Journal of Advances in Medicine and Medical Research

Volume 37, Issue 1, Page 119-126, 2025; Article no.JAMMR.129493
ISSN: 2456-8899, NLM ID: 101711724
(Past name: British Journal of Medicine and Medical Research, Past ISSN: 2231-0614, NLM ID: 101570965)

Efficacy of Bone Graft and Photobiomodulation in Alveolar Preservation: A Case Report in a Post-Bariatric Surgery Patient

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jammr/2025/v37i15702

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/129493

Case Report

Received: 10/11/2024
Accepted: 13/01/2025
Published: 15/01/2025

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Cite as: *Mello, Erika da Silva, Glaucia Gonçales Abud Machado, Cícero Dayves da Silva Bezerra, Vanessa Dalapria, Luciana Toledo Costa Salviato, Anna Carolina Ratto Tempestini Horliana, and Alessandro Melo Deana. 2025. "Efficacy of Bone Graft and Photobiomodulation in Alveolar Preservation: A Case Report in a Post-Bariatric Surgery Patient". Journal of Advances in Medicine and Medical Research 37 (1):119-26. https://doi.org/10.9734/jammr/2025/v37i15702.*

ABSTRACT

Bariatric surgery has been shown to enhance health outcomes and quality of life in the obese population. However, post-surgical alterations in nutrient absorption may lead to impaired bone remodeling. In the context of dental extraction, bone grafts are commonly regarded as the preferred method for multidimensional alveolar ridge preservation. Photobiomodulation, which stimulates osteoblast activity, has proven effective in promoting bone neoformation. This case report describes the removal of residual roots of teeth 24, 25, and 26, along with a bone graft performed in a single surgical procedure on a patient with a history of malnutrition following bariatric surgery. The procedure was complemented by photobiomodulation applied to the alveolar ridge using a combination of red and infrared lasers (660 nm and 808 nm, respectively), delivering 18 J per point for 20 seconds at nine distinct points over a period of 26 weeks. Tomographic analysis revealed an increase in alveolar ridge bone height ranging from 6.85% to 16.07% compared to initial measurements. However, a reduction in alveolar ridge thickness between 26.55% and 51.42% was observed. Despite this, the remaining bone volume was deemed sufficient for the successful placement of dental implants. This clinical case underscores the potential benefits of combining red and infrared lasers in the preservation of alveolar ridge bone following tooth extraction in patients with a history of bariatric surgery and malnutrition, warranting further investigation in future studies.

Keywords: Bone graft; photobiomodulation; bariatric surgery; obesity is a chronic disease.

1. INTRODUCTION

Obesity is a chronic condition that significantly contributes to an increase in morbidity, mortality, and a reduction in quality of life (Blüher et al., 2023; Tzenios, 2023). The need to address or mitigate these health-related concerns has led to a substantial rise in the demand for bariatric surgery (Stenberg et al., 2021). However, this surgical intervention may result in inadequate absorption of essential nutrients, including calcium, vitamin D, iron, folic acid, vitamin B12, zinc, copper, selenium, and vitamins A, E, and K, all of which are critical for the maintenance of bone homeostasis (Stenberg et al., 2021; Ha et al., 2021; Schafer, 2017). Nutrient deficiencies of this nature can impair bone remodeling, decrease bone mass, and increase the risk of fractures (Mele et al., 2017).

Human studies have demonstrated that dimensional changes in the alveolar ridge can lead to a reduction in its width of up to 50% within the first year following tooth loss, particularly in the premolar and molar regions. Approximately two-thirds of these changes occur within the first three months post-extraction (Schropp et al., 2003; Araújo et al., 2005). Additionally, assessments of the alveolar bone in patients who have undergone bariatric surgery reveal greater bone loss and a moresparse trabecular structure when compared to eutrophic individuals (Vargas et al., 2020).

To prevent post-extraction bone loss and preserve both hard and soft tissue contours, alveolar preservation techniques are recommended. These methods help to maintain the bone structure of the socket, thereby facilitating subsequent rehabilitation with dental implants (Sanz et al., 2015; Horváth et al., 2013). Systematic reviews have indicated that xenografts are a promising bone substitute for alveolar preservation, with evidence suggesting that they result in less bone loss compared to other grafting materials (Avila-Ortiz et al., 2014; Ten et al., 2011). Furthermore, the application of laser therapy has been shown to improve tissue organization and promote the formation of more mature bone tissue (Dalapria et al., 2022), primarily through the proliferation and differentiation of osteogenic and angiogenic cells, mediated by a reduction in the inflammatory response (Berni et al., 2023). Laser therapy has demonstrated efficacy in enhancing bone repair, particularly in the context of alveolar ridge preservation (Kulkarni et al., 2023; Rosso et al., 2019; Amaroli et al., 2020).

