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# Photobiomodulation Therapy in the Delayed Treatment of Nerve Injury Secondary to Orthognathic Surgery. A Case Report

## Terapia de Fotobiomodulación en el Tratamiento Tardío de Lesión Nerviosa Secundaria a Cirugía Ortognática. Un Reporte de Caso

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**SUMMARY:** Orthognathic surgery can sometimes cause sensory disturbances in the orofacial region. The objective of this study was to evaluate effects of photobiomodulation therapy (PBMT) in a treatment of a 24-year-old female patient who experienced decreased chin and lower lip sensation following orthognathic surgery performed two years earlier. PBMT using a 808±10 nm diode laser was administered over nine clinical sessions. The dosimetry used consisted of power 0.1W of power, energy per point of 3J, exposure time/point of 30 seconds per spot in continuous mode and 69.76 J/cm$^2$ of energy density. The treatment protocol involved irradiation of the extraoral pathway of the inferior alveolar nerve. In addition, nine points were selected for the application of the laser on the chin and four points on the inner and outer surface of the lower lip. The patient reported a significant improvement in sensory perception, indicating an almost complete recovery of sensation in the affected area. This case highlights the potential efficacy of PBMT in restoring sensory function, even in cases where sensory deficits persist long after surgery.

**KEY WORDS: Photobiomodulation therapy; Orthognathic surgery; Nerve regeneration; Laser; Diode.**

## INTRODUCTION

Orthognathic surgery is commonly performed to correct various skeletal discrepancies of the maxillae, often resulting in significant improvements in facial aesthetics and function. However, sensory disturbances such as hyperesthesia, paresthesia, or anesthesia may occur in the orofacial region as a result of a nerve injury during the surgical procedure (Zuniga, 2015). Significant research attention has been directed to injury of the inferior alveolar nerve (IAN), which traverses the mandible in the vicinity of osteotomy cuts (Hakimiha *et al*., 2020; Fernandes-Neto *et al*., 2020). While these sensory deficits often resolve spontaneously over time, some patients may experience persistent sensory impairment, negatively affecting their quality of life.

Photobiomodulation therapy (PBMT), also known as low-level laser therapy (LLLT), has shown promise in promoting tissue repair and neuroregeneration, making it a potential complementary treatment method for sensory recovery after nerve injury (Bittencourt *et al*., 2017). Recently, its importance has grown, especially in the context of peripheral nerve regeneration, despite the fact that the precise mechanisms by which therapeutic lasers work remain unclear. Research shows that LLLT can create conditions that support nerve growth and inhibit the inflammatory processes essential for regeneration (Gomes *et al*., 2012). Furthermore, it sustains the functional activity of damaged nerves over extended periods, minimizes the formation of scar tissue at the injury site, and markedly boosts axonal growth and myelination (Rochkind, 2009).

This case report is particularly significant due to the long time interval between the surgery and the initiation of laser PBMT, a substantially longer period compared to other documented cases in the literature, which generally report a shorter time span between the trauma and the received therapy.

Here, we present a case of successful sensory recovery using PBMT in a patient with persistent sensory deficits 2 years after orthognathic surgery.

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## MATERIAL AND METHOD

The study was carried out in accordance with the Helsinki declaration and patient signed the informed consent. The study was conducted in accordance with CARE guidelines (https://www.care-statement.org/).

## CASE REPORT

The study was carried out in accordance with the Helsinki declaration and patient signed the informed consent.

A 24-year-old female patient presented with decreased sensation in the right chin and lower lip, both internally and externally, following orthognathic surgery performed two years earlier. The patient had no relevant medical history other than the orthognathic procedure. The sensory deficit was assessed using a 10-cm visual analog scale (VAS), where a score of zero (0) represented the total absence of sensation, and a score of ten (10) indicated normal sensation (Girão Evangelista *et al*., 2019). The patient was assessed using the VAS at the beginning of each session to track sensory improvement. During the initial consultation and history, the patient reported loss of sensation in the right side of the chin and lower lip, both internally and externally, extending to the right corner of the mouth. An important detail to highlight is that the patient was administered a pharmacological treatment 2 months after the surgery, which consisted of 75 mg pregabalin, one tablet every 24 h for 21 days. However, satisfactory results were not achieved, and the almost total absence of sensation persisted at the end of the treatment. The tactile examination was done using the microbrush touch sensitivity test on both the affected area and the contralateral side.

