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Synergic Photobiomodulation and Massage Therapy for Managing Inferior Alveolar Neurosensory Disturbances after Oral Surgery: An Interventional Case Series

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Abstract

Introduction: Traumatic injury to the Inferior Alveolar Nerve (IAN) may cause persistent neurosensory dysfunction (NSD) in the lower lip and chin, severely impairing quality of life. Massage therapy has emerged as a supportive intervention for managing such disturbances following peripheral nerve injuries. However, effective non-invasive interventions for neurosensory recovery remain elusive. This study aimed to evaluate the synergic effect of photobiomodulation (PBM) and massage Therapy on neurosensory recovery associated with the lower lip and chin in patients with IAN injury.

Methods: This was an interventional prospective case series including six patients (n = 6; 4 females, 2 males; aged 28–42 years) with NSD post-oral surgery. They received PBM therapy (635 nm, 4 J/cm²) at extraoral and intraoral sites every 48 hours for ≥ 8 sessions, plus daily 10-minute self-administered massage therapy with gentle circular strokes to promote circulation and reduce paresthesia. Neurosensory assessments used quantitative tactile boundary mapping at baseline, post-sessions, and at the 6-month follow-up. Visual analogue scale (VAS) neurosensory tests were recorded at the first treatment session (mean 2.0 ± 1.8) and after the last treatment session (mean 9.0 ± 0.9).

Results: Pre-treatment assessments documented symptoms including lip biting, drooling, and food retention. After ≥ 8 sessions, these symptoms resolved completely in 100% of patients (n = 6). The duration of paresthesia was inversely correlated with changes in the VAS. Objective boundary mapping revealed the elimination of numbness areas in patients, with residual areas reduced to approximately 1 cm² in the remainder.

Conclusion: A multi-site 635 nm photobiomodulation (PBM) protocol combined with massage therapy was associated with subjective and objective improvements in patients with traumatic inferior alveolar nerve (IAN) neurosensory disturbances. These preliminary findings suggest potential benefits of this non-invasive approach for managing IAN-related sensory deficits. Further research with larger samples and a rigorous design is needed to confirm its efficacy.

Keywords: Low-level laser therapy, Photobiomodulation, Inferior alveolar nerve injury, Neurosensory disturbance, Peripheral nerve regeneration

Introduction

Traumatic injury to the inferior alveolar nerve (IAN) is a frequent complication of dento-alveolar surgery, often manifesting as persistent chin numbness that markedly diminishes patients' quality of life and functional comfort.[1,2]

Patients may experience various neurosensory changes, such as hypoesthesia, hyperesthesia, and paresthesia in situations involving such nerve injuries.[3] In addition, these occurrences could lead to reactive depression, which could exacerbate the patient's clinical condition and prompt legal action against the physician.[4]

PBM therapy has emerged as a non-invasive biostimulatory modality that enhances mitochondrial activity, promotes axonal regeneration, and reduces inflammatory mediators, thereby accelerating sensory recovery after peripheral nerve damage.[1,5,6]

There is currently no established procedure for treating nerve injuries. Medication and supportive physical therapy have been suggested to reduce symptoms and recovery time in low to moderate nerve injuries known as neuropraxia and axonotmesis.[7] In cases of fully damaged nerve injuries, which are called Neurotmesis, microneurosurgery is

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recommended.[8] Nevertheless, none of these methods typically result in full rehabilitation. PBM therapy has gained popularity recently, particularly in the fields of physical medicine and rehabilitation. In situations with mild to moderate nerve damage, PBM therapy may be helpful.

Recent clinical investigations have demonstrated that photobiomodulation applied to the IAN can produce progressive sensory improvement, with complete resolution of paresthesia reported after a series of intra- and extra-oral laser sessions.[9–11] In particular, adjunctive photobiomodulation following IAN lateralization in an elderly patient led to full neurosensory recovery within six weeks, underscoring the potential of laser therapy to shorten rehabilitation time even in populations with limited regenerative capacity.[9,12]

Furthermore, massage therapy has emerged as a supportive intervention for managing neurosensory disturbances following peripheral nerve injuries, potentially accelerating rehabilitation by enhancing blood flow, reducing inflammation, improving muscle function, and promoting neural recovery through physical stimulation and fascial restoration.[13-15]

Building on these findings, this case series aims to document the outcome of a standardized, multi-site PBM therapy protocol using a 635 nm wavelength laser combined with adjunctive massage therapy in patients with chin numbness resulting from IAN trauma, along with a novel method for objective sensory assessment.

