/cm^2 in all ulcerated areas of the oral mucosa, 0.55 cm^2.	The degree of oral mucositis at the end of cancer treatment was lower in the LLLT group than in the other two groups.
Cappellanes *et al*., 2021	Oral mucositis	Red laser of 660 nm, contact mode, 30 mW, 4J/cm^2. Red laser of 660 nm, contact mode, 30 mW, 8 J/cm^2, until complete remission.	The remission of oral mucositis was observed from the 7th week until the end of the treatment.
Campos *et al*., 2021	Oral pseudomembranous candidiasis unresponsive to	0.01% methylene blue spray, 3 minutes, 660 nm laser, contact mode (Therapy EC; DMC®, São Carlos, SP, Brazil),	Within 72 hours, there were no symptoms or signs of fungal infection.

	micafungin.	100 mW, 5 J and 50 s per point.	
Sobral *et al*., 2021	Oral lichen planus (OLP) compared to corticosteroid.	Groups: Control (0.05% clobetasol propionate) and Photobiomodulation (660 nm, 100 mW, 177 J/cm2, 5 s, 0.5 J) twice a week for 30 days.	PBM and corticosteroid significantly improved the quality of life of patients with OLP.
Shousha, Alayat & Moustafa, 2021	Low-level laser therapy (LLLT) vs. occlusal splint therapy (OST) on the temporomandibular joint opening index (OI).	LLLT was applied perpendicularly to each sensitive point of the bilateral masseter and temporal muscles for 10 seconds with an energy density of 2.5 J/cm².	A significant reduction was reported in OI, VAS, and surface electromyography (SEMG) in the LLLT and OST groups, as well as a significant decrease in all outcomes between the groups in favor of the LLLT group.
Cetira Filho *et al.*, 2022	Low-level laser therapy (LLLT) and nimesulide on inflammatory parameters after lower third molar (3MI) surgery.	LLLT (Ga-Al-As) (Therapy XT®, DMC, São Carlos, São Paulo, Brazil) continuous emission, 100 mW (0.1 W), 600 μm width, 24 J (3 J per point), 3.537 mW/cm², 106 J/cm², 30 s.	In the LLLT group, there were significantly lower average pain scores than in the subgroup without LLLT.
Alves *et al.*, 2021	Photobiomodulation in patients with	(GaAlAs), 830 nm, dose of 3 J, fluence of 48	The experimental group showed an

	muscular temporomandibular dysfunction (TMD).	J/cm².	increase in the measurements of mandibular opening and protrusion movements.
Ramalho *et al.*, 2021	Photodynamic therapy (PDT), topical acyclovir (AC), and the combination of both in the recurrence of Herpes simplex type 1 (HSV-1).	Group 1 - PDT: methylene blue, 660 nm laser, 40 mW, 120 J/cm², 4.8 J, 120 s. Group 2 - Acyclovir (AC): topical application of 5% acyclovir. Group 3 - PDT + AC	All three treatments showed a significant reduction in the size of the lesion on day 3.
Ajmal, 2021	Photodynamic therapy combined with topical acyclovir in the treatment of cold sores.	Red laser 660 nm, 150 mW, 300 J/cm², 4.5 J; 0.028 cm², 30 seconds.	According to the data obtained in the clinical evaluation, all study groups reported a decrease in the observed parameters.

The selected studies will be described below in comparison with the established protocols for use in the present work:

PAIN AND TEMPOROMANDIBULAR DYSFUNCTION (TMD)

The studies by Shousha, Alayat, & Moustafa (2021), as well as those by Dias *et al.*, (2021) and Alves *et al,.* (2021), showed a reduction in painful symptoms and an improvement in the quality of life of TMD patients using the following parameters: Alves *et al.,* (2021) used gallium-aluminum-arsenide (GaAlAs) laser, 830 nm wavelength, a dose of 3 J, and fluence of 48 J/cm². Dias *et al.,* (2021) used gallium-aluminum-arsenide (GaAlAs) infrared laser at a dose of 6 J, energy density of 51 J/cm² in the first session, and a dose of 4 J, energy density of 34 J/cm² in the second session.

Meanwhile, Shousha, Alayat, & Moustafa (2021) employed gallium-aluminum-arsenide (GaAlAs) laser (energy density of 2.5 J/cm², dose of 2 J, 10 s, 940 nm).

