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Case Report

PHOTO-BIO-MODULATION AND BIO-ENGINEERING TO PROMOTE THE REGENERATION OF PERI-IMPLANT SOFT TISSUE: A CASE REPORT

G. Caccianiga[1] and P. Caccianiga[1*]

[1]School of Medicine and Surgery, University of Milano-Bicocca, 20900 Monza, Italy

*Correspondence to:
Paolo Caccianiga, DDS
School of Medicine and Surgery,
University of Milano-Bicocca,
20900 Monza, Italy
e-mail: p.caccianiga@campus.unimib.it

ABSTRACT

Several factors compete for both achievement and the long-term maintenance of osseointegration; among these, of importance is the width and integrity of the peri-implant soft tissue. Many authors have already underlined the importance of maintaining a good biological seal with a low bacterial loading for achieving long-term success in implant-prosthesis rehabilitation. The aim of this work is to present, through a clinical case, a new technique that focuses on the regeneration of soft tissue around an implant inserted in a post-extractive socket. A post-extractive implant surgery was performed in an inferior molar site in conjunction with three-dimensional collagen matrices, equine spongy bone granules, and dye-free photodynamic therapy. This combined technique allows the creation of new gingiva around the implant.

KEYWORDS: *Soft tissue, regeneration, dental implant, laser, photobiomodulation.*

INTRODUCTION

The surgical technique for inserting dental implants has a rigorous protocol to ensure predictable results since the nineties (1). However, surgical protocols are changing nowadays since clinical evidence contrasts with what was thought previously.

Several factors compete for both the achievement and the long-term maintenance of osseointegration; among these, of paramount importance is the width and integrity of the peri-implant soft tissue. Many authors have already underlined the importance in implant-prosthesis procedures to have a good biological seal and a low bacteria loading around fixtures to have a healthy periodontium (this is also valid for a natural tooth with an undamaged periodontium) (2).

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When an implant is inserted, a second surgery is needed to place a trans-mucous element (i.e., the healing cap). Then the body adapts to create a barrier that avoids bacteria from entering. The mucous surrounding the implant is then covered in keratinized tissue supported by supracrestal connective tissue, which mimes the periodontium structure (2, 3); this structure is called biological width.

Once this concept was recognized and supported by clinical studies, new techniques were introduced to improve the prosthetic procedures, such as gingiva translation or roll-flap technique, to keep part of the gingiva around the implants or to increase its thickness. These techniques are usually employed during implant insertion (4, 5).

The lack of quality and quantity of the peri-implant soft tissue is generally due to bone loss in the same area. The bone loss can be restored before or while the implant is placed with reconstructive interventions to restore the normal bone morphology (6). If a wrong evaluation of initial clinical parameters is done or the implant is wrongly placed, bone loss and the subsequent collapse of soft tissues happen during the healing phase; the outcomes will be evident in the second surgical phase (7, 8).

In these situations, the second surgical phase becomes an important step because the correct use of soft tissue could cover the underneath bone loss (9-11). This work describes a new technique of soft tissue regeneration combined with a laser protocol without thermal stresses.