In the first session, a VAS of 1 was recorded in the affected chin and lip area, while a VAS score of 10 was recorded in the unaffected contralateral area. After clinical and radiological evaluation, paresthesia of the inferior dental nerve was diagnosed, leading to loss of sensation in this case. Nine clinical sessions (3 sessions per week) of PBMT were performed using 808 nm ± 10 nm diode laser in infrared mode. Laser Therapy XT DMC (São Carlos, SP, Brazil) was used with a spot size of 0.043 $cm^2$ (Fig. 1A). The dosimetry used consisted of power 0.1W of power, energy per point of 3J, exposure time/point of 30 s per spot in continuous mode and 69.76 $J/cm^2$ of energy density (Table I).

The treatment protocol involved irradiation of the extraoral pathway of the inferior dental nerve on the right side of the face (Fig. 1B). In addition, nine points were selected for laser application on the chin (Fig. 1C) and four points on the inner (Fig. 1D) and outer surface of the lower lip (Fig. 1E), with a separation of 1 cm between each point.

Table I. Laser parameters used for treatment of parethesia

| Wavelength (nm) | Power (W) | Energy per point (J) | Time (sec) | Energy density ($J/cm^2$) | Number of points | Spot size ($cm^2$) |
|---|---|---|---|---|---|---|
| 808 | 0.1 | 3 | 30 | 69.76 | 22 | 0.043 |

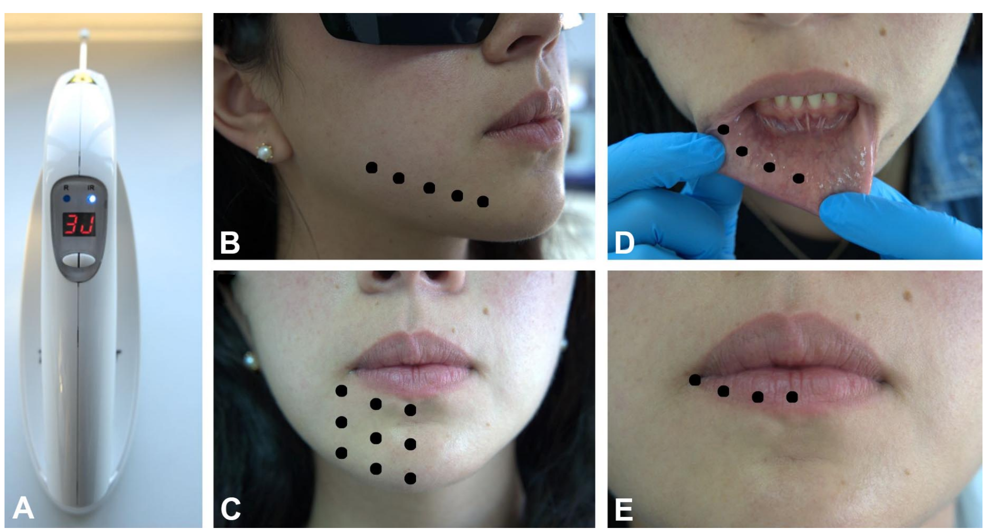


Fig. 1. Graphic representation of the utilization of Laser Therapy XT DMC, with a spot size measuring 0.043 $cm^2$ (A). The treatment protocol entailed irradiating the extraoral pathway of the inferior dental nerve specifically on the right side of the face (B). Furthermore, nine distinct points were designated for laser application on the chin (C) and four points were identified on both the inner (D) and outer surface of the lower lip (E), with each point being spaced 1 cm apart.

The irradiation protocol was administered consistently and promptly, with direct contact with the area, using continuous mode and ensuring that the laser beam was perpendicular to the tissue (Fig. 2). Before irradiation, the patient's skin and oral mucosa were dried with sterile gauze to remove saliva, sweat, and/or cosmetic products, thus avoiding possible interference with the laser beam. All biosafety standards were strictly complied with. After the first session, the patient reported having recovered sensation in the affected area (VAS=6), which was considered clinically relevant. Subsequently, there were no changes on the measurement scale in the third, fourth, and fifth sessions. However, after the sixth session, the patient reported further improvement in sensation with a VAS score of 8, indicating an almost complete recovery of sensation in the affected area. Moreover, in a check-up 1 month after the last session, the patient reported a VAS of 9 in the entire affected area. The patient expressed satisfaction with the treatment outcome and reported increased comfort in daily activities such as eating and speaking.