Based on the presented doses, a dose variation ranging from 2 to 6 J was considered in the protocol.

- Filling/Signing of the Informed Consent Form;

- Cleansing with skin cleansing gel over the affected musculature;

- Location, by palpation, of trigger points and sensitive points;

- Irradiation of the points with infrared laser (808nm) with a total energy per point of 2 to 6 J/point;

- Application points in the temporomandibular joint (TMJ): 1st central point in the region of the left and right TMJ, 2nd point above the central point of the left and right TMJ, 3rd point to the right of the central point of the left and right TMJ, 4th point to the left of the center point of the left and right TMJ, 5th point below the central point of the left and right TMJ. Then, 1 point in the external acoustic meatus, 2 points in the left and right masseter muscle, 2 points in the left and right anterior temporal muscle, 1 intraoral point directed towards the region of the medial pterygoid muscle, and 1 point in the mastoid region on the left and right sides.

LABIAL HERPES SIMPLEX - PRODROMAL, PRE-VESICULAR, AND CICATRICIAL PHASES / LABIAL HERPES SIMPLEX - VESICULAR OR BLISTER PHASE - ACTIVE CLINICAL PERIOD

In studies involving the application of low-intensity laser therapy in lesions caused by Herpes simplex virus type I (HSV-1), various parameters were observed. The wavelength used in the studies by Ajmal *et al.*, (2021) and Ramalho *et al.*, (2021) was 660 nm (red) in the vesicular phase of herpes. The energy density or fluence was 300 and 120 J/cm², the power was 150 and 40 mW, the dose per point was 4.5 and 4.8 J, and the irradiation time per point was 30 to 120 seconds, respectively. Both studies used diode lasers, but from different brands (HELBO®, TheraLite, and MMOPTICS®), with the application of 0.005% methylene blue photosensitizer for 5 minutes. Parameters

such as power density and beam area were not mentioned, nor were the number of sessions, time interval between sessions, and irradiation mode.

Considering the protocol proposed by Almeida-Lopes & Massini (2002), the energy density in both studies is outside the proposed range. This differs from the findings contained in the protocols of Moreira (2020) and Lizarelli (2021), which present energy densities ranging from 35 to 71 J/cm², with doses of 9 J per point in the vesicular phase. Regarding the prodromal and crust phases, the doses varied from 1 to 2 J per point.

-Filling/Signing of the Informed Consent Form;

-Prodromal Phase (period of up to 24 hours before the disease manifests explicitly): irradiation of 1 central point in the lesion with red laser for 2 seconds (2J) and completion with application of a lip protector (dexpantenol, for example) and SPF 30 sunscreen;

-Pre-vesicular Phase (follows the prodromal period in the perioral skin and lip semimucosa erythematous and hyperthermic): irradiation of 1 central point and 4 points around the lesion with red laser for 20 seconds per point (2 J) and completion with application of lip protector and sunscreen, if necessary;

-Cicatricial Phase (period of reduction in size and volume of the vesicles): irradiation of 1 central point and 4 points around with red laser for 20 seconds per point (2 J) and completion with application of lip protector and sunscreen, if necessary.

HERPES SIMPLEX LABIAL - VESICULAR OR BLISTER PHASE - ACTIVE CLINICAL PERIOD

-Filling/Signing of the Informed Consent Form;

-Cleansing with 2% chlorhexidine antiseptic solution;

-Topical anesthetic and puncturing of the vesicle(s) with a sterile needle;

-Application of 0.005% aqueous methylene blue solution, wait for 5 minutes;

-Irradiation with red laser: photodynamic function, with a total energy of 9 J per point, in contact, a single point in the center of the lesion or the necessary number of points to cover the entire lesion (1 point per 1 cm^2).

ORAL LICHEN PLANUS

Sobral *et al.*, (2021) evaluated the effect of photobiomodulation (PBM) with red laser (660 nm, 100 mW, 177 J/cm^2, 5 s, 0.5 J per point) on the quality of life of patients with oral lichen planus compared to therapy with topical 0.05% clobetasol propionate gel. They found that both therapies resulted in a significant improvement in the quality of life of the evaluated patients. Considering that the size of the lesion varies in each patient, and including the distance between each point at 1 cm, the adopted dose for application (0.5 J) can vary between 2 to 3 J.