Materials and Methods

Study Design and Participants

This was an interventional prospective case series including six patients and was conducted in accordance with the CARE guidelines for case reports and series.

During the study period, all referred cases presenting sensory deficits indicative of IAN anesthesia were included. The heterogeneity among cases is attributed to the small number of referrals to the center. One of the primary reasons for reporting these cases is the increased level of awareness among dentists regarding PBM therapy and its efficacy across various etiologies of IAN injury.

All the patients presented with clinically comparable baseline symptoms and similar patterns of sensory deficits, indicating homogeneity in the severity of IAN involvement across cases. None of the patients received any standard care prior to enrollment.

In coordination with the surgeon, the decompression procedure was performed on the implant 72 hours after surgery, once the onset of neurosensory deficit became evident in the patient and before the initiation of osseointegration. Vitamin B12 and prednisolone, 1 week after surgery, were prescribed for the patients as a classic base treatment.

This intervention aimed to eliminate the compressive force exerted on the inferior alveolar nerve (IAN) canal wall, which was identified as the primary etiological factor underlying the patient's symptoms, thereby enabling the subsequent photobiomodulation (PBM) therapy to exert its effect on symptom recovery.

According to Seddon's (1942) classification of nerve injuries, three distinct types are recognised:

1. Neurapraxia – a transient conduction block without axonal disruption, attributed to focal demyelination. Motor weakness and proprioceptive loss predominate, whereas sensory loss is minimal. The onset of symptom improvement is typically observed from the second week, with recovery generally occurring within 6–8 weeks; however, delayed recovery of up to 16 weeks has been reported in some cases.
2. Axonotmesis – axonal disruption with Wallerian degeneration distal to the injury site, while the endoneurial sheath remains intact. Complete loss of motor, sensory, and autonomic function is observed. Muscle atrophy develops, and a progressive Tinel sign advances distally at approximately 1 mm per day. Spontaneous regeneration is possible, albeit slow, over several months.
3. Neurotmesis – complete transection of the entire nerve trunk, including the axon, endoneurium, perineurium, and epineurium. It results in total motor paralysis, complete anaesthesia, profound muscle atrophy, and a non-advancing Tinel sign localised to the injury site. Spontaneous recovery does not occur; surgical intervention is required, and functional outcomes are often incomplete.[16] All the patients involved in this article were at the neurapraxia stage.

Patients with persistent neurosensory disturbances of the inferior alveolar nerve (IAN) following oral surgery (third molar extraction, implant placement, implant extraction, and mandibular fracture) were referred to a private dental office in Boujnord, Iran. Inclusion criteria were as follows: confirmed IAN injury via clinical examination, age 28–42 years, and no contraindications to PBM therapy or massage.

Exclusion criteria encompassed active infection, systemic conditions affecting nerve regeneration (e.g., diabetes mellitus), and taking drugs that were considered "neuropathy-effective" (e.g., antidepressants, anticonvulsants, or other neuroactive medications). Informed consent was obtained from all participants. All relevant patient information was documented in the medical records.

Visual Analogue Scale Test (VAS)

A 10-cm, 10° line with divisions at 1-cm intervals was used for the test; 0 represented total lack of sensation, and 10 at the extreme end represented fully normal sensation. During each test, the patients were asked to select a number on the line between 0 and 10.[17]

Photobiomodulation Therapy Device and Dosage Protocol

Concerning the PBM therapy protocol and parameters, extraoral and intraoral irradiation took place using a diode laser with a wavelength of 635 nm (Pulsar laser device, Iran). Treatment parameters were selected based on established therapeutic windows for peripheral nerve

biostimulation and repair, as supported by clinical evidence demonstrating efficacy in reducing neurosensory deficits post-IAN injury. Parameters are detailed in Table 1.[18, 19]

Laser Irradiation Procedure

Safety Measures: Protective eyewear compliant with laser safety standards (ANSI Z136.1) was mandatory for both the patient and operator to prevent ocular exposure.

Application Technique: The laser handpiece was applied in direct contact mode with gentle pressure to minimize light reflection, scattering, and loss, thereby optimizing photon delivery to the IAN.