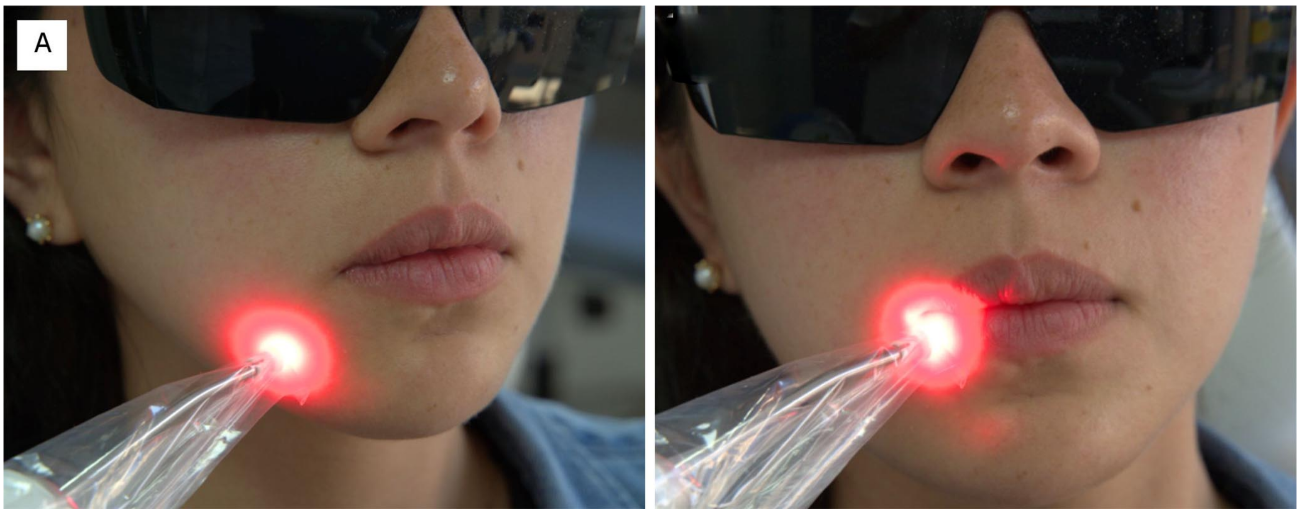


Fig. 2. Illustration of the consistent and immediate administration of the irradiation protocol, with direct contact maintained with the area. This was achieved through the utilization of the continuous mode and ensuring that the laser beam was perpendicular to the tissue.

## DISCUSSION

The use of PBMT presents a promising noninvasive approach to promoting nerve regeneration and tissue repair in patients experiencing sensory disturbances following orthognathic surgery (Fellin *et al*., 2024). While orthognathic surgery is beneficial in correcting skeletal discrepancies, it carries the inherent risk of nerve injury, resulting in sensory deficits in the orofacial region. Although spontaneous recovery is common, persistent sensory disturbances may require additional therapeutic interventions.

Through its mechanism of action involving photon uptake by mitochondrial chromophores, which results in increased adenosine triphosphate (ATP) production and subsequent modulation of cellular processes, PBMT has shown potential to promote neuroregeneration, neovascularization, and collagen deposition (Hamblin, 2018). The mitochondrion plays a central role, with its cytochromes either directly acting as photoacceptors or indirectly influencing through changes in the vibrational and energetic states of bound water, with water itself also acting as a photoacceptor (Ravera *et al*., 2021).

By enhancing cellular metabolism and facilitating the release of growth factors, PBMT holds promise for facilitating nerve repair and functional recovery (de Oliveira *et al*., 2015). Clinical studies investigating the impact of low-level laser therapy on damaged nerves have demonstrated enhanced nerve function and improved myelin production capacity (Tay & Go, 2004). However, despite the potential benefits of PBMT, a systematic review of randomized clinical trials highlighted the insufficient number and heterogeneity of the studies, which prevented the performance of a meta-analysis and the formulation of a pragmatic recommendation on the use of laser therapy (Bittencourt *et al*., 2017). This underscores the need for further research to standardize clinical protocols and demonstrate the efficacy of PBMT in improving sensory recovery after orthognathic surgery-related nerve injury.

Several case reports and retrospective studies have demonstrated encouraging results with applying low-energy laser therapy to promote sensory recovery after nerve injury. For example, Fernandes-Neto *et al*. (2020) reported significant sensory improvement in a patient treated with PBMT after a mandibular third molar extraction. Similarly, Hakimiha *et al*. (2020), observed positive effects of PBMT in patients with inferior alveolar nerve injury associated with implant or third molar procedures, with shorter durations of paresthesia showing more favorable responses to therapy. Combining PBMT with conventional treatment protocols has also facilitated wound healing in endodontic procedures involving 1 % sodium hypochlorite extrusion (Bramante *et al*., 2015). In addition, retrospective studies have indicated the positive impact of low-power laser therapy with beam emission in the infrared spectrum on sensory recovery after orthognathic or minor oral surgeries (de Oliveira *et al*., 2015).

