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Photobiomodulation Therapy for Facial Nerve Repair: Systematic Review

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ABSTRACT

Introduction: Microsurgery interventions for direct nerve repair often lead to serious complications and limited success. Non-surgical methods, although somewhat effective, have limited benefits. Photobiomodulation therapy (PBMT) has emerged as a promising approach based on clinical and laboratory studies. The photobiomodulation may accelerate and improve nerve regeneration. This review explores various methodologies used in photobiomodulation for regenerating nerve sensitivity after surgical trauma involving nerve structures in the oral and perioral region.

Materials and Methods: Articles available in PubMed, Scopus, Web of Science, and Google Scholar databases with similar topics over the 20-year period from 2005 to 2025 were selected and reviewed based on inclusion and exclusion criteria. Articles were retrieved by searching for the keywords photobiomodulation, facial nerves and facial nerve injury.

Results: Seven studies related to Photobiomodulation treatment with 810 nm diode laser on facial nerves were selected and reviewed. Of the seven studies reviewed, 2 in 2022, 1 in 2021, 3 in 2017, and 1 in 2014.

Conclusion: Light modulation at 810 nm has a significant, rapid effect on improving visual analog scale (VAS) scores for general sensory perception and thermal discrimination. Notably, the use of photobiomodulation shows the possibility of accelerating the recovery of these sensory functions.

Keywords: Photobiomodulation therapy; Low-level laser light therapy; Complication; Trauma; Facial nerve injuries.

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Introduction

Facial nerve injury is a common clinical condition that can be caused by congenital, infectious, idiopathic, traumatic, neoplastic, endocrine, neurological, and systemic causes. Nerve lesions of iatrogenic origin can affect the sensory and motor trunk, leading to potentially painful symptoms and dysfunction of the oral and maxillofacial region [1-3]. These nerve lesions can be caused by various treatments, such as oral or maxillofacial surgery, implant surgery, local anesthetic injections, or root canal treatments [1-3]. The methods used so far to restore the function of the damaged nerve had challenges in achieving stable results [4].

Among these methods, light-based therapy, known as photobiomodulation therapy (PBMT), has shown promising results in various clinical and laboratory studies [4]. Studies show that PBMT induces migration and proliferation of nerve fiber clusters. PBM enhances mitochondrial function by increasing mitochondrial membrane potential (MMP), which leads to improved electron transport and adenosine triphosphate (ATP) production. Studies have shown that cell proliferation responds differently to different wavelengths of PBM: 660 nm and 810 nm enhance proliferation, while 415 nm and 540 nm inhibit it [5,6].

According to these studies, it can be concluded that photobiomodulation is a non-invasive treatment without side effects. Today, due to its therapeutic effectiveness in some pathology, this treatment method is still under study, although it is a valid alternative for pathologies in other areas, especially in the fields of dentistry and dermatology. Therefore, this study was designed and implemented to investigate the effect of photobiomodulation treatment with diode laser on facial nerves.

Materials and Methods

A systematic review of the literature was conducted in September 2025 on the effect of photobiomodulation treatment on facial nerves.

2.2. Search strategy

This review searched for potentially relevant articles published between September 2005 and September 2025 (20-year period). The search was conducted on PubMed, Scopus, Web of Science, and Google Scholar databases. The keywords photobiomodulation AND facial nerves AND facial nerve injury were used as Subjects.

2.3. Inclusion criteria

- Article's medium of language: English.

- Type of studies: all clinical and experimental studies like randomized clinical trials, cohort studies, case series, animal studies, except for systematic review and meta-analysis (to avoid double-counting), on the above mentioned databases between September 2005 and September 2025.

2.4. Screening and selection of the literature

PubMed, Scopus, Web of Science, and Google Scholar databases were initially searched for pertinent articles. The review's rigorous screening and selection phase started after identifying the first raw hits. From the initial raw hits, some literature was excluded as duplicates by EndNote and manual duplicate search strategies. Of these, a specific number of potentially relevant articles were selected based on Title and/or abstract vicinity to the study subject.