Nevertheless, the specific effects of bariatric surgery on the maxilla and mandible, both pre- and post-operatively, as well as the outcomes of combining bone grafts with photobiomodulation in these patients, remain insufficiently explored and warrant further investigation.

2. CASE REPORT

The patient, MML, a 65-year-old Caucasian female, with a height of 1.55 meters and an initial weight of 104.6 kilograms, presented with a

pre-diabetic condition. Bariatric surgery was indicated and performed in October 2013. Post-operatively, the patient experienced frequent episodes of vomiting. In November 2016, she was admitted to the Intensive Care Unit for potassium replacement and diagnosed with severe malnutrition, primarily attributed to protein deficiency. At present, the patient reports experiencing dry skin, hair loss, and osteoporosis, and is under ongoing medical supervision with a gastroenterologist and nutritionist. Her current weight fluctuates between 45 and 47 kilograms.

In July 2020, during a dental examination, residual roots of teeth 24, 25, and 26 were identified (Fig. 1). A volumetric computed tomography (Cone Beam) scan was conducted at ICC Radiologia Diagnóstico Odontológico (Fig. 2). The panoramic images confirmed the presence of the residual roots (Fig. 3).

Fig. 1. Initial oral condition

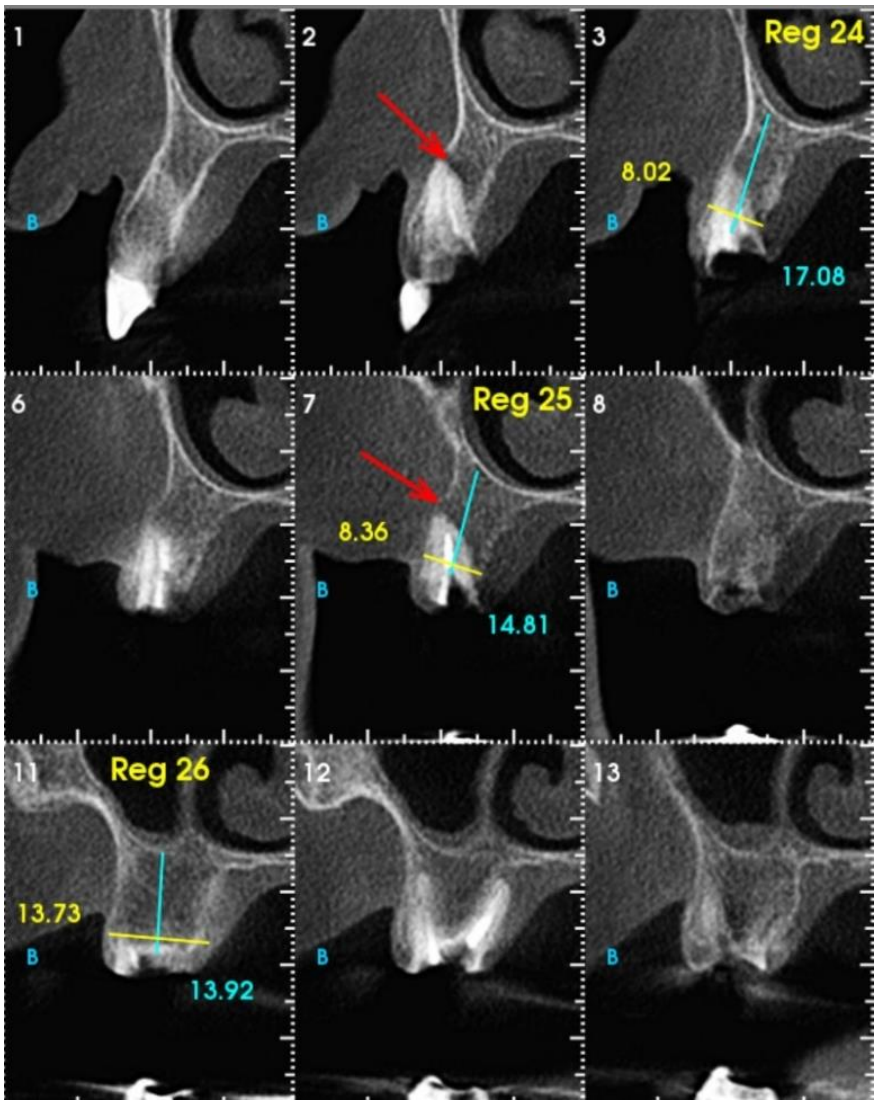

Fig. 2. Tomography initial teeth 24, 25, and 26

Fig. 3. Initial panoramic radiograph

The extraction of the residual roots was performed in November 2020. During the procedure, a bone graft of bovine origin, Lumina-Bone® (Critéria), with medium granulation (600 to 425 µm), batch LB 0104/20, expiration date 27/03/2022, was applied. Additionally, a bovine collagen membrane, Lumina-Coat® (Critéria), measuring 1 X 20 X 30 mm, batch LC 036/20, expiration date 04/02/2022, was used. Following the surgical procedure, sutures were placed and removed after 15 days. Photobiomodulation therapy was then administered at the buccal and lingual points, as well as the occlusal region (Fig. 4).

