

# LOW-LEVEL LASER THERAPY AS AN ALTERNATIVE TREATMENT FOR INFERIOR ALVEOLAR NERVE PARESTHESIA

## LASER DE BAIXA POTÊNCIA COMO TRATAMENTO ALTERNATIVO PARA PARESTESIA DO NERVO ALVEOLAR INFERIOR

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**Abstract: Introduction:** Paresthesia, or loss of sensitivity in a certain region, is the fourth most common complication resulting from dental procedures. The most commonly observed symptoms are tingling, numbness, reduction or cessation of nerve impulse. Due to its recurrence, dentists have increasingly sought new treatment alternatives, among which laser therapy stands out, which acts on the regeneration of nerve cells by improving the transport of oxygen and cellular energy in a painless and non-painful way. **Objective:** To search for clinical protocols and evidence, in current studies, on the effectiveness of using low-level laser to minimize symptoms resulting from paresthesia of the inferior alveolar nerve. **Methodology:** The present study is characterized as a narrative literature review, of a descriptive and exploratory nature, carried out through the search of scientific articles in

the electronic databases PubMed, LILACS and SciELO, from July 2021 to April 2022. **Results and Discussion:** After the initial search, 3,023 articles were found and, after applying the inclusion and exclusion criteria, 3,010 articles were excluded, and 13 articles were then selected for qualitative synthesis. The present review showed that laser therapy with low power laser presents promising results in sensory regeneration and in the reduction of clinical signs related to local inflammation. **Conclusion:** More clinical studies with different populations are needed, aiming to standardize treatment protocols.

**Keywords:** Technology dependency. Neuropsychology. Nervous system diseases.

## INTRODUCTION

Paresthesia is known as a nerve injury characterized by the loss of sensitivity in the affected region, in a transient or permanent way of the injured nerve, causing symptoms such as burning sensation, numbness, decreased sensitivity to cold and heat, tingling and itching in the skin<sup>(1-4)</sup>. The etiology of paresthesia may be due to mechanical failures, from trauma, compression or stretching of the nerve, being the fourth most common complication due to dental procedures<sup>(5)</sup>, after alveolitis, infection and bleeding<sup>(6)</sup>. According to De Lima et al.<sup>(7)</sup> (2018) the general prevalence of this complication after the extraction of third molars in the inferior alveolar nerve (NAI) is 18.6% and in the lingual nerve is 7.0%.

According to Seddon<sup>(8)</sup> (1975), nerve lesions can be classified into neuropraxia, axonotmesis and neurothmesis. Neuropraxia is considered the least severe form, characterized by the physiological blockade of the conduction of the stimulus due to the compression of the nerve where the cause increases the intraneural pressure and can cause paralysis. It is characterized by being temporary, due to the absence of degradation, preventing the presence of permanent sequelae, where the integral recovery of the nerve occurs in a few days or weeks; axonotmesis occurs when there is the loss of the continuity of the axon, that is, there is the partial impairment of the axons and the myelin sheath, but because it is partial, the neurylem remains unchanged. Depending on the amount of fibers injured, this lesion can have a repair without sequelae, usually returning in a period between 2 and 6 months, depending on the severity and duration of the compression, as well as the factors related to the patient, such as age, comorbidities and tobacco use; neurothmesis is considered as the most severe degree, where there is loss of myelin sheaths, and depending on the level of destruction, it can result in an incomplete or irreversible recovery<sup>(8-11)</sup>.

The treatment of paresthesia covers drug protocols, such as with the derivative of the vitamin B1 complex associated with strychnine and the cytidine-hydroxycobalamin complex, as well as non-

drug protocols, through acupuncture, electrostimulation, physiotherapy and humid heat<sup>(2,5)</sup>. Also, Castro et al.<sup>(2)</sup> (2015), state that the use of low-power laser (LBP) can be considered an effective treatment in cases of paresthesia, especially when there are long-term sensory disorders of NAI. The main factor that makes LBP an important adjuvant in the therapeutic planning of paresthesia is its ability to react with photosensitive proteins, recovering the affected nervous tissue<sup>(5)</sup>.

Among the different applications in Dentistry, LBP stands out for its biostimulating action of nerve fibers, as is necessary in cases of paresthesia. The main mechanism of action is based on the penetration of light into the tissues, reaching specific receptors that have the ability to optimize and accelerate healing. Also, it is able to decrease the inflammatory process and activate the immune system with therapeutic effects that induce tissue regeneration<sup>(12,13)</sup>.

