

Clinical considerations for optimizing results in bone grafting: part II

Claudio Ferreira **NÓIA**¹, Bruno Costa Martins de **SÁ**², José Marcelo Vargas **PINTO**³, Paulo Hemerson de **MORAES**⁴, Rafael Ortega **LOPES**⁵

88

Abstract: Optimization of results is an ongoing concern shared by professionals in the field of Implantology. In order to achieve the best results possible, it is necessary to adequately address factors that can directly affect them. Thus, the aim of the present study was to assess and discuss the importance of some aspects that have a direct effect on bone tissue grafting, such as adaptation and fixation to the receptor site, the use of biomaterial to fill interfaces and cover grafts, together with the use of resorbable membranes. In addition, we address and discuss the increasing use of biomaterial to fill the buccal gap in cases of immediate implants, which renders immediate implant placement safer by stabilizing all tissues involved. Thus, it is possible to state that results obtained with immediate implants are satisfactory and can reduce the number of large-scale reconstructions. **Keywords:** Increase in alveolar ridge. Bone resorption. Dental implants

¹Professor, UNIARARAS, Araras, São Paulo, Brazil and CIODONTO, Porto Velho, Rondônia, Brazil.

²Professor, CIODONTO, Porto Velho, Rondônia, Brazil.

³Professor, Faculdade São Lucas, Porto Velho, Rondônia, Brazil.

⁴PhD in Oral and Maxillofacial Surgery and Traumatology, UNICAMP, Campinas, São Paulo, Brazil.

⁵Professor, Associação Paulista de Cirurgiões-Dentistas, Piracicaba, São Paulo, Brazil.

How to cite this article: Nóia CF, Sá BCM, Pinto JMV, Moraes PH, Lopes RO. Clinical considerations for optimizing results in bone grafting: Part II. Dental Press Implantol. 2015 Jan-Mar;9(1):88-103. doi: <http://dx.doi.org/10.14436/2237-650X.9.1.088-103.oar>

Submitted: 19/10/2014 - **Revised and accepted:** 5/03/2015

Contact address: Claudio Ferreira Nóia

Departamento de Odontologia, UNIARARAS - Av. Dr. Maximiliano Baruto, 500 - Jd. Universitário - Araras/SP - Brazil

CEP: 13607-339 - E-mail: claudionola@uniararas.br / claudioferreira2004@yahoo.com.br

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

» Patients displayed in this article previously approved the use of their facial and intraoral photographs.

INTRODUCTION

Loss of one or multiple teeth causes an imbalance between bone formation and resorption of the alveolar process, which usually leads to alveolar atrophy and bone defects of height, thickness or both.^{1,2} In addition, it is also known that the quantity and quality of bone in the implant receptor site are key to the success of implant treatment protocols.^{3,4,5}

Thus, bone graft prior to dental implant placement is considered a feasible option that, when well executed, is able to readjust atrophic ridges, thereby providing implant placement with long-term stability in these regions.^{2,6-10}

Immediate implant placement aims at optimizing results and promoting long-term stability. Importantly, it has become more and more popular in recent years. This technique might be associated with immediate implant loading when patients seek treatment with the condemned tooth still in the oral cavity.^{11,12,13}

However, achieving satisfactory outcomes as a result of bone grafting or immediate implant placement remains a challenge for implantodontists, particularly in more complex cases or when unpredictable defects are involved.^{8,10,13-20} Thus, further studies are required to assist professionals in their search for better clinical results.

In light of the above, the aim of this study was to provide clinical professionals with a number of peculiarities, aspects and

measures that should be assessed and taken into consideration when using bone grafts. These include adaptation and fixation of graft and its association with biomaterial, as well as certain peculiarities related to filling buccal gaps in cases of immediate implants, which allow excellent results to be achieved.