Irradiations in both pulsed and continuous wave modes influence IAN nerve regeneration and neurosensory recovery when applied with precise wavelengths and doses (Ravera *et al*., 2021). The findings reported by Girão Evangelista *et al*. (2019) in a case study involving a young patient treated with low-energy laser therapy for IAN paresthesia after excision of a complex odontoma exhibit parallels with our study. In the study cited, the low-energy laser produced substantial improvements in sensory perception, as indicated by VAS scores, with the patient reporting an increase from an initial score of "3" at the first session to "9" at the tenth and final session. The treatment protocol used by Girão Evangelista *et al*. (2019) involved the combination of two wavelengths (660 nm and 808 nm), and laser therapy started 24 h after surgery. In contrast, our study employed a different treatment approach, using a single wavelength of 808 nm ± 10 nm for PBMT. Moreover, in our case, the laser treatment was initiated two years after the surgical procedure, presenting a notable difference in the timing of treatment compared to the other article. Despite these variations, both studies demonstrated significant improvements in sensory perception after PBMT, suggesting the potential efficacy of this method in promoting sensory recovery after nerve injury secondary to orthognathic surgery.

It has been reported that the distal stump exhibits a reduced capacity to support regeneration following delayed nerve repair, likely due to a decreased number of Schwann cells and increased fibrosis or scarring (Jonsson *et al*., 2013). In contrast, it has also been shown that axonal regeneration in groups of rats undergoing tibial nerve transections can occur up to 12 months later (Kobayashi *et al*., 1997).

The results observed in our case report, characterized by a significant improvement in sensory perception, as evidenced by an increase in VAS score from the baseline, further support the potential effectiveness of PBMT as a complementary treatment for sensory recovery after orthognathic surgery-related nerve injury. The 808-nm wavelength at 100 J/cm$^2$ (0.07 W; 2.5 W/cm$^2$; pulsed at 50 Hz; 27 J per point; 80 s) in rats and the 800-nm wavelength at 0.2 W/cm$^2$ (0.2 W; 12 J/cm$^2$; 12 J per point; 60 s, CW) in humans have proven to be reliable therapies, a conclusion that could be further validated by extensive studies (Ravera *et al*., 2021). However, future research efforts should endeavor to clarify the optimal treatment parameters, including wavelength selection, treatment initiation timing, and therapy duration, to maximize the therapeutic benefits of PBMT in this clinical setting. In addition, larger-scale studies and randomized controlled trials are warranted to validate the findings and establish PBMT as a standard adjunctive therapy for sensory disturbances after orthognathic surgery.

## CONCLUSION

PBMT represents a promising therapeutic approach for the treatment of long-standing sensory deficits after orthognathic surgery. The case presented here demonstrates the effectiveness of PBMT using an 808±10 nm diode laser to promote sensory recovery in a patient with persistent sensory disturbances after two years in the chin and lower lip. More research is needed to clarify the optimal treatment parameters and long-term outcomes of PBMT in this patient population.

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**BETANCOURT, P. & HIRAMATSU AZEVEDO, L.** Terapia de fotobiomodulación en el tratamiento tardío de lesión nerviosa secundaria a cirugía ortognática. Un reporte de caso. *Int. J. Morphol., 42(6)*:1524-1528, 2024.

**RESUMEN:** La cirugía ortognática en ocasiones puede causar alteraciones sensoriales en la región orofacial. El objetivo de este estudio fue evaluar los efectos de la terapia de fotobiomodulación (PBMT) en el tratamiento de una paciente de 24 años que experimentó una disminución de la sensación del mentón y del labio inferior después de una cirugía ortognática realizada dos años antes. Se administró PBMT utilizando un láser de diodo de 808?10 nm durante nueve sesiones clínicas. La dosimetría utilizada consistió en potencia de 0,1W de potencia, energía por punto de 3J, tiempo de exposición/punto de 30 segundos por punto en modo continuo y 69,76 J/cm2 de densidad de energía. El protocolo de tratamiento implicó la irradiación de la vía extra oral del nervio alveolar inferior. Además, se seleccionaron nueve puntos para la aplicación del láser en el mentón y cuatro puntos en la superficie interna y externa del labio inferior. El paciente refirió una mejora significativa en la percepción sensorial, indicando una recuperación casi completa de la sensación en la zona afectada. Este caso resalta la eficacia potencial del PBMT para restaurar la función sensorial, incluso en casos donde los déficits sensoriales persisten mucho después de la cirugía.

**PALABRAS CLAVE: Terapia de Fotobiomodulación; Cirugía ortognática; Regeneración nerviosa; Láser; Diodo.**

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