Treatment Areas: Irradiation targeted three anatomically relevant sites, each receiving five sequential 60-second doses:

Extraoral Target 1: Cutaneous projection along the mandibular canal path on the skin (Figure 1).

Intraoral Target 2: One point on the buccal site of injury (Figure 2).

Sequential Dosing Protocol: To mitigate risks of tissue overheating or photobiological saturation, doses were not applied consecutively to the same site. A minimum 1-minute cooling interval was enforced between repeated doses on any area.

Intraoral irradiation was delivered as point applications, with the full exposure time applied to each fixed point. Extraoral irradiation covered the trajectory of the inferior alveolar nerve canal and the corresponding area of sensory deficit using a scanning technique. The intraoral protocol and the extraoral protocol included five doses.

Boundary Mapping Assessment

Neurosensory function was quantitatively evaluated using a novel, reproducible boundary mapping method adapted from quantitative sensory testing (QST) protocols for orofacial neuropathies. This method focused on tactile threshold detection to delineate areas of hypoesthesia or paresthesia, enabling pre- and post-treatment comparisons.

Preparation: Patients were positioned in a reclined chair with eyes closed to eliminate visual bias and enhance focus on tactile stimuli. A fine-tip, non-toxic marker served as the standardized stimulus tool.

Threshold Testing: Light touch was applied via the marker tip to assess sensory perception.

Table 1. PBM Therapy Parameters Used in This Study

Parameter	Value
Wavelength (nm)	635 nm (red light)
Manufacture	Pulsar laser device, Iran
Mode of irradiation	Continuous
Power output (mW)	30 (intraoral) / 60 (extraoral)
Beam spot size at target (cm2)	0.5 (intraoral) / 1 (extraoral)
Irradiance at target (mW/cm2)	60
Energy density (J/cm²)	4
Exposure time (s)	60 per point
Frequency	Every 2 days
Minimum sessions	8 sessions
Number of places irradiated	2 places (1 extraoral along the nerve canal, 1 intraoral)
Doses per area	5 doses (extraoral) / 5 doses (intraoral)

Border Demarcation

A 0.6 cm horizontal reference line was drawn at the lip commissure, a typically sensate area in IAN injuries.

Testing commenced below this line: An initial point was stimulated. If sensation was reported, the point was shifted 2 mm medially toward the midline and retested until adjacent sensate and non-sensate points were identified. Boundary mapping involved marking a new point 1 mm inferior to the initial points. Subsequent rows used randomized point selection to prevent patient anticipation and reduce bias. Sham trials (no contact) were intermittently included. Rows continued until the full numbness boundary was outlined, with the central unmarked region quantifying the deficit area.

Boundary refinement: From a provisional edge point, adjustments of 2 mm centrally (if sensate) or peripherally (if non-sensate) confirmed the threshold.

Columnar Mapping: A vertical line of points delineated the sensate boundary, with a parallel line 2 mm medially marking the non-sensate zone. This generated a visual map for area calculation and longitudinal tracking.

Assessments were performed at baseline, after each session, and at follow-up (6-month post-treatment) by one trained operator.

Digital imaging software was not utilized in this study. The treatment protocol involved obtaining a digital photograph of the anatomical landmarks marked on the patient's face. This photographic documentation provided

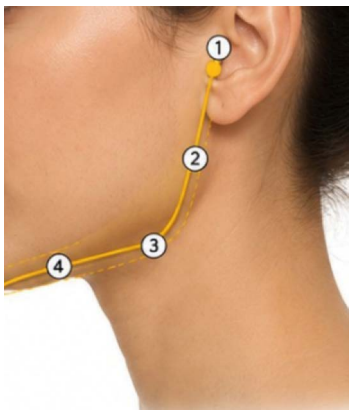


Figure 1. Extraoral Target of Irradiation

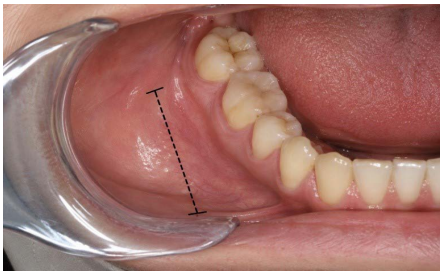


Figure 2. Intraoral Target of Irradiation

the treating clinician with a reliable means to compare pre- and post-treatment outcomes without the need for specialized software.