CLINICAL CONSIDERATIONS RELATED TO BONE GRAFTING AND DENTAL IMPLANTS

1) Importance of graft modelling and adaptation to the receptor site

Contact between bone graft and the receptor site is extremely important for bone grafting success.^{3,4} However, in most cases, the receptor site is not completely flat, which would favor adaptation of the graft. Furthermore, the block graft itself, which is harvested from a donor site, does not always exhibit shape and/or characteristics that favor this contact.^{2,7,10}

The existence of gaps between the surface of the graft and the receptor site hinders nutrition of the block graft and favors resorption. It also hinders revascularization and favors the invasion of soft tissue in the area, which, in turn, prevents the implant from adapting to the receptor site and leads the procedure to failure (Fig 1).^{1,3,21}

As a result, most of times, it is necessary to wear down the medullary surface of the graft with the aid of drills and under copious irrigation with saline solution.

This promotes close contact between graft and receptor site. Even when the block graft is worn down to favor con-

tact, adaptation is often not ideal and needs to be complemented with particulate autogenous bone graft. Lyophilized

90

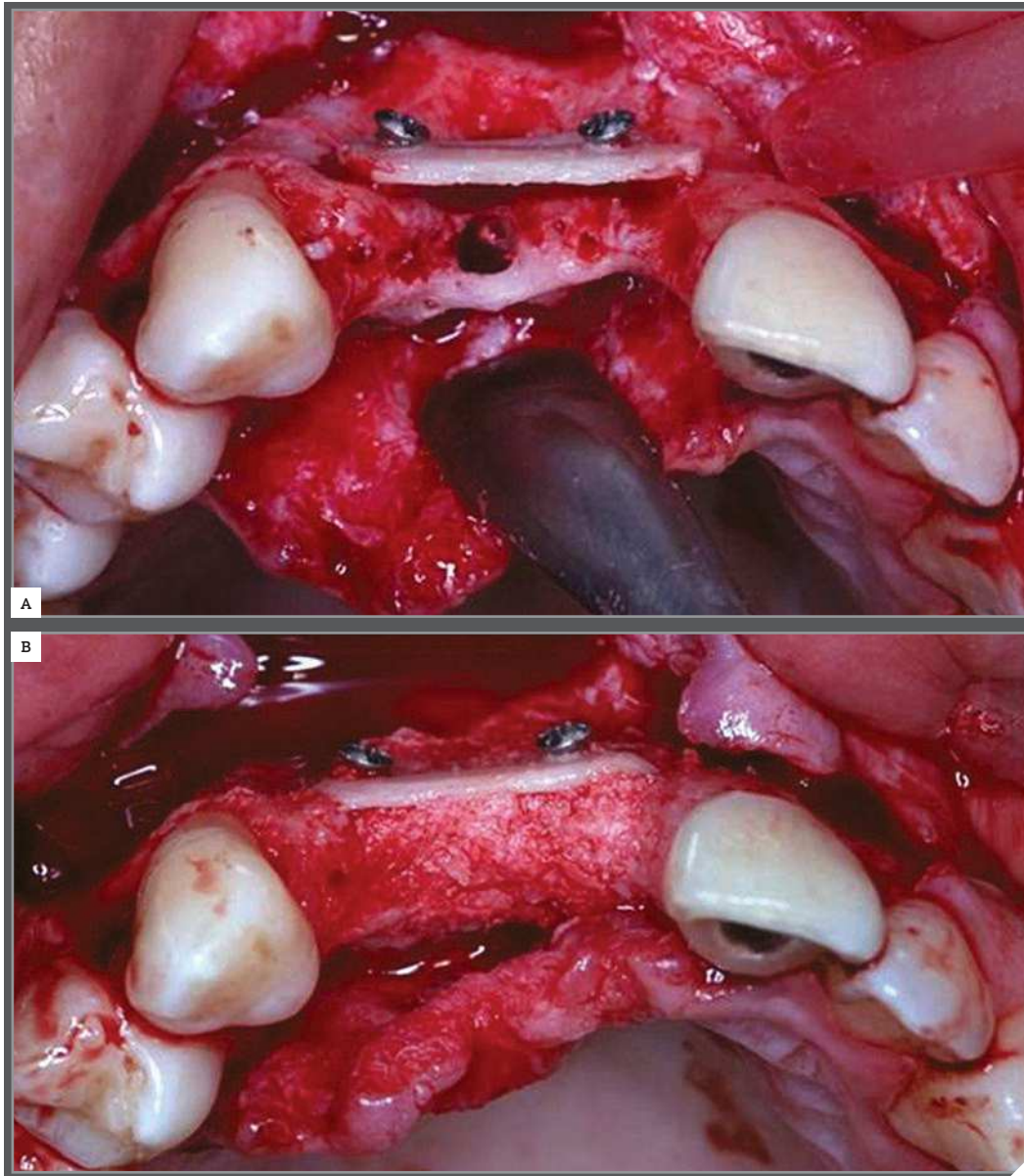


Figure 1. **A)** Block bone graft adapted to an irregular receptor ridge. Note the large gap between the two surfaces, which allows invasion of soft tissue. **B)** The gap is filled with autogenous bone graft, which provides reconstruction with homogeneity and prevents invasion of soft tissue, thereby leading to better overall results.

biomaterial should be carefully used, since it tends to reabsorb and enable the invasion of soft tissue (Fig 2).^{3,4,9}

It is also possible, although less recommended, to wear down the surface of the receptor site in order to flatten it and favor adaptation of the block graft. However, when performed, wear must

be kept to a minimal in order to avoid compromising the next surgical stage (fixation of block graft).^{3,4,9}

In cases of extremely irregular receptor sites, another option is to grind the block bone graft and use it in particulate together with a titanium mesh. However, this type of graft tends to