Considering that paresthesia is among the main complications resulting from dental treatment, it is necessary that the study of non-invasive therapeutic approaches in this field be carried out in order to offer new safe and effective possibilities to patients. Therefore, this narrative review of the literature was carried out with the objective of seeking scientific evidence and clinical protocols on the effectiveness of the use of low-power laser in the treatment and reduction of symptoms related to paresthesia of the inferior alveolar nerve after oral surgeries.

## METHOD

The present work is characterized as a narrative review of literature, of a descriptive and exploratory nature, carried out through the search of scientific articles in the electronic scientific academic databases PubMed, LILACS and SciELO, in the period from July 2021 to April 2022, based on the acronym PICO, from the crossing of the following DeCS/MeSH descriptors in Portuguese and English, respectively: "laser therapy", "laser therapy", "paresthesia", "paraesthesia", "traumas of the lower alveolar nerve" and "inferior alveolar nerve injuries", using the Boolean descriptors AND and OR.

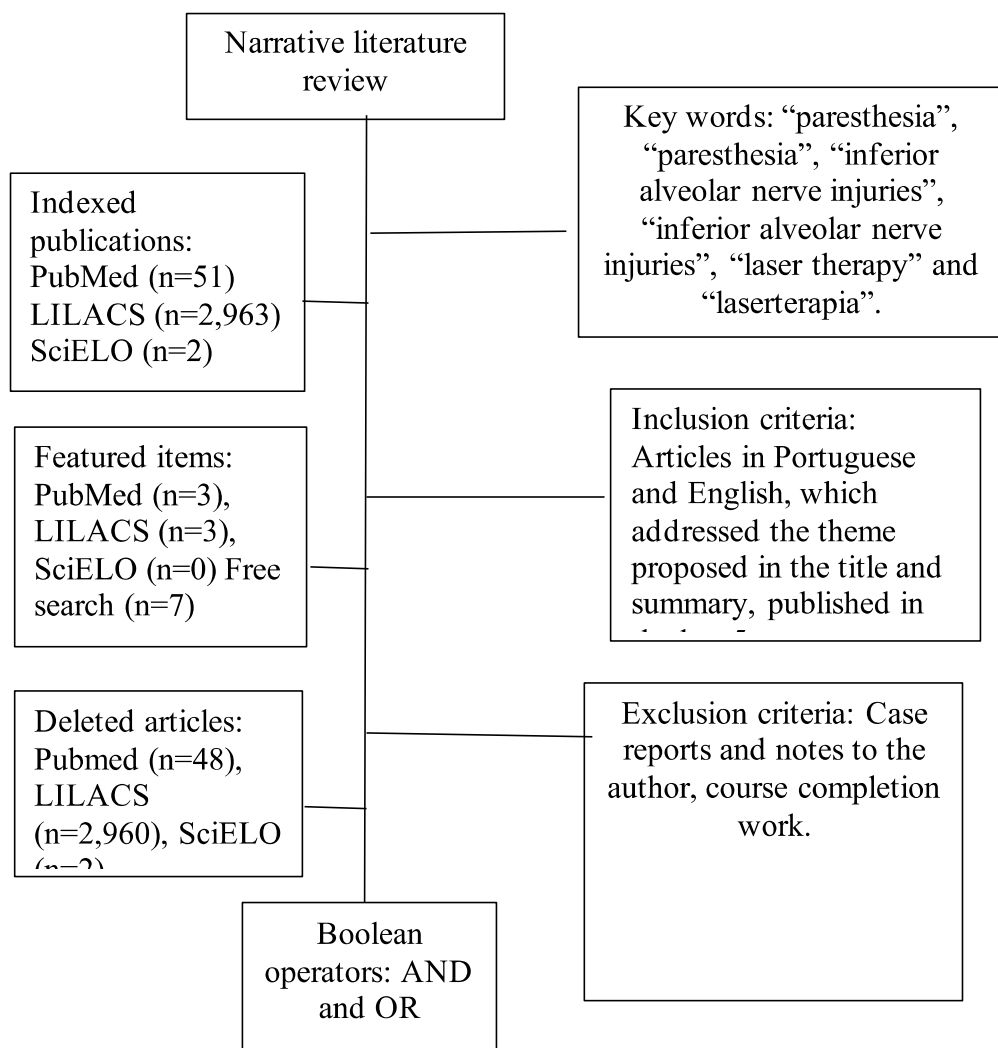
The inclusion criteria established were scientific articles of systematic review, narrative literature review, controlled clinical trial, thesis and observational study that contemplated the proposed theme and could present protocols; publications made in the period between 2017 and 2022 and written in English or Portuguese languages. The exclusion criteria used were articles that did not address or did not present the descriptors in the title or abstract/abstract, case reports, notes to the author and course completion papers.