Results

The present study was designed to investigate the effect of photobiomodulation treatment on facial nerve repair. For this purpose, out of a total of 37 articles reviewed, 7 articles were ultimately selected for study. All studies published within a 20-year period were selected based on the inclusion criteria, and 7 studies related to the study of the effect of photobiomodulation treatment on facial nerve repair were selected and reviewed. Among the 7 reviewed studies, 2 in 2022, 1 in 2021, 3 in 2017, and 1 in 2014 investigated the issue. Five studies were clinical trials and two studies were animal models.

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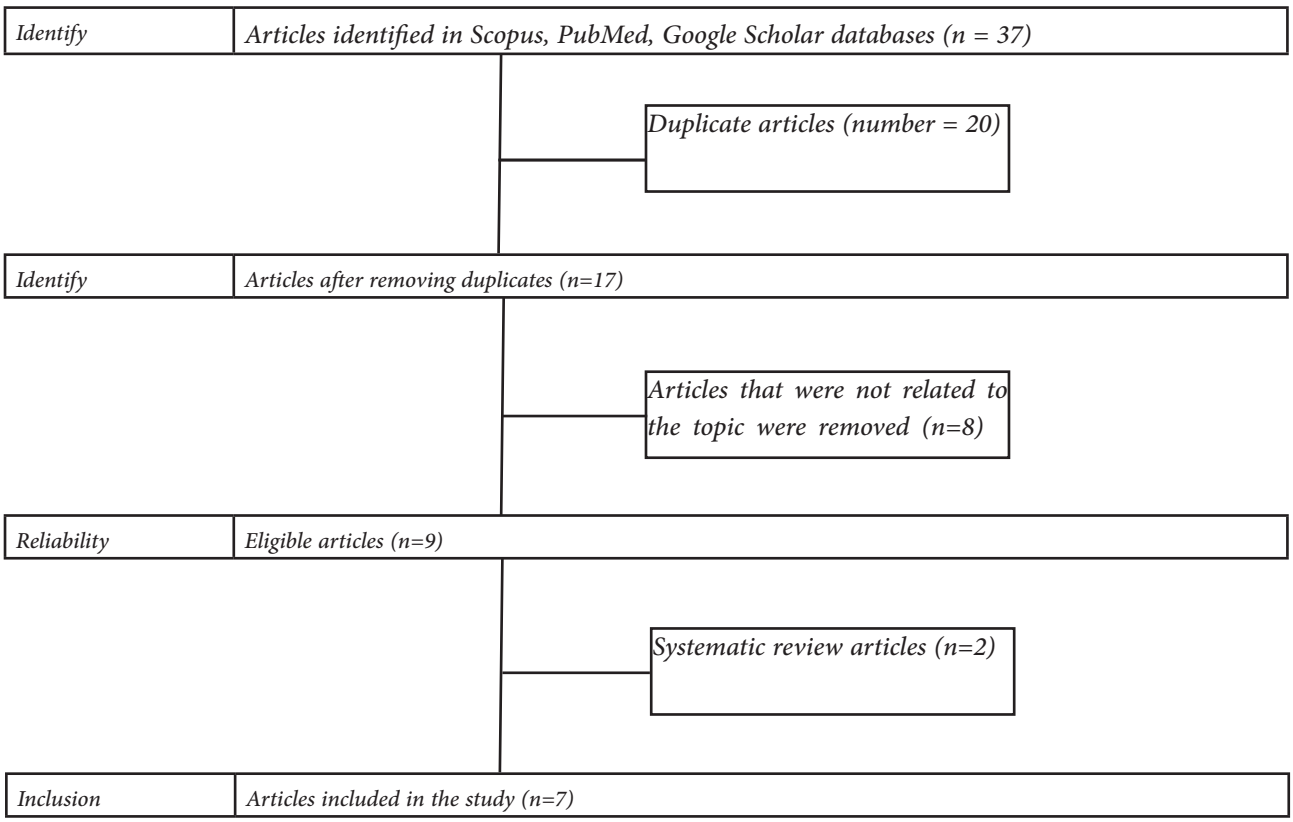

Diagram 1. Scheme of the selection of articles in this review.

Table 1. Results obtained in previous studies.