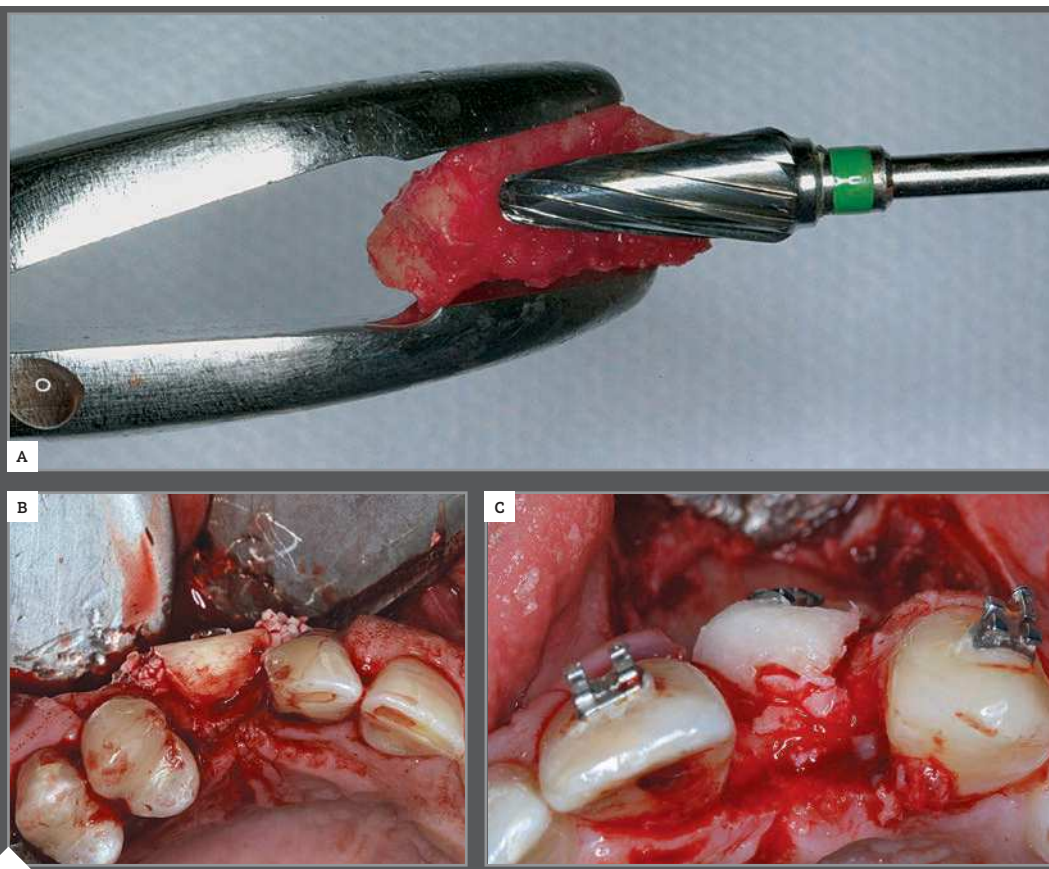


Figure 2. **A)** Wearing down the medullary surface of bone graft with the aid of a drill in order to improve adaptation to the receptor site. **B, C)** Block bone graft completely adapted to the receptor site. Note the close contact between the two surfaces.

undergo greater resorption and exhibit a higher exposure rate than block bone graft (Fig 3).^{3,4,21,22,23}

2) Importance of the graft fixation technique

Complete absence of mobility is ex-

tremely important to achieve bone graft success. According to the literature, graft exhibiting mobility tends to be lost (reabsorbed) during the incorporation process. Graft without mobility is completely dependent on the fixation technique used.^{24,25,26}