The photobiomodulation was performed using the EC® Laser Therapy device (DMC), employing simultaneous red (InGaAlP) and infrared (AlGaAs) irradiation. Phototherapy sessions were conducted weekly, with a total of 26 sessions. The parameters for photobiomodulation are provided in Table 1.

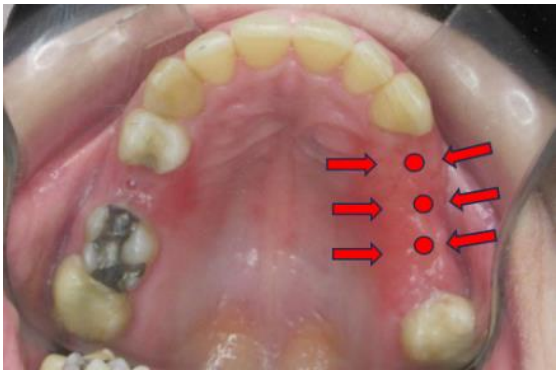

Fig. 4. Irradiation points

Table 1. Parameters photobiomodulation

Parameters	Red	Infrared
Central wavelength (nm)	660	808
Spectral Width- FWHM (nm)	20	20
Operation mode	Continuous	
Mean maximum power (mW)	100	100
Polarization	Random	
Beam Profile	Top hat	
Beam area (cm²)	0,098	0,098
Irradiance at target (mW/cm²)	1016	
Exposure time (s)	20 per point	20 per point
Radiant energy per point (J)	2	2
Radiant Exposure (J/cm²)	20,41	
Number of points irradiated	9	
Total energy per session (J)	18	18
Aplication Technique	Contact	
Number of sessions and frequency	weekly during 6 month	
Total energy irradiated (J)	468	468

A tomographic examination of the treated area was conducted in April 2021 to evaluate its suitability for the placement of dental implants (Fig. 5).

The implants were placed in May 2021. In the regions of teeth 24 and 25, conical implants with dimensions Ø3.8 X 11.5 mm, reference SWHI 3811N (SIN®), batch T080293945, were inserted. In the region of tooth 26, a conical implant measuring Ø4.5 X 11.5 mm, reference SWHI 4511N (SIN®), batch T080293847, was installed (Fig. 6). Immediately following the procedure, photobiomodulation was administered according to the initial parameters and was continued weekly for the first month, totaling 4 sessions.