Author (year)	Number of cases	Type of study	Type of injury	Neurological tests	Type of layer	Wavelength	Number of sessions	Outcome
Salari et al., (2022) [7]	19	Triple-blind randomized clinical trial	Neurosensory impairment in patients with mandibular nerve neurotemesis following traumatic mandibular fracture	Light touch sensation (with a cotton swab and wooden cotton swab), 2-point detection test, thermal detection (cold and hot stimuli), and electric pulp test	GaAlAs diode laser	Continuous wave 810 nm	12 sessions 2 times a week for 6 weeks	The results showed that the tactile sensation of light (cotton swab), light (wooden cotton swab), and sharp (dental needle) and the two-point recognition test improved in the PBMT group after the tenth, eleventh, tenth, and tenth sessions, respectively. Two-way repeated measures ANOVA showed that the trend of light touch sensation with cotton swabs and two-point discrimination test was statistically significant (p-value = 0.002 and 0.001, respectively). The results of OHIP-14 test showed a higher mean in the PBMTT group 3 months after PBMTT. There was no statistically significant difference in EPT and thermal detection tests in the patient group.

Author (year)	Number of cases	Type of study	Type of injury	Neurological tests	Type of layer	Wave-length	Num-ber of sessions	Outcome
Er-Rouassi et al., (2022) [8]	184 mice	Animal model	section-suture of the distal branches of the facial nerve for buccal and marginal mandibular branches nerve	By filming with a high-speed camera	Infrared light (IR)	850nm	2 weeks	IR treatment at a distal site has a significant positive effect on facial nerve recovery.
Bashiri et al., (2021)[9]	17	Parallel con-trolled trial	Neurosensory dysfunction after zygomatic trauma	(VAS) for general sensitivity, two-point detection and pain detection	GaAlAs diode laser	Continu-ous wave 810 nm	12 ses-sions in 6 weeks	The baseline results showed that there was no significant difference between the two groups based on VAS, pain, and two-point discrimina-tion. Also, for the VAS scale, significant differences were observed between the groups after "one and three months of treatment." The difference in pain and two-point discrimination between the intervention and control groups showed significant differences one month after treatment, at the end of treatment, and three months after treatment, respectively.
Eshghpour et al., (2017) 10	16	Randomized double-blind trial	Neurosenso-ry disorders resulting from bilateral sagit-tal osteotomy of the mandible	2-point diagnostic test	Diode laser	660 nm intraoral wave, 810 nm extraoral continuous wave	Twice a week for 3 weeks	This method is effective in treating neurosensory disorders.
Mohajerani et al., (2017)[11]	20	Randomized double-blind trial	Neurosenso-ry disorders resulting from bilateral sagit-tal osteotomy of the mandible	Touch and thermal sensitivity test	Diode laser	Combi-nation of 810nm laser and 632nm LED beams	6 pro-grams	Low-level laser therapy and light-emitting diode may improve VAS scores, 2-point discrimination, and brush stroke test results without any effect on touch or pin-prick detection test results.
Buchaim et al., 2017 [12]	42 rats	Animal model (Randomized double-blind trial)	buccal branch of the facial nerve was sectioned and epineural suture was per-formed on the right side, and a fibrin sealant was used on the left side	functional analysis (subjective obser-vation of whisker movement)	Diode laser	6 pro-grams		LLLT enhanced axon regeneration and accelerated the functional recovery of whiskers, and both repair techniques promoted axon growth.
Fuhrer-Valdivia et al., (2014) 13	31	Randomized double-blind trial	neurosensory disorders resulting from bilateral man-dibular sagittal split osteotomy	visual analog scale (VAS) for pain and sensitivity, directional and 2 point discrim-ination, thermal discrimination	Gallium – aluminum – arsenide - diode (GaA-lAs) low-level laser	Continu-ous wave 810 nm	8 pro-grams	Low-level laser therapy was beneficial for this group of patients on recovery of neurosensory impairment of mandibular nerve, com-pared to a placebo.