After the collection of articles in the aforementioned databases, 3,023 articles on the subject were found, of which 2,963 articles were found on the LILACS platform, 51 on PubMed, 2 on

SciELO and 7 by free secondary search, taken from the Google Academic platform through the free terms "treatment", "paraesthesia" and "laser therapy" following the inclusion criteria and selected through the compatibility of the themes that would be relevant to this article.

After the application of the inclusion and exclusion criteria, a total of 3,010 studies were excluded and 13 articles were selected for the present study. Of these, 7 were categorized as narrative literature reviews, 1 observational study, 2 systematic reviews and 3 controlled clinical trials. The summary of the search strategy used for this narrative literature review can be found in Figure 1.

**Figure 1:** Flowchart referring to the search strategy used.



Source: Own authorship, 2022.

## RESULTS AND DISCUSSION

### Paresthesia of the lower alveolar nerve

Paresthesia is characterized by the absence of sensitivity in a certain affected region, such as the NAI region<sup>(14)</sup>. Among the symptoms that precede this complication, one can report the sensation of burning, numbness, decreased sensitivity to cold and heat, tingling and itching in the skin<sup>(4)</sup>, which can even lead to a change in the patient's lifestyle, because paresthesia can be associated with phonetic, food problems, in the control of saliva in the oral cavity and smiling<sup>(15)</sup>.

The paresthesia of the NAI is caused by mechanical factors, which are related to the compression and rupture of the nerve; physical factors linked to excess heat; microbiological factors, which can derive from infections that affect the vicinity of the NAI; pathological, related to the presence of benign or malignant pathologies, causing the compression and/or destruction of the nerve; and by chemical factors, such as the anesthetic application from an incorrect technique<sup>(2)</sup>.

However, the most common cause of paresthesia is due to nerve damage related to the extractions of lower third molars and bilateral sagittal osteotomy of the mandibular branches<sup>(16)</sup>. This is usually due to the anatomical proximity that the NAI has to the roots of the lower third molars, in addition to the position and level of angulation of these<sup>(7,14)</sup>. Although paresthesia has a close relationship with tooth extraction procedures, it may also be related to other procedures, such as anesthetic toxicity, orthodontic procedures, trauma caused by the needle, orthognathic surgeries, endodontic treatments, surgical removal of cysts or tumors located in the gnathic region, placement of dental implants and even facial traumas<sup>(17)</sup>. The visualization of the main dental procedures that are associated with paresthesia are described in Table 1.

**Table 1:** The most common dental procedures that cause paresthesia.

Author/ year	Kind of study	Cause of paresthesia	Prevalence of trauma
Lima et al. <sup>(8)</sup> (2018)	Prevalence study	Extraction of lower third molars	18,6%
Dantas et al. <sup>(18)</sup> (2020)	Prevalence study	Extraction of lower third molars	3,9%
Oliveira et al. <sup>(17)</sup> (2015)	Retrospective study	Orthognathic surgery	16,8%
Oliveira et al. <sup>(17)</sup> (2015)	Retrospective study	Implant placement	12,8%
Oliveira et al. <sup>(17)</sup> (2015)	Retrospective study	Facial trauma	6,4%

Oliveira et al. <sup>(17)</sup> (2015)	Retrospective study	Extraction of third molars	46,4%
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**Source:** Own authorship, 2022.

As a way to prevent a possible injury to the NAI, it is recommended for dental surgical planning to request computerized cone beam tomography (CBT), but the most widely used imaging examination currently is panoramic radiography, because it is of lower cost and requires reduced doses of radiation<sup>(16,19-21)</sup>. In the analysis of panoramic radiography, there are seven signs that point to an increased risk of injury to the NAI during the extraction of the third molars, namely: the darkening of the roots, deviation of the roots or roots in the shape of a hook, narrowing of roots, tips of bifid roots, interruption of the corticals of the mandibular canal and deviation and/or narrowing of the mandibular canal. The deviation, narrowing and loss of the cortex of the mandibular canal are the three signs of greatest expressiveness<sup>(16,19,21,22)</sup>.