-Filling/Signing of the Informed Consent Form;

-Application of red laser at a wavelength of 660 nm, total energy of 2 to 3 J per point in contact with the lesion.

-It is recommended to apply the therapy for four weeks on consecutive or alternate days.

MUCOSITIS

Mohamed *et al.*, (2022) evaluated the effectiveness of low-level laser therapy against benzydamine hydrochloride therapy in the treatment and prevention of oral mucositis (OM) in patients with head and neck cancer (HNC). The LLLT group (Ga-Al-As diode laser, 870 nm) received a power of 60 mW on trigger points over a spot area of 0.55 cm^2. Patients who developed mucositis received a curative protocol with an energy density of 6 J/cm^2. The results showed that diode laser irradiation (670 nm) positively influenced the form and prevention of oral mucositis in the studied patients.

Ramos-Pinto *et al.*, (2021) compared the efficacy of two intra and extraoral LLLT protocols for preventing mucositis in patients undergoing hematopoietic stem cell

transplantation (HSCT). The study's results demonstrated that the 660 nm (100mW, 33.3 J/cm², 1 J, 3300 mW/cm², 34 points, daily application frequency), 810 nm, and 990 nm (2000 mW, 4.07 J/cm², 20 J, 407 mW/cm², 6 points of daily application) lasers were effective in managing oral mucositis in transplant patients.

Cappellanes *et al.,* (2021) sought to evaluate the effect of photobiomodulation in preventing and controlling the severity of oral mucositis in 8 patients with head and neck cancer undergoing radiotherapy. The results showed that PBM with a 660 nm laser was effective in controlling painful sensitivity and the severity of OM lesions with energy density parameters of 4 J/cm², power of 30 mW for prevention, and in therapeutic mode with energy density of 8 J/cm² applied until complete lesion remission.

In addition to the above, Nunez, Garcez, & Ribeiro (2021) postulate the following parameters used in the treatment for OM: 660 nm laser, 100 mW power, energy of 2 J per point, and 20 seconds of exposure. Moreira (2020) presents in the red laser prevention protocol: 10 to 71 J/cm² of energy density (0.24 to 2 J) per point, 2 to 3 applications per week. For the treatment protocol, the prevention protocol is maintained, but with the indication of associating red and infrared laser for the lesions that appear with the following parameters: 71 to 142 J/cm² of energy density (2.0 – 4.0 J) per point until lesion remission. For the purposes of use in this work, we considered the following protocol:

-Filling/Signing of the Informed Consent Form;

-For prevention cases, it is recommended: 2 to 3 sessions (one per day) before the start of oncological treatment, using the red wavelength (660 nm), total energy of 1 to 2 J/point, covering the entire oral mucosa, including the dorsum and ventral surface of the tongue;

-For cases of established mucositis, it is recommended: red and infrared laser with a total energy of 2 to 4 J (100 mW) per point, with a 24-hour interval, daily until the lesions remit.

-Adnan et al., (2021) reported that although extraoral LLLT is effective in preventing mucositis, it requires justified dosimetric protocols due to the anatomical

structures through which the light must pass to reach the oral mucosa. No additional protocols have been reported thus far.

PARESTHESIA

Regarding nerve bioestimulation in cases of paresthesia, the study by Oliveira *et al.*, (2021) aimed to evaluate the reversal of paresthesia in 60 patients, divided into 3 groups, after lower third molar extractions with systemic medication ETNA (group 1), laser therapy: 808 nm, 100 mW, 40 sec/point, 4 J/point, intra/extrabucal, irradiation following the nerve pathway (group 2), and laser acupuncture: same parameters as the laser therapy group, applied at six acupuncture points on the affected side (group 3). The results demonstrated that systemic therapy with ETNA and laser therapy were superior to laser acupuncture treatment for paresthesia after extractions.