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Discussion

The use of photobiomodulation in the field of medical innovation has emerged as a promising approach for the treatment of nerve injuries in the oral region [14-16]. Efforts to optimize this type of treatment depend on the selection of the appropriate laser type and wavelength. Exploration of the optimal laser type, such as low-level laser therapy (PBMT), and the most effective wavelengths is considered an important and effective pursuit in achieving successful results [15,16]. Various therapeutic modalities, including exercise, electrical stimulation (ES), magnetic stimulation, low-intensity ultrasound (LIU), and phototherapy, have been investigated to enhance peripheral nerve regeneration. PBMT, using low-level infrared light, stimulates SC proliferation and axon diameter expansion, but standardized application parameters remain a serious challenge [17].

Hakimiha et al. evaluated the effectiveness of PBMT on nerve regeneration using a mouse model. Their findings indicated that in studies involving highly metabolically active cells such as neural tissue, adverse outcomes are usually attributed to excessive rather than insufficient doses. In the present study, rapid nerve recovery was achieved using an energy density of 6 J/cm2. This discovery supports the concept of a "biphasic dose-response" phenomenon in PBMT, in which positive bio-stimulatory responses are elicited at doses below 10 J/cm2, while inhibitory responses are prominent at doses above 20 J/cm2 [17]. Nevertheless, the concept of the "window effect" has been extensively investigated in various studies, and the findings of the study under review are in good agreement with the existing data in this field [18-31].

In the research of Bashiri et al. [9], Salari et al. [7], Fuhrer-Valdivia et al. [13] used GaAlAs laser in their experiments with a wavelength of 810 nm. According to these studies, their photobiomodulation protocol can significantly increase recovery and sensitivity can be restored after nerve injury, based on improved pain scales and mechanical testing results. However, Salari et al. showed that there was no statistical difference between the control and treatment groups in terms of thermal sensitivity at all periods studied [7]. Diode lasers were used by Eshghpour et al. [10] and Mohajerani et al. [11], respectively. Studies have shown that diode lasers can be considered as effective as GaAlAs lasers. In fact, all studies demonstrated improved pain relief, quality of life, and faster recovery. The diode laser used was 810 nm, in continuous mode, and with a scanning method [10,11]. Peripheral nerve lesions are mainly caused by osteotomies of the maxillofacial region and, to a lesser extent, by nerve lesions following the extraction of third molars. In the reviewed clinical trials, the assessment of nerve sensitivity and paresthesia sensation was assessed through various tests, including: mechanical sensory tests for the routine assessment of trigeminal nerve injuries, such as the brushstroke test, the 2-point detection test, the Semmes–Weinsten single-strand test, and thermal sensitivity tests to assess the neural response to temperature changes. Regarding the perceived impairment by the patient, the VAS scale is performed in almost all studies [7,9-10,13]. Studies in this area have shown objective improvement in symptoms without adverse effects, although in some cases much longer treatment programs have been considered. In the reviewed studies, none of the authors reported medium-term or long-term follow-up of the effects of light modulation on the patients studied [7,9-10,13]. Studies in animal models, such as mice [8,18-31], have shown that PBM can enhance nerve regeneration by increasing axonal growth, reducing inflammation, and increasing cellular metabolism. These experiments typically involve the application of specific wavelengths of light to the injured nerve area, which can lead to improved nerve function and accelerated healing. While further research is needed to fully understand the underlying mechanisms and optimize treatment protocols, the potential of photobiomodulation as a tool for peripheral nerve regeneration represents an exciting avenue for future medical applications.

Conclusion

The results of this comprehensive and extensive review provide substantial evidence that the use of photobiomodulation has a significant and rapid effect on improving visual analog scale (VAS) scores for general sensory perception and thermal discrimination. Notably, the use of photobiomodulation has shown the potential to accelerate the recovery of these sensory functions. This is particularly noteworthy given the non-invasive nature of photobiomodulation and the high level of patient tolerance. Therefore, photobiomodulation is proposed as a powerful and efficient therapeutic strategy for effectively addressing and managing neurosensory disorders that may develop postoperatively. The promising results observed in this review highlight its potential as a valuable complement to the array of existing therapies used to reduce and treat postoperative neurosensory complications.

Conflict of Interest

There is no conflict of interest to declare.

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