The diagnosis, however, is made through the careful analysis of the dental-medical history, from the report of the first symptoms and sensorineural tests in the affected areas, through thermal stimuli, mechanical action and electrical and chemical tests. Sensorineural tests are performed, therefore, to determine the degree of nerve damage. The test with mecanoceptives is based on static touches, where the patient indicates the difference between two points, emphasizing the normal and altered sensitivity; and by nociceptive means, in which thermal and pain tests are performed, using a needle in the form of a fast bite in sufficient intensity to be perceived by the individual<sup>(11,23)</sup>.

It is important to report that this paresthetic state can be temporary or permanent, depending on the degree of NAI injury. When transient, sensitivity can return in a period of 4 to 8 weeks<sup>(24)</sup> and begins to be considered permanent when it lasts for a period longer than 6 months<sup>(25)</sup>.

### Treatment of paresthesia

Among the various treatments for paresthesia, the scientific literature addresses acupuncture, PBL, drug treatments, microneurosurgery, electrostimulation, physiotherapy and humid heat as the most promising. It should be remembered that the treatment differs according to the cause and that none of these therapies promises total effectiveness in the restoration of the traumatized nerve<sup>(2,17)</sup>.

The first step before starting the treatment itself is to make the patient aware of his condition, warning that in cases related to damage, approximately 96% of the sensitivity returns to normal spontaneously, but after 3 months, the chances that the injury is permanent become greater. In both cases, it is extremely important that there is the follow-up of the case through sensory tests, on a



weekly basis, with subsequent evolution to monthly, bimonthly or quarterly follow-ups, depending on the prognosis of the patient's clinical case. This should be guided regarding the care in daily activities, such as the performance of oral hygiene, consumption of food and hot drinks and be careful not to traumatize the jugal mucosa, which may cause soft tissue injuries<sup>(26)</sup>.

The most recommended treatments for paresthesia have been associated with surgical and/or drug therapies<sup>(2)</sup>. Drug treatment consists of the use of vitamin B1 with the combination of strychnine, at a dose of one milligram per ampoule, in 12 days of intramuscular injections, which contributes to the metabolism of carbohydrates, favoring the decarboxylation of alpha-acetoacid, acting on the part of conduction and neurotransmission, and consequently accelerating sensory recovery. The treatment can be done in association with other B vitamins, such as B2, B6 and B12<sup>(26)</sup>.

Surgical treatment is considered a microsurgery, which has the purpose of restoring motor function and sensory loss of the damaged nerve, which can be started from the moment of nerve rupture, taking into account the time in which the decompression was performed. The less time, the lower the amount of scar tissue and this will affect the capacity for regeneration<sup>(2,26)</sup>.

Among the alternative treatments, acupuncture has been associated with the treatment of paresthesia due to its ability to renew the tissue resulting from the application of needles at specific points, triggering, through endogenous substances, analgesic mechanisms that are responsible for the activation of the healing response, nerve conduction and blood flow at the trauma site<sup>(27)</sup>. Physiotherapy can also be used as an alternative treatment, through a personalized treatment, thinking about the patient's collaboration and his need. However, the recommended involves a period ranging from 15 days to 3 weeks for milder cases, and up to 4 years for the most severe cases, being incorporated into the process massage, re-education of the facial muscles, electrotherapy, facial exercises and stimulation with ice<sup>(26)</sup>.

### **Use of low-power laser in paresthesia**

LBP is a non-invasive therapy, and can be used either as an isolated treatment or as an adjunct to other therapies. Its use has been growing in Dentistry after its recognition in 2008, as an integrative and complementary practice to oral health, involving the specialties in the dental clinic, due to its beneficial effects on hard and soft tissues<sup>(28)</sup>.

It is important to understand that the irradiation of LBP light varies according to the propagation of the wave, thus resulting in the emission of red or infrared light. The difference between them can be observed through the mechanisms of action related to the diffusion and the action on the structures of cellular organelles of the irradiated tissues and in the objective that the Dental Surgeon intends for

each individualized case, with the action of light in a more superficial way, through red light, or deeper, by infrared light<sup>(29)</sup>.

In the red laser rays, which act in the visible range between 660nm and 690nm, the biomodulatory effect is observed directly in the structure of the mitochondria, with action on the respiratory chain. In laser beams at infrared wavelength, light is invisible and acts in the range between 780nm and 1064nm. Tissue penetration is therefore deeper in the structure of the cell wall, promoting an increase in protein synthesis. Generally for the treatment of paresthesia, the infrared emission laser is used, in the area that can extend from the region of the retromolar triangle to the lower incisors<sup>(1,30)</sup>.