92

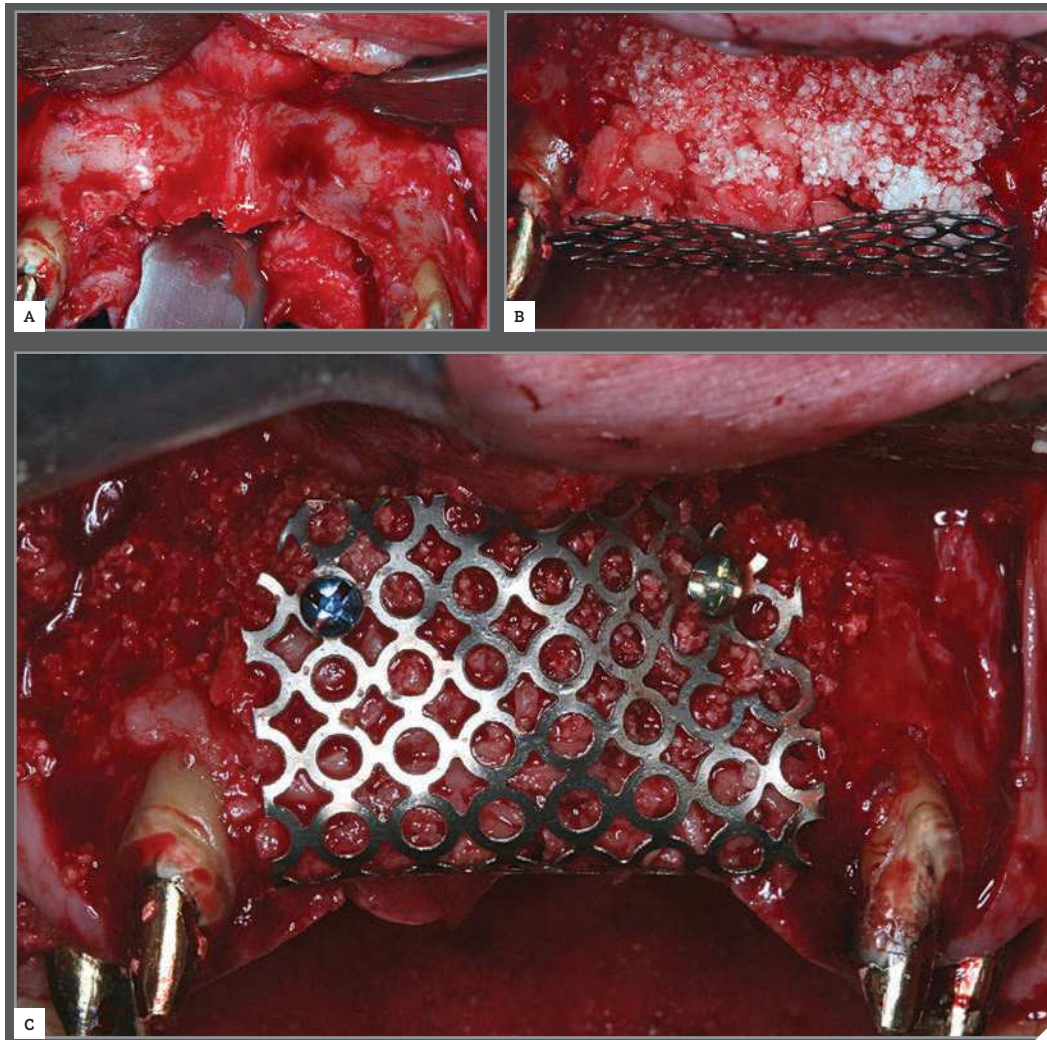


Figure 3. Irregular ridge hindering satisfactory adaptation of the block bone graft. The alternative in this case was the use of particulate autogenous bone graft combined with a titanium mesh.

Block bone grafts are fixed by bicortical screws, using one of the following techniques:

» **(2a) Positional technique:** Both block bone graft and receptor site are drilled by a milling cutter of smaller diameter than the screw. For example, if perforation was performed with a 1.2-mm milling cutter, fixation would be conducted using a 1.5-mm screw. Thus, fixation load will be shared by both surfaces, given that the screw will be engaged by both (Fig 4).^{3,4,14,22}

» **(2b) Compression technique:** Block bone graft is drilled by a milling cutter of larger diameter than the screw, whereas the receptor site is drilled by a milling cutter of smaller diameter