Adjunctive Massage Therapy

Patients were instructed to perform a self-administered gentle massage of the affected numb region once daily for 10 minutes in a quiet environment while observing the area in a mirror. This technique aimed to enhance proprioceptive feedback, improve local blood flow, and complement PBM therapy by promoting neural plasticity and reducing muscle tension. The massage involved light circular strokes and effleurage, avoiding excessive pressure to prevent further irritation. Compliance was monitored via self-reported logs, and prior studies support the role of massage in alleviating facial neuropathy symptoms through increased circulation and sensory re-education.

Adherence to massage therapy was not objectively monitored beyond patient self-report. Nevertheless, all the patients received standardized verbal instructions and a thorough explanation of the indications and correct massage technique during the initial treatment session.

Statistical methods

Data analyses were performed using IBM SPSS Statistics, Version 25 (IBM Corp., Armonk, NY, USA). Continuous variables, including VAS scores and mapped numbness area, were summarized as mean ± standard deviation (SD), median, and range. Categorical variables were reported as numbers and percentages. The normality of continuous data was evaluated using the Shapiro–Wilk test. Pre- and post-treatment differences in VAS scores were assessed using the Wilcoxon signed-rank test. Due to the small sample size and ceiling effects related to complete sensory recovery in some cases, changes in the objective numbness area were analyzed descriptively. All statistical tests were two-sided, and a P value < 0.05 was considered statistically significant.

Results

Six patients (4 female, 2 male; age 28–42 years) presented with neurosensory disturbance following implant surgery, third molar extraction, mandibular fracture, or maxillofacial surgery (In this study, the term "maxillofacial surgery" specifically refers to bilateral sagittal split osteotomy (BSSO) performed with aesthetic goals). All completed the required minimum of eight sessions. Initial VAS scores for sensory perception ranged from 0 to 4 (mean (SD): 2 (1.89), median: 2). In all the six cases of this series, meaningful subjective improvement was reported post-treatment (P = 0.027), with final VAS scores ranging from 8 to 10 (mean (SD): 9 (0.89), median: 9), demonstrating a mean increase of 7.0 points. Quantitative tactile boundary mapping demonstrated significant reductions in the area of numbness, with a baseline median numbness area of 3.5 cm² (range 2–6 cm²) decreasing to a post-treatment median of 0.4 cm² (range 0–1 cm²), corresponding to a mean percentage reduction of 87.67 (95% CI: 77.54 - 97.79). As an example, an image from one of the patients has been included, showing improved sensory function through the pre- and post-intervention boundary maps (Figure 3).

In terms of recovery classification, complete sensory resolution was achieved in 2 out of 6 patients, while the remaining 4 out of 6 patients had a residual deficit of less than 1 cm². No adverse events or worsening of sensory symptoms were reported.

All 6 patients achieved at least a 5-point improvement on the visual analogue scale (VAS). Four patients reached a VAS score of > 8 or higher at the final session, and 2 patients achieved complete recovery with a VAS score of 10. A moderate inverse correlation was found between the duration of paresthesia and the degree of VAS improvement (Spearman r = –0.62; P = 0.03), indicating that earlier intervention was associated with greater subjective improvement.

Subjective Outcomes

The patients commonly reported pre-treatment complaints such as unintended lip biting during chewing, drooling or food trapping at the lower lip, tingling or pricking sensations, and altered comfort during speech; however, all patients experienced meaningful subjective improvement following PBM therapy. Objectively, two patients achieved complete resolution of the mapped numbness, while four patients showed a marked reduction with less than 1 cm² of residual numb area remaining. A summary of individual cases is presented below (Table 2).

Discussion

The findings of this case series confirm the therapeutic efficacy of PBM therapy in promoting neurosensory recovery following traumatic IAN injury, corroborating the positive outcomes reported in recent systematic reviews.[19,20] The specific parameters used—a 635 nm wavelength at a fluence of 4 j/cm²—appear to be a highly effective combination for this clinical indication. The 635 nm (red) wavelength is known for its strong absorption by cellular photoreceptors, and when delivered in a multi-dose, multi-site approach, it can penetrate and exert its biostimulatory effect on the nerve trunk and its terminal branches.

A critical aspect of this protocol is the multi-site irradiation (extraoral nerve path, mapped area, and intraoral site). This ensures that the entire affected neural



Figure 3. Pre- and post-treatment boundary mapping of the numbness area (A: baseline; B: after PBM).