Parameters similar to those mentioned above are seen in the protocol for paralysis/paresthesia by Nunez, Garces, & Ribeiro (2021), which applies 5 J of energy per point, 5 seconds, along the entire affected nerve pathway. Moreira (2020) selects the following parameters for paresthesia treatment: infrared laser 107 to 142 J/cm², 3 to 4 J of energy per point, 2 to 3 times per week. Given that these data are closer to the reference by Almeida-Lopes & Massini (2002), a dose variation of 2 to 6 J was adopted in the protocol depending on the intensity of the paresthesia. In summary, for the purposes of use in this work, we considered the following protocol:

-Filling/Signing of the Informed Consent Form;

-Irradiation with infrared laser 808 nm, around 2 to 6 J of total energy (20 to 60 seconds) per point (the patient may complain of "shock", "vibration" or "burning") along the entire affected nerve pathway.

-5 to 10 sessions can be performed, along with a prescription of vitamin B12 during the treatment, and the patient should be reassessed after 30 days of improvement.

XEROSTOMIA

A case study conducted by Seabra *et al.*, (2021) on a patient irradiated in the head and neck region, presenting decreased salivary flow and a sensation of dry mouth

with low-level laser therapy, showed satisfactory results with parameters of 808 nm wavelength, power density of 100 mW, 3 mm² spot area, with 1 J (10 s) per application point and a fluence of 0.33 J/mm². The applications were distributed in extrabucal and intrabucal areas, with a total of 10 treatment sessions, once a week.

For the irradiation of the major salivary glands, Nunez, Garcez & Ribeiro (2021) proposed the following parameters to improve xerostomia and hyposalivation: 808 nm, 0.1 W, 69.12 J/cm², 2 to 3 J per application point, 10 sessions, twice a week. Moreira (2020) proposes an application fluence of 35 J/cm², 1 J per application point. Meanwhile, in the DMC® protocol, the recommendation is to apply 808 nm, 1 J in the first two applications. From the third application onwards, the dose becomes 2 to 3 J per application point.

The number of irradiation points was similar in the above studies, with 5 points in each parotid gland, 3 points in each submandibular gland (extrabucal), and 3 points in the sublingual glands (intrabucal). For the purposes of use in this work, we considered the following protocol:

-Filling/Signing of the Informed Consent Form;

-Local irradiation with infrared laser (808 nm), 0.1 W of power, 1 to 3 J of energy per point in 10 sessions, twice a week;

-Irradiation points: 5 extrabucal points in each parotid gland, 3 extrabucal points in each submandibular gland, and 3 intrabucal points in each sublingual gland;

-After the 10 sessions, if the patient is salivating at least 70% of normal, maintenance should be done with weekly irradiation for another four weeks.

RECURRENT AFTOSA ULCER

In the treatment of traumatic or recurrent aphthous ulcers, the literature presents varied studies regarding the application parameters. Dhopte & Bagde (2022) evaluated the application of LLLT in recurrent aphthous ulcers in 54 patients compared to topical triamcinolone 0.1%. The parameters were a wavelength of 810 nm, fluence of 6.3 J/cm²,

starting at 10 mm from the lesion and gradually approaching the lesion within a range of 2 mm for approximately 30 seconds. After 10 days of follow-up, the healing of the lesions and reduction of pain were significantly more evident in the LLLT group compared to the topical triamcinolone group.

Marangoni *et al.,* (2022) analyzed the effectiveness of LLLT in the regression of major aphthous ulcers in a pediatric patient. LLLT proved to be effective in the healing and reduction of the recurrence of aphthous ulcers with the following parameters: 808 nm infrared laser, 4 points around the lesion, a dose of 4.2 J per point, 120 mW, 35 seconds.

In contrast to the parameters presented by Moreira (2020), which indicates red laser parameters: 35 to 71 J/cm², 1 to 2 J of energy per point around the entire lesion, applied daily until complete healing of the lesion; and infrared laser: 35 to 71 J/cm², 1 to 2 J per point, one point in the center of the lesion, in case of more intense pain.

Differing also from the protocol of Lizarelli (2021), which proposes the application of 0.0005% methylene blue photosensitizer (to decontaminate the lesion), waiting for 3 to 5 minutes, and applying 9 J of energy around the lesion. Therefore, for the purpose of use in this work, we consider the following protocol:

- Filling/Signing of the Informed Consent Form;

- Extra and intraoral hygiene with antiseptic;

- Irradiation with red laser with 1 to 2 J (100 mW, 10 to 20 seconds) per point, covering the entire lesion, 1 central point and points along the edges of the wounds in the case of larger lesions;

- Irradiation with infrared laser 1 to 2 J, in case of more intense pain.