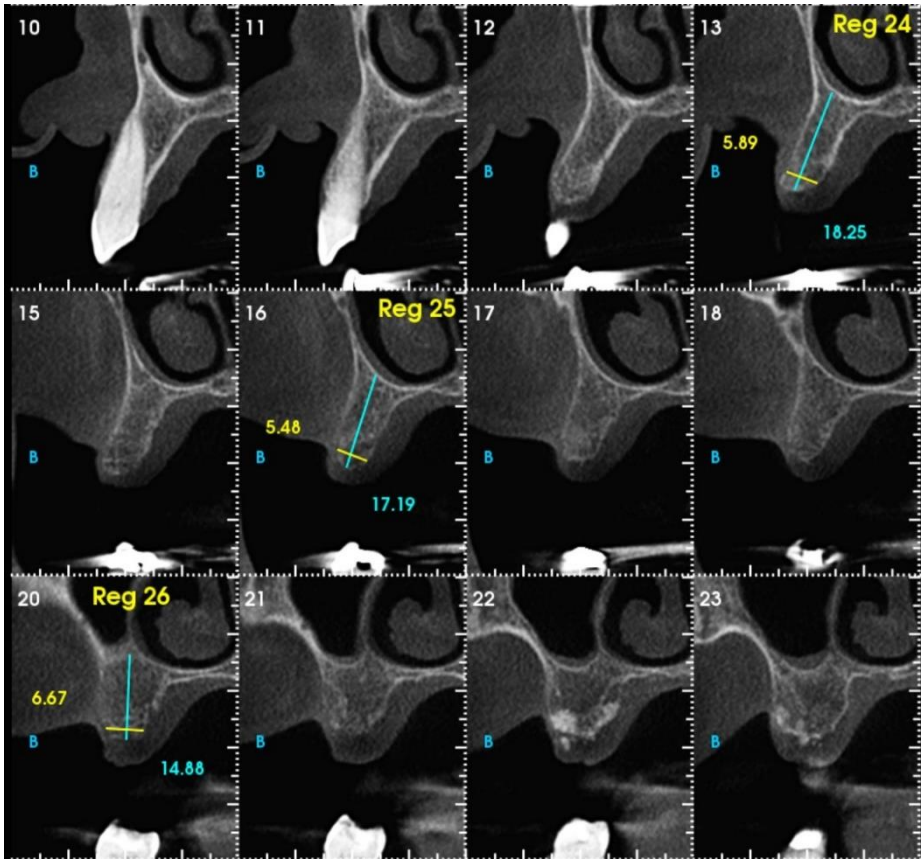

Fig. 5. Tomograph of the alveolar bone in the region of the teeth 24, 25, and 26

Fig. 6. Radiography of the position of the implants

Table 2. Measurement of the width and length of the alveolar ridge in millimeters and percentages

	10/23/2020		04/20/2021		Percent	
	Height	**Width**	**Height**	**Width**	**Height**	**Width**
Tooth 24	17.08	8,02	18.25	5,89	+6,85	-26,55
Tooth 25	14.81	8.36	17,19	5.48	+16,07	-34,80
Tooth26	13.92	13.73	14.88	6.67	+6,89	-51,42
	Initial		After 26 sessions		After 26 sessions	

Table 2 presents the reduction in bone width, which ranged from 26.55% to 51.42% (2.16 to 7.25 mm) after 26 consecutive weeks of photobiomodulation. In contrast, there was an increase in bone height, ranging from 6.85% to 16.07% (0.96 to 2.38 mm).

3. DISCUSSION

The literature reports that dimensional changes in the width of the alveolar ridge following tooth extraction can result in up to a 50% reduction within the first year, with two-thirds of this loss occurring within the first three months (Schropp et al., 2003; Araújo et al., 2005; Santos et al., 2021). Vignoletti et al. (2012) observed a significant reduction in bone width following alveolar ridge preservation (ARP), with an average loss of 1.83 mm. In this case report, following six months of the surgical procedure involving a bone graft and weekly photobiomodulation sessions using an 850 nm laser, the reduction in alveolar ridge width for teeth 24 and 25 was 2,13 and 2,88 mm (26.55% and 34.80%), respectively. The region of tooth 26 exhibited a reduction of 7,06 mm (51.42%), consistent with the pattern described in the literature (Kulkarni et al. 2019).

Tomlin et al. (2014) indicate that the expected vertical bone loss of the alveolar ridge following tooth extraction typically ranges from 0.5 to 0.9 mm over a 12-month period (Tomlin et al., 2023). In the current case, where weekly photobiomodulation was applied, initial bone increase of 1.17 mm at tooth 24, 2.38 mm at tooth 25, and 0.96 mm at tooth 26 were observed (Vittorini et al. 2013).

Vargas et al. (2020) indicate that patients who have undergone bariatric surgery typically exhibit more significant bone loss and a more sparse trabecular bone pattern. In the case under consideration, the extent of bone loss was comparable to that observed in eutrophic patients as reported in the literature, with no evidence of a sparse trabecular bone pattern. Therefore, it becomes apparent that the integration of bone grafting and photobiomodulation techniques is crucial for preserving the alveolar ridge.

Photobiomodulation using low-power lasers has been explored as an effective approach for enhancing vascularized bone regeneration by promoting both osteogenesis and angiogenesis (Bai et al., 2021). These studies highlight the ability of this therapy to accelerate and stimulate the neoformation of bone tissue, thereby improving the overall repair process at the surgical site (Romão et al., 2015; AboElsaad et al., 2009). In light of the patient's medical history, which includes a reported case of severe malnutrition (Canullo et al., 2024), as well as her ongoing bariatric surgery, a low-intensity laser was employed to facilitate successful healing and osseointegration of the bone graft. This was further supported by the computed tomography scan conducted prior to implant placement and by the primary stability of the implants during surgery, which allowed for subsequent osseointegration and a complication-free rehabilitation process.

4. CONCLUSION

Considering the compromised nutritional status of the patient resulting from bariatric surgery, the preservation of alveolar bone through the useof an exogenous bone graft, in conjunctionwith simultaneous use of red and infrared laser therapy, proved to be effective in maintaining alveolar dimensions. This approach facilitated the proper positioning of the implants and contributed to successful oral rehabilitation.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) to publish this case report and accompanying images. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/129493