Table 2. Summary of Clinical Findings and Outcomes

				VAS score			Sensory Outcome				
Case	**Age/ Sex**	**Etiology**	**Duration of Paresthesia**	**Baseline VAS**	**Final VAS**	**ΔVAS**	**VAS 6-Month Follow-up**	**Baseline Numbness Area (cm²)**	**Final Numbness Area (cm²)**	**% Reduction**	**Outcome Classification**
1	42/F	Implant placement	6 weeks	0	9	+9	10	4	0.8	80%	Residual < 1 cm²
2	30/F	Implant extraction	10 days	1	9	+8	10	3.5	0.7	80%	Residual < 1 cm²
3	28/M	Mandibular fracture	3 months	3	10	+7	7	6	0	100%	Complete recovery
4	40/F	Third molar extraction	1 week	4	8	+4	10	3	0.5	83%	Residual < 1 cm²
5	39/M	Third molar extraction	1 month	0	10	+10	8	2	0	100%	Complete recovery
6	41/F	Maxillofacial surgery (BSSO)	1 month	4	8	+4	9	3.5	0.6	83%	Residual < 1 cm²

pathway from the site of injury to the distal sensory deficit is stimulated, maximizing the potential for axonal regeneration and myelin repair. The use of a gentle pressure application further optimizes the effective dose reaching the deeper IAN.

The complete resolution of functional complaints (lip biting, drooling, etc.) is perhaps the most clinically meaningful outcome, as these represent a return of both gross sensation and fine proprioceptive function necessary for coordinated oral movements.[20] The objective demonstration of complete or near complete (confined to 1 cm^2) resolution of the numb area via the novel mapping technique provides a quantifiable measure of success, which is often difficult to standardize in neurosensory testing. The simplicity and repeatability of this mapping method offer a practical tool for clinical follow-up.

The adjunctive use of 10 minutes of daily massage likely contributes to the positive results by providing constant peripheral stimuli, which is believed to help guide and strengthen the regenerating axons.[21]

Despite the absence of standardized clinical guidelines for Photobiomodulation Therapy (PBM) in managing paresthesia, its efficacy remains a subject of debate. Mellor et al. (2018) highlighted that due to this lack of protocol standardization, several studies have failed to report statistically significant improvements in paresthesia symptoms following low-level laser therapy.[22]

This inconsistency in the literature contrasts with the well-documented physiological effects of massage therapy. Specifically, massage has been consistently shown to enhance local tissue perfusion and increase blood flow, a mechanism critical for nerve healing.[23,24]

These findings suggest that while the optimal parameters for PBM are still under investigation, manual therapies such as massage offer a more established route for improving regional vascularity and, potentially, neurosensory recovery.

The VAS assessments in this case series revealed substantial improvements in subjective sensory perception following the multi-site 635 nm PBM therapy protocol. Initial VAS scores ranged from 0 to 4 (mean 2.0 ± 1.8), reflecting severe neurosensory deficits, while final scores post-treatment increased to 8–10 (mean 9.0 ± 0.9), yielding a mean enhancement of 7.0 points ($P < 0.027$, Wilcoxon signed-rank test). These changes demonstrate the capacity of the protocol to uncover previously elusive recovery in persistent NSD, with all patients (n = 6) achieving clinically meaningful gains regardless of injury timing (10 days to 3 months post-trauma). Notably, complete sensory restoration (VAS 10) occurred in two cases with baseline scores of 3 and 0, contrary to prevailing views on chronic IAN injury outcomes. This quantifiable shift establishes PBM therapy as a transformative non-invasive option, paving the way for broader application in neurosensory rehabilitation.

One of the major challenges faced by patients with inferior alveolar nerve (IAN) injury is the concern about developing visible facial changes. In the treatment protocol reported in this study, the patient's attention to the anesthetized area during daily mirror-supervised massage demonstrates that any alteration in the facial region is purely sensory in nature, with no change occurring in facial motor activities. This finding helps modify the patient's perception of the problem and reduces their social concerns.