than the screw. For example, if the block bone graft is drilled by a 1.6-mm milling cutter, the receptor site is drilled by a 1.2-mm cutter, and overall fixation is performed with a 1.5-mm screw. Thus, fixation load purely affects the receptor site, given that the screw will passively by-pass the block, completely engaging with the receptor site. In this technique, the block bone graft is pressed against the receptor site, which improves adaptation and eliminates/decreases potential gaps, thereby favoring the incorporation process (Fig 5).^{3,4,14,22}

Consequently, the compressive technique is recommended for fixation of block bone grafts. The number of screws should be decided on a case-by-case basis.

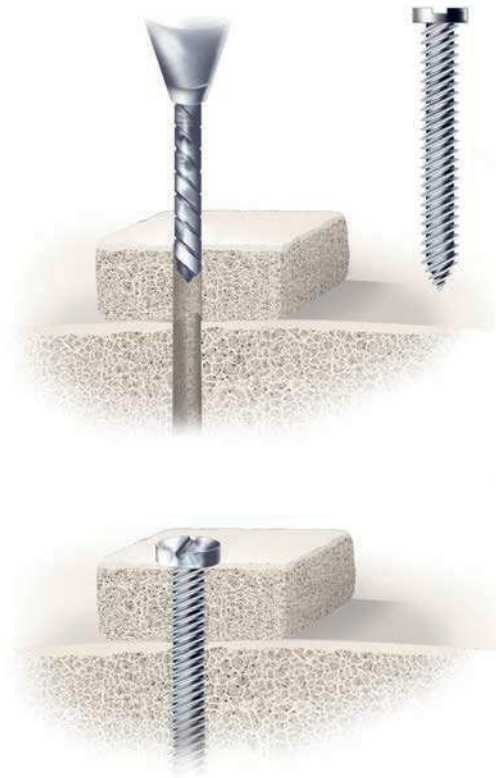


Figure 4. Positional fixation technique. Note the engagement (locking) of the screw, both in the graft and the receptor site (Source: Mazzonetto et al⁴).