Fig. 1. *Initial Orthopantomography.*

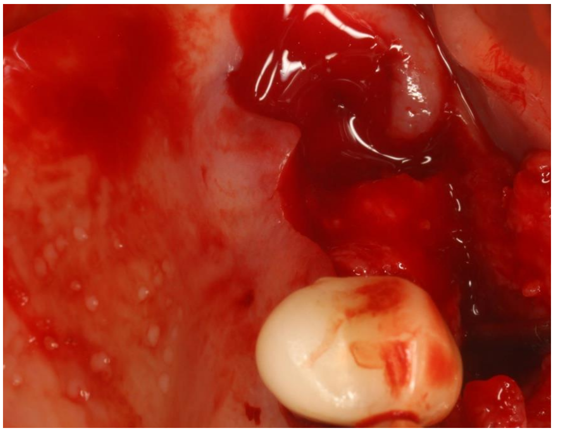

Fig. 2. *Post extractive alveolar sack.*

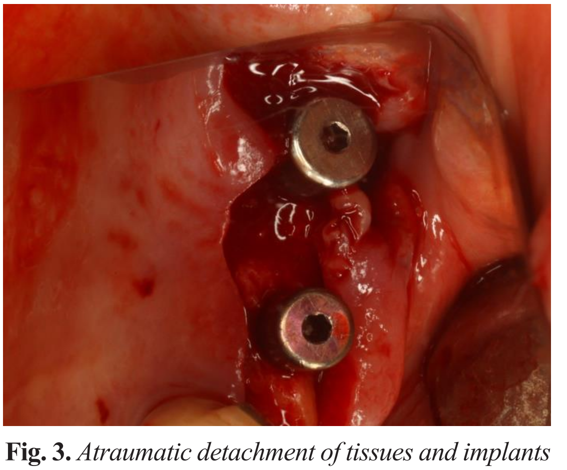

Fig. 3. *Atraumatic detachment of tissues and implants insertion.*

CLINICAL CASE

The patient M.M., 47 years old, had a clinical evaluation for a grade 2 mobility and percussion sensitivity of the 2.6 tooth (Fig. 1). At the probing test, a buccal bone loss on the mesio-vestibular root of 2.6 was detected. In the orthopantomography, radio-transparent damage on the mesial and palatal roots was evident. The patient was examined both from a prosthetic and surgical point of view to obtain the best esthetical and functional rehabilitation. After evaluating different therapeutic options, it was choosen to extract the element, replace it with two implants, 2.5 (already missing) and 2.6, and regenerate the tissue using a collagen matrix and equine granular biomaterial. The patient was informed and signed a written consent form. Treatment was performed in accordance with the Declaration of Helsinki of 2013.

Surgical protocol

After root separation and atraumatic extraction, we came across bone loss, and the alveolar sack was removed without damaging the papilla (Fig. 2). Flap was elevated at 2.5 in an atraumatic manner (Fig 3). Afterward, the surgical site was irrigated with SiOxyl+

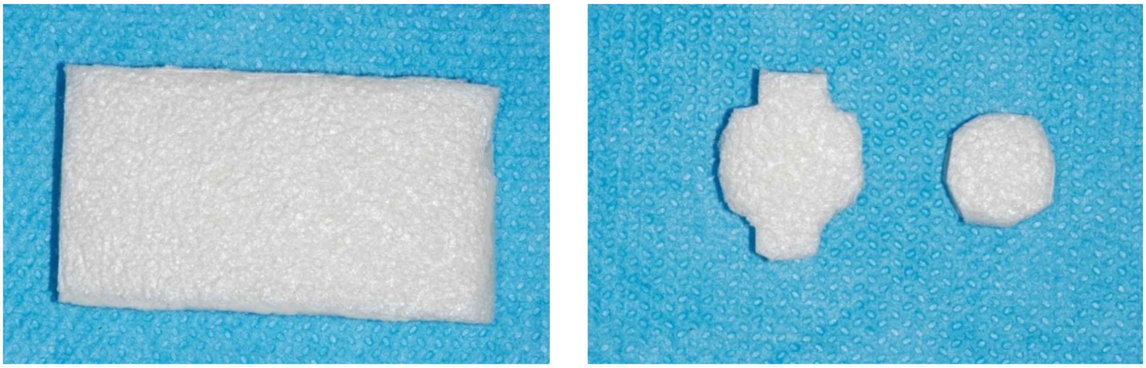

Fig. 4. *(**a**): Three-dimensional collagen matrix (Bioteck); (**b**): three-dimensional modeled collagen matrix (Bioteck).*

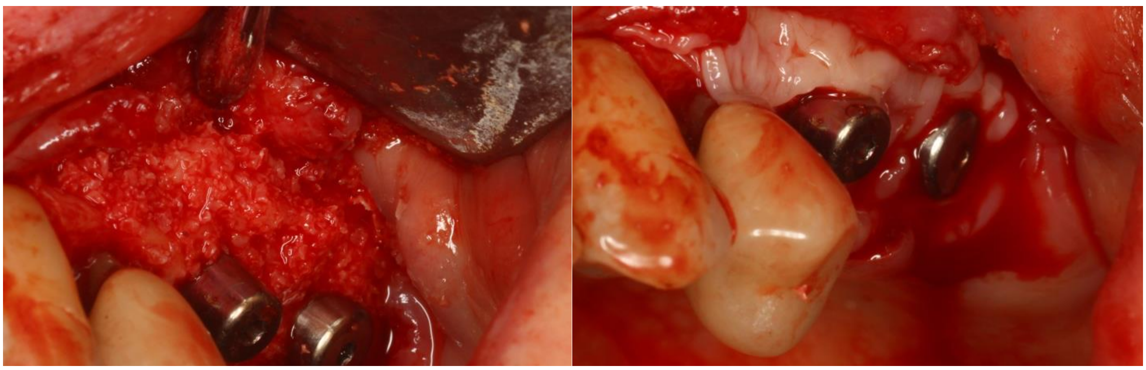

Fig. 5. *(**a**): In situ implants, heterologous biomaterial placed in surgical site; (**b**): Collagen matrix inserted in the buccal portion.*