ALVEOLITIS

Nejat *et al.,* (2021) evaluated the effectiveness of PBM in preventing the incidence of alveolar osteitis after extraction of impacted third molars in 80 patients. One group received PBM, and the control group received sham treatment. The results

showed that the incidence of alveolar osteitis was lower in the PBM group compared to the control group. The parameters used in the study were: red 660 nm, 200 mW power, beam area on tissue ~0.64 cm², 312.5 mW/cm², 1 J, 1.6 J/cm²). In addition, infrared 810 nm, 200 mW power, applied on the tissue surface at three points on the gingiva and three points on the lingual gingiva, for 15 seconds (400 mW/cm², 3 J, 6 J/cm²).

These parameters differ from the findings in the protocols of Moreira (2020) and Lizarelli (2021), which indicate the application of a 0.005% aqueous solution of methylene blue for 3 to 5 minutes, red laser 660 nm, energy of 9 J per application site. Meanwhile, Nunes, Garcez, & Ribeiro (2021) recommend, for this case, red laser 660 nm, power of 100 mW, energy of 1 J per point, 10 seconds, 2 points on the buccal surface and 2 points on the lingual surface. Subsequently, they recommend two more applications every 48 hours with infrared laser 808 nm, 1 J per point, 100 mW, 10 seconds for bone bioestimulation. In summary, for the purposes of use in this work, we considered the following protocol:

- Filling/Signature of the Informed Consent Form;

- Removal of sutures and irrigation with saline solution using a disposable syringe;

- Application of 0.005% aqueous solution of methylene blue and waiting for 5 minutes;

- Irradiation of the entire affected area with red laser at 9 J, maintaining a distance of 1 cm from each point;

- After 48 hours, irradiate the entire area with infrared laser at 1 J per point, for 10 seconds.

CANDIDIASIS

Evaluating the effects of antimicrobial photodynamic therapy (aPDT) using red laser light, Campos *et al.*, (2021) report a clinical case of a patient undergoing hematopoietic stem cell transplantation with non-responsive pseudomembranous

candidiasis to systemic antifungal - micafungin. The application of aPDT performed with the parameters (0.01% methylene blue spray for 3 minutes, red laser 660 nm, with 100 mW, 5 J and 50 s, 178 J/cm², 0.028 cm², continuous mode, over the entire extent of the lesion) was effective in treating candidiasis, with complete remission observed within 72 hours.

In comparison, the DMC® protocol recommends the application of 0.005% methylene blue for 5 minutes, red laser light 660 nm, and 9 J of energy, once a week. Similarly, Lizarelli (2021) indicates the same parameters for the treatment of candidiasis. In contrast to the aforementioned parameters, in the protocols proposed by Moreira (2020) and Nunez, Garcez, & Ribeiro (2021), the energy doses varied, being 12 J/point and 6 J/point, respectively. Given the variations in parameters and the satisfactory result in the clinical case approach, a dose range of 6 J to 12 J per point was adopted. In summary, for the purposes of use in this work, we considered the following protocol:

-Filling/Signing of the Informed Consent Form;

-Application of 0.005% methylene blue solution over the lesions, wait for 5 minutes, and irradiation with the red laser from 6 to 12 J (100 mW, 60 to 120 seconds) per point, covering the entire lesion.

The protocol for angular cheilitis follows the same indication as above, in case of infection by Candida albicans. In cases without infection and with smaller lesions, the recommendation is the application of red laser, with doses of 1 to 2 J.

OSTEONECROSIS

The application of LLLT in osteonecrosis was investigated by Mobadder *et al.* (2022) in a case study of an 83-year-old patient. The treatment protocol consisted of PBM at the sites with bone exposure using a 635 nm diode laser, 4 J/cm², 50 mW power, 8 mm applicator tip diameter, irradiation for 40 s at each point, in continuous contact mode. The irradiation was performed at three points, including the vestibular, occlusal, and lingual parts for each of the areas of bone exposure. Within the suggested parameters, there was an improvement in the condition at the end of the treatment.