A major weakness in clinical laser therapy studies is the absence of standardized guidelines for radiation dosage, selected wavelength, and device milliwatt settings, which can lead to data heterogeneity. In this study, we aimed to mitigate this by adopting settings validated in similar prior research. While near-infrared lasers, such as 980 nm, are suitable for deeper tissues due to reduced absorption by hemoglobin and melanin chromophores, the superficial positioning of the IAN makes the 635-nm wavelength a more fitting option. Furthermore, given the domestic production of the 635-nm diode laser device in Iran (Pulsar Company) and its lower cost compared to similar foreign devices, this study sought to evaluate its effectiveness in this context.

Given the preliminary nature of this case series, the results should be interpreted cautiously. While the observed outcomes are promising, the small sample size precludes definitive statements regarding the effectiveness of the combined decompression and PBM protocol. Therefore, larger-scale prospective studies with standardized outcome measures and control groups are necessary to validate these findings.

Limitations

The present study is subject to several limitations. First, as a case series with a small sample size, the findings should be interpreted with caution and are not generalizable to the broader population. Second, the heterogeneity of the included cases limits the ability to draw definitive conclusions regarding treatment efficacy across different etiologies of IAN injury. Third, the lack of objective adherence monitoring for the massage component and the absence of digital imaging software for standardized outcome assessment represent additional methodological constraints.

Conclusion

Within the limitations of this study, a multi-site 635-nm PBM therapy protocol accompanied by massage therapy was associated with subjective and objective improvements in patients with traumatic IAN neurosensory disturbance. These observations support further investigation of photobiomodulation as a non-invasive adjunct for managing IAN-related sensory deficits.

In conclusion, although the findings of this case series suggest that the described protocol may have potential benefits for patients with IAN injury, these observations remain preliminary. Further research with larger sample sizes and rigorous methodological design is required to confirm the efficacy of this treatment strategy.

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Competing Interests

The authors have no conflict of interest, either directly or indirectly, in the laser devices or information listed in the article.

Data Availability Statement

The datasets generated during the current study are available from the corresponding author upon reasonable request.

Ethical Approval

Informed consent for the execution of the procedure was obtained from all the patients. The study was reviewed and approved by the Research Ethics Committee of North Khorasan University of Medical Sciences on May 19, 2026. Ethical approval was granted under the registration number IR.NKUMS.RES.1405.022.

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References

1. Ravera S, Colombo E, Pasquale C, Benedicenti S, Solimei L, Signore A, et al. Mitochondrial bioenergetic, photobiomodulation and trigeminal branches nerve damage, what's the connection? A review. Int J Mol Sci 2021;22(9):4347. doi:10.3390/ijms22094347
2. Hakimiha N, Rokn AR, Younespour S, Moslemi N. Photobiomodulation therapy for the management of patients with inferior alveolar neurosensory disturbance associated with oral surgical procedures: an interventional case series study. J Lasers Med Sci 2020;11(Suppl 1): S113-8. doi:10.34172/jlms.2020.S18
3. Zuniga JR. Sensory outcomes after reconstruction of lingual and inferior alveolar nerve discontinuities using processed nerve allograft--a case series. J Oral Maxillofac Surg 2015;73(4):734-44. doi:10.1016/j.joms.2014.10.030
4. Shavit I, Juodzbalys G. Inferior alveolar nerve injuries following implant placement - importance of early diagnosis and treatment: a systematic review. J Oral Maxillofac Res 2014;5(4): e2. doi:10.5037/jomr.2014.5402
5. Bahrami R, Pourhajibagher M, Gharibpour F, Hosseini S, Bahador A. The impact of low-level laser therapy (photobiomodulation) on the complications associated with conventional dental treatments and oral disorders: a literature review. J Dent Sci 2025;20(2):901-10. doi:10.1016/j.jds.2024.08.023
6. Ma Y, Yang M, Chen X, Qu W, Qu X, He P. The effectiveness of photobiomodulation therapy on inferior alveolar nerve injury: a systematic review and META-analysis. PLoS One 2023;18(8): e0287833. doi:10.1371/journal.pone.0287833
7. Pogrel MA. Nerve damage in dentistry. Gen Dent 2017;65(2):34-41.
8. Rizzo S, Lupi SM, Zampetti P. Nerve damage resulting from oral surgery and medical legal implications. J Osseointegration 2009;1(3):86-94. doi:10.23805/jo.2009.01.03.02
9. Nikparto N, Bahrami R. Adjunctive photobiomodulation for neurosensory recovery after inferior alveolar nerve lateralization: a case report in an elderly patient. Lasers Dent Sci 2025;9(1):32. doi:10.1007/s41547-025-00307-y
10. El Mobadder M, Nammour S, Ortega M, Grzech-Leśniak K. Photobiomodulation therapy applied after 6 months for the management of a severe inferior alveolar nerve injury. Life (Basel) 2021;11(12):1420. doi:10.3390/life11121420
11. Yari A, Fasih P, Sadeghi S, Movahed E, Hallajmoghaddam Sarand S, Goodarzi A. The effect of delayed photobiomodulation therapy on inferior alveolar nerve recovery after third molar removal: a triple-blinded randomized clinical trial. Photobiomodul Photomed Laser Surg 2024;42(7):463-72. doi:10.1089/pho.2024.0016
12. Scribante A, Pellegrini M, Pulicari F, Porrini M, Bosotti M, Spadari F. Nerve injury and photobiomodulation, a promising opportunity: a scoping review on laser assisted protocols for lesions in the oral region. Appl Sci 2023;13(16):9258. doi:10.3390/app13169258
13. Shafshak TS. The treatment of facial palsy from the point of view of physical and rehabilitation medicine. Eura Medicophys 2006;42(1):41-7.
14. Lindsay RW, Robinson M, Hadlock TA. Comprehensive facial rehabilitation improves function in people with facial paralysis: a 5-year experience at the Massachusetts Eye and Ear Infirmary. Phys Ther 2010;90(3):391-7. doi:10.2522/ptj.20090176
15. Bi R, Zhang Y, Liu X, Zhang S, Wang R, Liang B, et al. Application of myofascial induction therapy in the rehabilitation of patients with acute facial palsy: a nonrandomized controlled trial. NeuroRehabilitation 2022;50(1):143-9. doi:10.3233/nre-210204
16. Seddon HJ. A classification of nerve injuries. Br Med J 1942;2(4260):237-9. doi:10.1136/bmj.2.4260.237
17. Qi W, Wang Y, Huang YY, Jiang Y, Yuan L, Lyu P, et al.