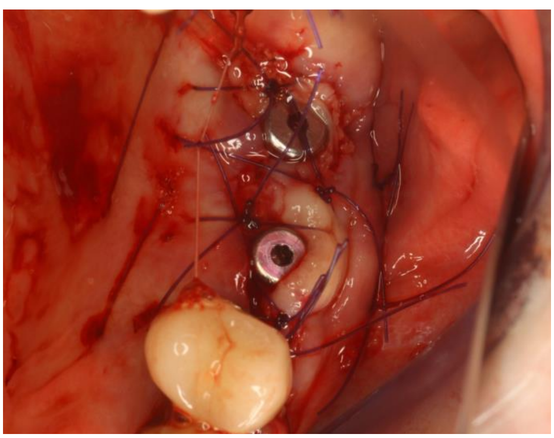

Fig. 6. *Suture.*

Fig. 7. *Healing evaluation after 7 days: occlusal view..*

solution, and a diode laser irradiated for 60 seconds the cavity (2,5 W Peak Power, 0,5 W Average Power, T-on 20 micron, T-off 80 micron, Frequency 10.000 Hz, tip 400 microns), in order to decontaminate the area and to improve the bone regeneration.

Implants were then inserted, guided prosthetically (Intralock 4.0 mm, 13 mm height), and the alveolar sack was filled with heterologous biomaterial (OX Bioteck, Vicenza, Italy). Two little wings modeled the collagen matrix: the first oval, which is cork, the second has an oval shape, and two wings, which are then placed between detached periosteal and bone (Fig. 4).

The buccal wing is shut down to cover the bone loss over the extracted medial root, previously probed (Fig. 5). The matrix is stabilized with a suture (Fig. 6). After seven days of healing (Fig. 7), a strip of soft tissue spreads through the superior portion of the matrix. This phenomenon is remarkable after 3 months (Fig. 8). At the end of the healing process, good quality and quantity of soft tissue around the implants were gained without any additional intervention.

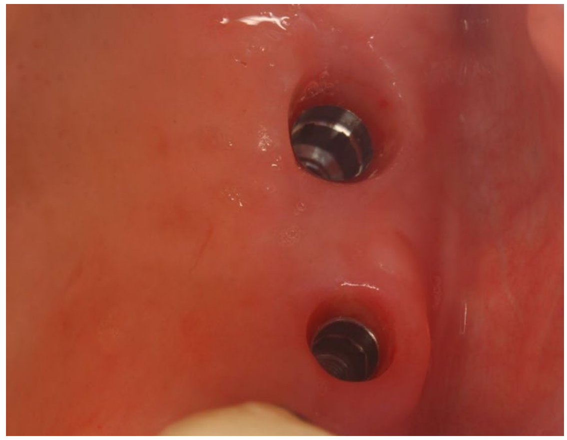

Fig. 8. *Healing evaluation after 3 months: occlusal view.*

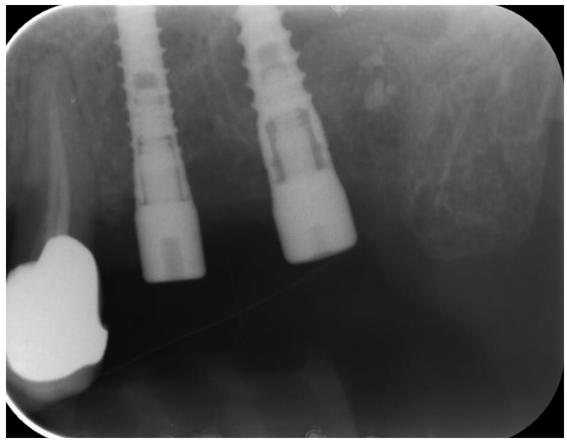

Fig. 9. *An X-ray was carried out after 3 months.*

Fig. 10. *Definitive ceramic prosthesis.*

Prosthetization

An X-ray was made after 3 months (Fig. 9). Then, a precision impression was obtained using an individual impression tray. A titanium stump with a shoulder height of 1 mm was then realized with a prosthetic crown made of zirconia-ceramic (Fig. 10).