Monteiro *et al.*, (2022) addressed in a similar case study the effect of PBM in a patient with thyroid carcinoma presenting osteonecrosis associated with Lenvatinib®. In this case, there was an improvement in the patient's quality of life and pain complaint with the following parameters: 635 nm diode laser, 5 consecutive weeks (one session per week) using an 8 mm applicator, continuous mode for 25 seconds, applying 10 J/cm² to the affected area.

In contrast to the above findings, the protocols of Moreira (2020), Lizarelli (2021), and Nunez, Garcez & Ribeiro (2021) point to PDT using 0.01% methylene blue for the treatment of osteonecrosis. The proposed parameters are: red laser (660 nm), 100 mW, 9 J per site/point until complete healing of the case. Nunez, Garcez & Ribeiro (2021) also propose PBM at the edges of the lesion to promote healing, using a dose of 1 to 2 J. PBM with infrared laser for bone modulation and analgesia, with a dose of 2 to 3 J per point. For the purposes of use in this work, we considered the following protocol:

-Filling/Signing of the Informed Consent Form;

-Evaluation of radiographic imaging exams (panoramic and periapical) regarding the extent of the lesion;

-PDT with 0.01% methylene blue for 5 minutes, photoactivation with low-power red laser at 9 J per point, for bone decontamination;

-FBM around the lesion for healing with low-power red laser and 1 to 2 J of energy per point;

-FBM for bone modulation and analgesia with infrared, 2 to 3 J of energy per point, simultaneously.

POSTOPERATIVE OF TOOTH EXTRACTIONS

The postoperative period following tooth extractions is often uncomfortable for patients. The main reported symptoms include pain, swelling, and trismus. In order to evaluate the effects of FBM in reducing discomfort after dental extractions, Hadad *et al.*, (2021) conducted a randomized double-blind split-mouth study with 13 patients presenting bilateral impacted third molars. In the study, an 810 nm wavelength infrared laser with a fluence of 6 J (100 mW, 60 seconds/point) was used on one side (the FBM side); a simulated laser irradiation was used on the contralateral side. The results

showed that the parameters used in the study were effective in reducing pain and swelling after impacted molar extractions.

Similarly, Yüksek & Eroglu (2021) evaluated the effect of FBM in 40 patients with impacted third molars, in single and repeated sessions, on the post-extraction inflammatory response. Two infrared wavelengths were evaluated, a 940 nm laser (power density 0.5 W/cm², energy density 4 J/cm², total energy 50 J, continuous mode, spot size 2.8 cm²); and an 810 nm laser (power density 0.14 W/cm², energy density 4 J/cm², for 30 seconds, continuous mode, spot size 2.1 cm²) were applied intra and extraorally. The results were positive for FBM in the immediate postoperative period up to 24 hours.

In comparison with current protocols, the parameters vary in terms of the applied dose. Nunez, Garcez, & Ribeiro (2021) list a dose of 3 J/point, 808 nm, 100 mW, 30 seconds of application. Meanwhile, Lizarelli (2021) indicates energy doses of 4 J/point in the first 72 hours postoperatively. Finally, Moreira (2020) suggests an application dose of 2 to 4 J/point, with a variation of energy density between 71 to 142 J/cm². Therefore, for the purposes of use in this work, we considered the following protocol:

- Filling/Signing of the Informed Consent Form;
- In the immediate postoperative period from 24 to 72 hours, the infrared laser (808 nm), a dose of 4 J/point, will be the most suitable for draining inflammatory markers, facilitating repair.

FINAL CONSIDERATIONS

Based on the results obtained, it was possible to conclude that the application of low-level laser therapy (LLLT) in the treatment of lesions/conditions related to the stomatognathic system is an alternative with high therapeutic efficiency and minimal side effects. Although the studies express the need for further research to define a universal protocol and demonstrate the use of various application protocols, LLLT has shown promising and satisfactory results, even compared to conventional pharmacological methods and other treatment modalities.

It is worth noting that this protocol is not definitive, as not only it, but also the articles on which it was based, need to be validated and verified through randomized experimental clinical studies.

This work also has the limitation of lacking the description of the dosimetric parameters necessary to establish an ideal application dose. According to the World Association for Laser Therapy, the necessary parameters are: wavelength in nanometers (nm), device power in milliwatts (mW), power density in mW/cm², treatment time in seconds (s), energy delivered in joules (J) and in J/cm² for small animals or cell culture research, size of the light beam exit point or spot area in cm², energy in all sessions in joules, application with or without contact with the skin (distance in cm), continuous or pulsed emission mode, number of treatment sessions and interval between sessions, measurements in the equipment's output power before and after the session (WALT, 2006).