Photobiomodulation therapy for management of inferior alveolar nerve injury post-extraction of impacted lower third molars. Lasers Dent Sci 2020;4(1):25-32. doi:10.1007/s41547-019-00075-6
18. Bahrami R, Pourhajibagher M, Gharibpour F, Rezazadeh A, Bahador A. The effect of photobiomodulation therapy on neurosensory recovery of infra-alveolar nerve following iatrogenic trauma: a literature review. J Dent Sci 2025. doi:10.1016/j.jds.2025.11.010
19. Firoozi P, Keyhan SO, Kim SG, Fallahi HR. Effectiveness of low-level laser therapy on recovery from neurosensory disturbance after sagittal split ramus osteotomy: a systematic review and meta-analysis. Maxillofac Plast Reconstr Surg 2020;42(1):41. doi:10.1186/s40902-020-00285-0
20. Alharbi G, Rao JK, Alnaim T, Alzamil N, Nagarajappa R. Efficacy of low-level laser therapy and microsurgery on neurosensory recovery following inferior alveolar and lingual nerve injuries: a systematic review. J Oral Biol Craniofac Res 2024;14(5):631-7. doi:10.1016/j.jobcr.2024.08.006
21. Buchaim RL, Andreo JC, Barraviera B, Ferreira Junior RS, Buchaim DV, Rosa Junior GM, et al. Effect of low-level laser therapy (LLLT) on peripheral nerve regeneration using fibrin glue derived from snake venom. Injury 2015;46(4):655-60. doi:10.1016/j.injury.2015.01.031
22. Miloro M, Criddle TR. Does low-level laser therapy affect recovery of lingual and inferior alveolar nerve injuries? J Oral Maxillofac Surg 2018;76(12):2669-75. doi:10.1016/j.joms.2018.06.001
23. Deetz D, Petrie BK. Massage therapy as a complementary treatment for stiffness and numbness post cervical spinal cord injury: a case study. Int J Ther Massage Bodywork 2022;15(4):3-8. doi:10.3822/ijtmb.v15i4.745
24. Menck JY, Requejo SM, Kulig K. Thoracic spine dysfunction in upper extremity complex regional pain syndrome type I. J Orthop Sports Phys Ther 2000;30(7):401-9. doi:10.2519/jospt.2000.30.7.401