DISCUSSION

The possibility of regenerating lost tissues is well known in Dentistry. Two types of tissue regeneration are known: Guided Bone Regeneration (GBR) and Guided Tissue Regeneration (GTR). They are considered the starting point of tissue engineering (TE). GBR is used for bone regeneration so that a patient will need a second surgery to graft soft tissues; GTR is the regeneration of the entire periodontium (cementum, periodontal ligament, alveolar bone proper, and gingiva).

It is also to be considered that the matrix, absorbable or not, must be entirely covered by the gingiva to avoid an unsuccessful outcome (12). Generally speaking, TE aims to achieve soft tissue regeneration. Several types of tissues can be regenerated with TE starting from mesenchymal stem cells (MSC), and indeed this is one of the most promising frontiers in biomedical research. However, when MSC are used, no regenerative procedures at the periodontal level offer predictable clinical results till now (13). Moreover, time is longer in TE because it needs several steps like cell-factory to isolate, expanse, and differentiate (in a cell factory), to replace missing tissues (14).

This report is based on the nature of the human body: during a person's life, the organism needs to continuously generate new cells to replace lost, old or damaged tissues. Stem cells guarantee tissues' homeostasis: they can selfrenovate and generate progenies which differentiate and become tissues. Besides, MSC are the main actors during the healing process.

This process is easy to observe in epidermis wounds: the skin is a system with a high regenerative capacity and is considered the best tissue for studying the regenerative role of the stem cells. Combining this procedure with a laser protocol gets a better soft and hard tissue regeneration (15-16) and decontamination of the surgical site (17-21).

Heterologous collagen was used to fill bone gaps. This material can be used in the wound while rebuilding to favor the tissue healing process. The matrix is the starting point of neovascularization and new tissue formation. It is well tolerated by the organism and replaced by the new tissue. Furthermore, collagen can be used in case of substantial bone tissue loss when a spongy bone transplant is not possible. This material plays a fundamental role in the reparative process and can improve the surgeon's everyday practice. This technique allows the surgeon to create new gingiva around an implant easily.

Regarding bone substitutes, they have to be of a biological matrix; the presence of native collagen makes bone substitutes a perfect base for regeneration. This matrix contains all characteristics that have been described by Hardwick et al. in 1994 (9):

biocompatibility: they need to be made with materials that will not trigger cytotoxic and/or immunogenic reactions;

occlusive: avoiding connective tissue and bacteria to go under it but allowing at the same time nutrients to pass through it and reach the blood flow;

integration in a different tissue;

space maintenance: stabilization of blood cloth with the subsequent tissue regeneration;

easy to handle: to help the surgeon deal with different anatomic situations.

CONCLUSIONS

This case report demonstrates that secondary surgery could be avoided (i.e., soft tissue grafting). In addition, the surgeon can stimulate bone regeneration, effectively reducing the treatment period and the patient's discomfort.

Author Contributions

GC designed the research study. GC performed the research. PC and GC wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

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Conflict of Interest

The authors declare no conflict of interest.

REFERENCES

1. Albrektsson T, Sennerby L. State of the art in oral implants. *Journal of Clinical Periodontology*. 1991;18(6):474-481. doi:10.1111/j.1600-051x.1991.tb02319.x
2. Sculean A, Gruber R, Bosshardt DD. Soft tissue wound healing around teeth and dental implants. *Journal of Clinical Periodontology*. 2014;41(15):S6-S22. doi:10.1111/jcpe.12206
3. Goldberg PV, Higginbottom FL, Wilson TG. Periodontal considerations in restorative and implant therapy. *Periodontology 2000*. 2001;25(1):100-109. doi:10.1034/j.1600-0757.2001.22250108.x
4. Esposito M, Maghaireh H, Grusovin MG, Ziounas I, Worthington HV. Soft tissue management for dental implants: what are the most effective techniques? A Cochrane systematic review. *European Journal of Oral Implantology*. 2012;5(3):221-238.
5. Esposito M, Maghaireh H, Grusovin MG, Ziounas I, Worthington HV. Interventions for replacing missing teeth:

management of soft tissues for dental implants. *Cochrane Database of Systematic Reviews*. Published online February 15, 2012. doi:10.1002/14651858.cd006697.pub2