Among the analyzed articles, none presented all the necessary dosimetric parameters for future experimental studies to be clinically reproducible, thus posing an obstacle in the formulation of a universal dosimetric protocol.

REFERENCES

ADNAN, Ather *et al*. The path to an evidence-based treatment protocol for extraoral photobiomodulation therapy for the prevention of oral mucositis. **Frontiers in Oral Health**, v. 2, p. 689386, julho 2021.

AJMAL, Muhammed *et al*. Effectiveness of photodynamic therapy as an adjunct to topical antiviral therapy in the treatment of herpes labialis: a randomized controlled clinical trial. **Photodiagnosis And Photodynamic Therapy**, v. 34, p. 102302, junho 2021.

ALMEIDA-LOPES, L.; MASSINI, R. J. Laserterapia: conceitos e aplicações. **Cd-Rom. Dmc, São Carlos, Brasil**, 2002.

ALVES, Giorvan Ânderson *et al*. Efeitos da fotobiomodulação associada à terapia miofuncional orofacial na disfunção temporomandibular muscular. **Codas**, v. 33, n. 6, p. 2020-0193, 2021.

CAMPOS, Luana *et al.* Photobiomodulation and antimicrobial photodynamic therapy for oral ulcers in a patient with thrombocytopenia following bone marrow transplantation. **Journal of Lasers in Medical Sciences**, v. 13, p. e17, 2022.

CAPPELLANES, Thais Benedetti Haddad *et al.* Photobiomodulation therapy for oral mucositis management in head and neck cancer patients undergoing

radiotherapy. **Revista Científica do CRO-RJ (Rio de Janeiro Dental Journal)**, v. 6, n. 3, p. 79-86, 2021.

CETIRA FILHO, Edson Luiz *et al.* Effect of preemptive photobiomodulation associated with nimesulide on the postsurgical outcomes, oxidative stress, and quality of life after third molar surgery: a randomized, split-mouth, controlled clinical trial. **Clinical Oral Investigations**, v. 26, n. 12, p. 6941-6960, 2022.

DE AQUINO, José Milton *et al.* Aplicação da laserterapia de baixa intensidade na odontologia: revisão integrativa. **Revista Eletrônica Acervo Saúde**, n. 39, p. e2142-e2142, 2020.

DHOPTE, Ashwini; BAGDE, Hiroj. Comparative evaluation of low-level laser therapy and topical triamcinolone acetonide 0.1% in recurrent aphthous stomatitis subjects. **Cureus**, v. 14, n. 6, 2022.

DIAS, Wellyda Cinthya Félix Gomes da Silva *et al.* Effects of photobiomodulation combined with orofacial myofunctional therapy on the quality of life of individuals with temporomandibular disorder. **CoDAS**, p. e20200313, abril.2022.

EL MOBADDER, Marwan *et al.* Management of Medication-Related Osteonecrosis of the Jaw with Photobiomodulation and Minimal Surgical Intervention. **Dentistry Journal**, v. 11, n. 5, p. 127, 2023.

GOMES, Monalisa da Nóbrega Cesarino *et al.* O ensino da terapia a laser de baixa intensidade em Odontologia no Brasil. **Revista da Faculdade de Odontologia-UPF**, v. 18, n. 1, 2013.

HADAD, Henrique *et al.* Photobiomodulation therapy improves postoperative pain and edema in third molar surgeries: a randomized, comparative, double-blind, and prospective clinical trial. **Journal of Oral and Maxillofacial Surgery**, v. 80, n. 1, p. 37. e1-37. e12, 2022.

KHALIGHI, Hamid Reza *et al.* The efficacy of low-level diode laser versus laser acupuncture for the treatment of myofascial pain dysfunction syndrome (MPDS). **Journal of Dental Anesthesia and Pain Medicine**, v. 22, n. 1, p. 19, 2022.

LIZARELLI, Rosane de Fátima Zanirato. Manual clínico do laser duo para cirurgiões-dentistas. São Carlos: MMOptics Ltda, 2021. 44 p.