The tissue and cellular effects promoted by the laser promote an increase in the vascularization of the affected region and the release of  $\beta$ -endorphin. Thus, the indication and application of laser light provide different benefits according to the absorption of the chromophores present in the tissue<sup>(29,31,32)</sup>.

Biomodulation in LBP occurs through energy absorption by chromophores. As a consequence, a mitochondrial change occurs with increased production of Adenosine Triphosphate (ATP), producing intracellular reactive oxygen species (ROS). These modifications make it possible to cause an inflammatory response, as well as improving angiogenesis, stimulating the production of  $\beta$ -endorphins and optimizing tissue repair. In the case of IAN injuries, the most used LBP is usually Aluminum Gallium Arsenide (GaAIAs)<sup>(26,28)</sup>.

The efficiency of LBP is related to numerous factors that need to be taken into account by the Dental Surgeon, such as power, wavelength, dose and time of application in the tissue. It becomes relevant, therefore, to know the parameters of each device used because they differ from each other, interfering with the result of the treatment. It is known that the density of the device is measured in J/cm<sup>2</sup>, which corresponds to the power (mW) of the device, multiplied by the time in seconds, divided by the squared emission surface. Thus, we have that for the establishment of an analgesic effect, it is usually used around 2 to 4 J/cm<sup>2</sup>; for a regenerative effect this parameter varies from 3 to 6 J/cm<sup>2</sup>; for a circulatory effect it is estimated that LBP should be used between 1 to 3 J/cm<sup>2</sup>; for anti-inflammatory effect it is usually used LBP between 1 to 3 J/cm<sup>2</sup>; and for a stimulating effect it is usually recommended doses lower than 8 J/cm<sup>2</sup><sup>(33)</sup>. In laser irradiation, when the light beam falls on the tissues, part of this beam will reflect and the other part will penetrate the tissue, which causes the stimulation of molecules and atoms of the cells, without significantly increasing the temperature of the tissue<sup>(1,4,27,30,34-39)</sup>.

In cases of long-term sensory loss of NAI, treatment with LBP has been recommended due to its ability to interact with photosensitive proteins, causing a recovery of the injured tissue or



decreasing the painful symptoms and the inflammatory process<sup>(4,5,26)</sup>.

The photobiological effects of LBP can have a short or long duration, with the short ones referring mainly to analgesia, and the long-term ones are considered as hours or even days after application, as the tissue repair process<sup>(28)</sup>. The application of LBP favors angiogenesis and the formation of granulation tissue, essential for tissue repair<sup>(12, 29)</sup>.

BPL-induced analgesia can be justified by the modulation of the chemical mediators of inflammation, in addition to benefiting the stimuli to the production of  $\beta$ -endorphin. It is known that these are able to limit the reduction of the excitability threshold of the receptors that cause pain, since they act on receptors of the central nervous system. Therefore, they promote an induction in the analgesic-peripheral effect, depressing nociceptive neurons, stimulating non-nociceptive cells. When the effects of LBP are studied from the mediators of inflammation, it is known that the beneficial effects are related to their ability to prevent prostaglandin formation, providing a decrease in the inflammatory process and consequent relief in pain. Another important aspect is its inhibitory potential on cyclooxygenase (COX)<sup>(15)</sup>.

The benefit of the use of LBP in the treatment of paresthesia is mainly due to accelerating the regeneration of injured nervous tissue; stimulating adjacent or contralateral nervous tissues; and biomodulating the nervous response, leading to the normality of the threshold of the action potential<sup>(15)</sup>. The absorption of laser energy stimulates or inhibits enzymatic activities and photochemical reactions that induce cascades of reactions and physiological processes mediating inflammation and activating the immune system with broad therapeutic connotations. Despite having these effects that influence the improvement of the symptoms of paresthesia, the greatest advantages of this therapeutic method are the positive effects on neuromuscular repair and improvement in functional indices<sup>(1)</sup>.

This therapy becomes advantageous because it is painless and non-traumatic and does not present adverse effects, in addition to the regenerative capacity and restoration of neural function. Sanchez et al.<sup>(30)</sup> (2018) found that with the use of LBP, there was a reduction in inflammation, a decrease in the degeneration of the myelin sheath and inflammation, consequently reducing painful stimuli.

The literature is very divergent in relation to the protocols used for the use of LBP associated with the treatment of paresthesia due to the different cases of patients with individual and unique complaints, in addition to organisms that react in different ways to the absorption and use of photosensitive light, it can be observed that these protocols vary according to the size of the NAI lesion. The protocols found from this study are exemplified in Table 2.