6. D 'ADdona A, Nowzari H. Intramembranous autogenous osseous transplants in aesthetic treatment of alveolar atrophy. *Periodontology 2000*. 2001;27(1):148-161. doi:10.1034/j.1600-0757.2001.027001148.x
7. Rossetti PHO, Bonachela WC, Rossetti LMN. Relevant Anatomic and Biomechanical Studies for Implant Possibilities on the Atrophic Maxilla: Critical Appraisal and Literature Review. *Journal of Prosthodontics*. 2010;19(6):449-457. doi:10.1111/j.1532-849x.2010.00615.x
8. Palacci P, Nowzari H. Soft tissue enhancement around dental implants. *Periodontology 2000*. 2008;47(1):113-132. doi:10.1111/j.1600-0757.2008.00256.x
9. Hardwick R, Scantlebury TV, Sanchez R, Whitley N, Ambruster J. Membrane design criteria for guided bone regeneration of the alveolar ridge. In: *Guided Bone Regeneration in Implant Dentistry*. Quintessence; 1994:101-136.
10. Hutmacher D, Hürzeler MB, Schliephake H. A review of material properties of biodegradable and bioresorbable polymers and devices for GTR and GBR applications. *The International Journal of Oral & Maxillofacial Implants*. 1996;11(5):667-678.
11. Behring J, Junker R, Walboomers XF, Chessnut B, Jansen JA. Toward guided tissue and bone regeneration: morphology, attachment, proliferation, and migration of cells cultured on collagen barrier membranes. A systematic review. *Odontology*. 2008;96(1):1-11. doi:10.1007/s10266-008-0087-y
12. Ling LJ, Hung SL, Lee CF, Chen YT, Wu KM. The influence of membrane exposure on the outcomes of guided tissue regeneration: clinical and microbiological aspects. *Journal of Periodontal Research*. 2003;38(1):57-63. doi:10.1034/j.1600-0765.2003.01641.x
13. Xiong J, Gronthos S, Bartold PM. Role of the epithelial cell rests of Malassez in the development, maintenance and regeneration of periodontal ligament tissues. *Periodontology 2000*. 2013;63(1):217-233. doi:10.1111/prd.12023
14. Pittenger MF, Mackay AM, Beck SC, et al. Multilineage potential of adult human mesenchymal stem cells. *Science (New York, NY)*. 1999;284(5411):143-147. doi:10.1126/science.284.5411.143
15. Caccianiga G, Cambini A, Donzelli E, Baldoni M, Rey G, Paiusco A. Effects of laser biostimulation on the epithelial tissue for keratinized layer differentiation: an in vitro study. *Journal of Biological Regulators and Homeostatic Agents*. 2016;30(2 Suppl 1):99-105.
16. Leonida A, Paiusco A, Rossi G, Carini F, Baldoni M, Caccianiga G. Effects of low-level laser irradiation on proliferation and osteoblastic differentiation of human mesenchymal stem cells seeded on a three-dimensional biomatrix: in vitro pilot study. *Lasers in Medical Science*. 2012;28(1):125-132. doi:10.1007/s10103-012-1067-6
17. Caccianiga G, Rey G, Baldoni M, Paiusco A. Clinical, Radiographic and Microbiological Evaluation of High Level Laser Therapy, a New Photodynamic Therapy Protocol, in Peri-Implantitis Treatment; a Pilot Experience. *BioMed Research International*. 2016;2016:1-8. doi:10.1155/2016/6321906
18. Caccianiga G, Rey G, Fumagalli T, Cambini A, Denotti G, Giacomello MS. Photodynamic Therapy (Association Diode Laser/Hydrogen Peroxide): Evaluation of Bactericidal Effects on Periodontopathy Bacteria: An in Vitro Study. *European Journal of Inflammation*. 2012;10(2_suppl):101-106. doi:10.1177/1721727x120100s220
19. Caccianiga G, Cambini A, Rey G, Paiusco A, Fumagalli T, Giacomello MS. The Use of Laser Diodes Superpulses in Implantology. *European Journal of Inflammation*. 2012;10(2_suppl):97-100. doi:10.1177/1721727x120100s219
20. Caccianiga G, Urso E, Monguzzi R, Gallo K, Rey G. Efecto bactericida del láser de diodo en periodoncia. *Avances en Periodoncia e Implantología Oral*. 2007;19(3). doi:10.4321/s1699-65852007000400002
21. Caccianiga G, Baldoni M, Ghisalberti CA, Paiusco A. A Preliminary In Vitro Study on the Efficacy of High-Power Photodynamic Therapy (HLLT): Comparison between Pulsed Diode Lasers and Superpulsed Diode Lasers and Impact of Hydrogen Peroxide with Controlled Stabilization. *BioMed Research International*. 2016;2016:1-6. doi:10.1155/2016/1386158