MARANGONI, Analúcia Ferreira *et al.* Fotobiomodulação por Laser em Baixa Intensidade no tratamento da estomatite aftosa maior–acompanhamento de dois anos. **Research, Society and Development**, v. 11, n. 6, 2022.

MOHAMED, Nashwa Helaly *et al.* Low level laser therapy versus benzydamin in prevention and treatment of oral mucositis induced by anticancer treatments (clinical and biochemical study). **Brazilian Dental Science**, v. 25, n. 4, 2022.

MONTEIRO, Luis *et al.* Photobiomodulation laser therapy in a lenvatinib-related osteonecrosis of the jaw: A case report. **Journal of Clinical and Experimental Dentistry**, v. 13, n. 6, p. e626, 2021.

MOREIRA, Francine do Couto Lima *et al.* Manual prático para uso dos lasers na odontologia. **Goiânia: Cegraf UFG**, 2020, 42 p.

NADHREEN, A.; ALAMOUDI, N.; ELKHODARY, H. Low-level laser therapy in dentistry: Extra-oral applications. **Nigerian Journal of Clinical Practice**, v. 22, n. 10, p. 1313-1313, 2019.

NEJAT, Amir Hossein *et al.* Effect of photobiomodulation on the incidence of alveolar osteitis and postoperative pain following mandibular third molar surgery: A double-blind randomized clinical trial. **Photochemistry and Photobiology**, v. 97, n. 5, p. 1129-1135, 2021.

NUNEZ, SILVIA C.; GARCEZ, AGUINALDO S.; RIBEIRO, MARTHA S. Aplicações clínicas do laser na odontologia. 1 ed. São Paulo, Barueri: Manole, 2022. 452 p.

RAMALHO, Karen Müller *et al.* Photodynamic therapy and Acyclovir in the treatment of recurrent herpes labialis: A controlled randomized clinical trial. **Photodiagnosis and photodynamic therapy**, v. 33, p. 102093, 2021.

RAMOS-PINTO, Mariana Bitu *et al.* Intraoral versus extraoral photobiomodulation therapy in the prevention of oral mucositis in HSCT patients: a randomized, single-blind, controlled clinical trial. **Supportive Care in Cancer**, v. 29, n. 11, p. 6495-6503, 2021.

SANTOS, Laura Tauani Ostemberg; SANTOS, Lucas Ostemberg; GUEDES, Cizelene do Carmo Faleiros Veloso. LASERTERAPIA NA ODONTOLOGIA: efeitos e aplicabilidades. **Scientia Generalis**, v. 2, n. 2, p. 29-46, 2021.

SEABRA, Sofia Bustamente *et al.* Laserterapia no controle da xerostomia após radioterapia na região da cabeça e do pescoço. **Revista Portuguesa de Estomatologia, Medicina Dentária E Cirurgia Maxilofacial**, v. 62, n. 2, 2021.

SHOUSHA, Tamer; ALAYAT, Mohamed; MOUSTAFA, Ibrahim. Effects of low-level laser therapy versus soft occlusive splints on mouth opening and surface electromyography in females with temporomandibular dysfunction: A randomized-controlled study. **PLoS One**, v. 16, n. 10, p. e0258063, 2021.

SOBRAL, Sérgio Sousa *et al.* Analysis of the psychopathological profile, quality of life, and cost-effectiveness of oral lichen planus patients treated with photobiomodulation. **Clinical Oral Investigations**, p. 1-10, 2022.

SRIVASTAVA, Vipul Kumar *et al.* Diode lasers: A magical wand to an orthodontic practice. **Indian Journal of Dental Research**, v. 25, n. 1, p. 78, 2014.

WORLD ASSOCIATION OF LASER THERAPY (WALT). Consensus agreement on the design and conduct of clinical studies with low-level laser therapy and light therapy for musculoskeletal pain and disorders. **Photomedicine and Laser Therapy**, v. 24, n. 6, p. 761-762, 2006.

YÜKSEK, Mehmet Nuri; EROĞLU, Cennet Neslihan. Clinical evaluation of single and repeated sessions of photobiomodulation with two different therapeutic wavelengths for

reducing postoperative sequelae after impacted mandibular third molar surgery: a randomized, double-blind clinical study. **Journal of Applied Oral Science**, v. 29, 2021.