**Table 2:** Protocols for the use of LBP in paresthesia recently found in the scientific literature.

Study	Protocol	Sessions	Results
Matos et al. <sup>(5)</sup> (2019)	2 J/cm <sup>2</sup> Intraoral and extraoral 600 to 1000 nm 90 seconds at each point.	10 sessions 3 times a week	In 10 sessions
Bastos et al. <sup>(40)</sup> (2021)	5 J/cm <sup>2</sup> Intraoral and extraoral 30 J/cm <sup>2</sup> or 70 J/cm <sup>2</sup> 820 to 940nm.	Not included	Third session already results related to patients' sensory changes.
Aquino et al. <sup>(1)</sup> (2020)	6 to 20 J/cm <sup>2</sup> Length not included wave 40 - 50 mW.	Not included	Not included
Fernandes-Neto et al. <sup>(41)</sup> (2020)	3 J/cm <sup>2</sup> 808 minutes 100 mW 30 seconds at each point.	26 sessions 2 times a week	The first signs of recovery were seen 72 hours after the first laser application. Total return on sensitivity in 26 sessions.

**Source:** Own authorship, 2022.

Matos et al. <sup>(5)</sup> (2019) bring a protocol in which the infrared laser should be applied in at least ten sessions, ideally 3 times a week, and can be applied both extraorally and intraorally. The application lasts 90 seconds, so that it acts point-to-point. The wavelengths used can range from 361 to 1064 nm, and most results showed that laser therapy was effective. The density of energy used varies widely in human studies. The highest energy density used in the study by Yoshimoto et al. (2011), cited in the work of Aquino et al. <sup>(1)</sup> (2020), with humans was 140 J/cm<sup>2</sup> and the lowest was

4 J/cm<sup>2</sup>, and both energy densities were effective in the repair of nervous tissue. The studies described in the literature showed differences with respect to the wavelength, the parameters of irradiation and dosimetry used, making it difficult to obtain clear and objective information to facilitate the clinical application by the professional. The work of Fernandes-Neto et al.<sup>(41)</sup> (2020) demonstrates that the application of the 3J should be done for 30 seconds at each point, twice a week. In the study in question, the patient had been paresthesia for 6 months and after 26 sessions the total return of sensitivity was observed, but the first signs of recovery were seen after 72 hours of the first laser application. Aquino et al.<sup>(1)</sup> (2020) presented in their study that the treatment is usually done with infrared laser, with an energy density of 6 to 20 J/cm<sup>2</sup>, divided by points and power of 40 - 50 mW. Bastos et al.<sup>(40)</sup> (2021) showed a possible protocol using energy for intraoral application of 5 J/cm<sup>2</sup> and extraoral application of 30 J/cm<sup>2</sup> or 70 J/cm<sup>2</sup>, in order to reduce the discomfort in the first 72 hours, and the wavelength used was infrared from 820 to 940nm, acting in deeper regions. Two studies point out that from the third session it is already possible to achieve results related to the sensory alteration of patients<sup>(1,41)</sup>.

Pinto et al.<sup>(14)</sup> (2021) concluded in their study that factors such as age and the beginning of therapy with PBL were relevant to the effectiveness of the treatment, and it is recommended to start using it soon after the surgical procedure and until at least the seventh day after the surgery

In the study by Pol et al.<sup>(25)</sup> (2016), LBP was used at the wavelength of 650 nm, in patients with an average of 35 years, and the results presented were complete recovery of sensitivity with the beginning of sensory recovery from the sixth session. In the end, the authors obtained a positive response of 83.3% regarding sensorineural recovery. However, in the study by Aquino et al.<sup>(4)</sup> (2020), there was a wide age group among the patients and the authors observed varied results: in younger patients, an excellent recovery was observed, observing in patients over 60 years of age the predominance of a moderate recovery of sensitivity<sup>(4,25)</sup>. There is then a divergence of efficacy for recovery of sensitivity related to the age group of patients in the face of LBP, but it is notorious the effectiveness in it in a beneficial way as an alternative for cases of paresthesia.

## FINAL CONSIDERATIONS

From this present narrative literature review, it was possible to observe that the use of LBP in the management of symptoms caused by NAI paresthesia is a painless method and with promising results in sensory regeneration and in the reduction of clinical signs related to inflammation and local nervous tissue injury. However, more clinical studies are needed to establish safe protocols for different cases that may be presented by patients, because there is also an important divergence

regarding the protocols currently used.

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