Fixation of particulate graft performed on the alveolar ridge should be combined with a titanium mesh and monocortical screws. In such cases, fixation is achieved by the positional technique (Fig 6).^{3,4,14,22}



Figure 5. Compressive fixation technique. Note that engagement only occurred in the receptor area. According to the literature, this method provides better results (Source: Mazzonetto et al⁴).

94

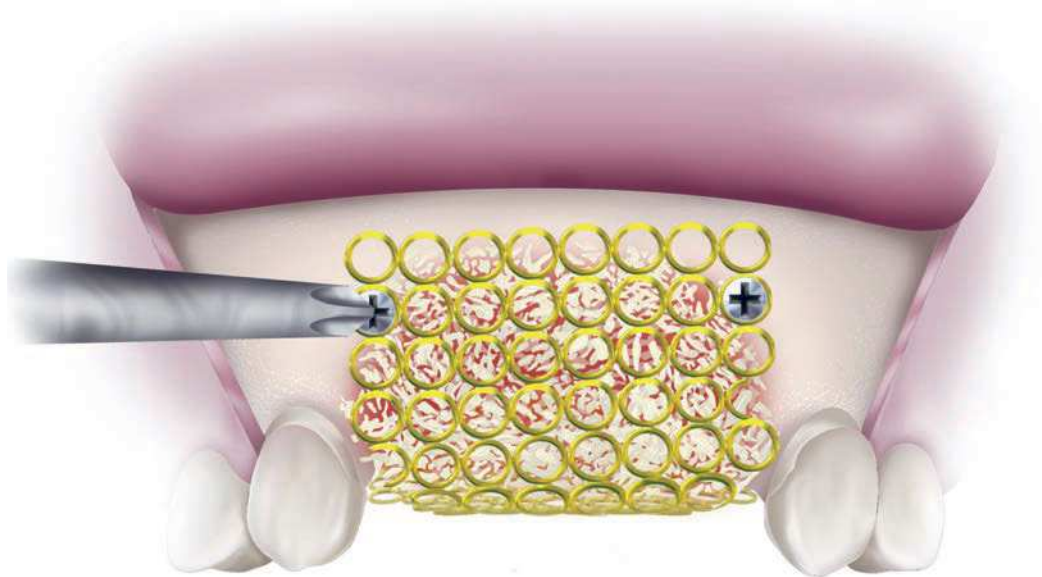


Figure 6. Fixation of particulate graft with a titanium mesh and screws (Source: Mazzonetto et al⁴).

3) Importance of interface filling, graft coverage with lyophilized bone and resorbable membrane

In recent years, placing a layer of heterogeneous material over autogenous bone and its interface areas, together with a resorbable collagen membrane, has been frequently mentioned in the literature as a method to decrease resorption.¹⁵⁻²⁰ Monje et al¹⁵ used computed tomography scans to assess the increase in thickness of 19 block bone grafts harvested from the iliac crest or mandibular ramus, and associated with heterogeneous graft. The authors concluded that this technique is predictable and favors implant placement. Similarly, Maiorana et al¹⁶ conducted a

histomorphometric analysis on the efficiency of combining autogenous graft with anorganic bovine bone and resorbable membrane. They found that the technique was capable of maintaining the volume of block bone grafts, particularly those with greater amount of spongy tissue.

The great advantage of coverage lies in the fact that the collagen membrane isolates the graft from the overlying soft tissue of which healing process is quick, with a tendency to early invasion towards the block bone graft. On the other hand, when the block bone graft is covered by lyophilized material, periosteum tension and resorption are concentrated on this material, which protects the block (Fig 7).

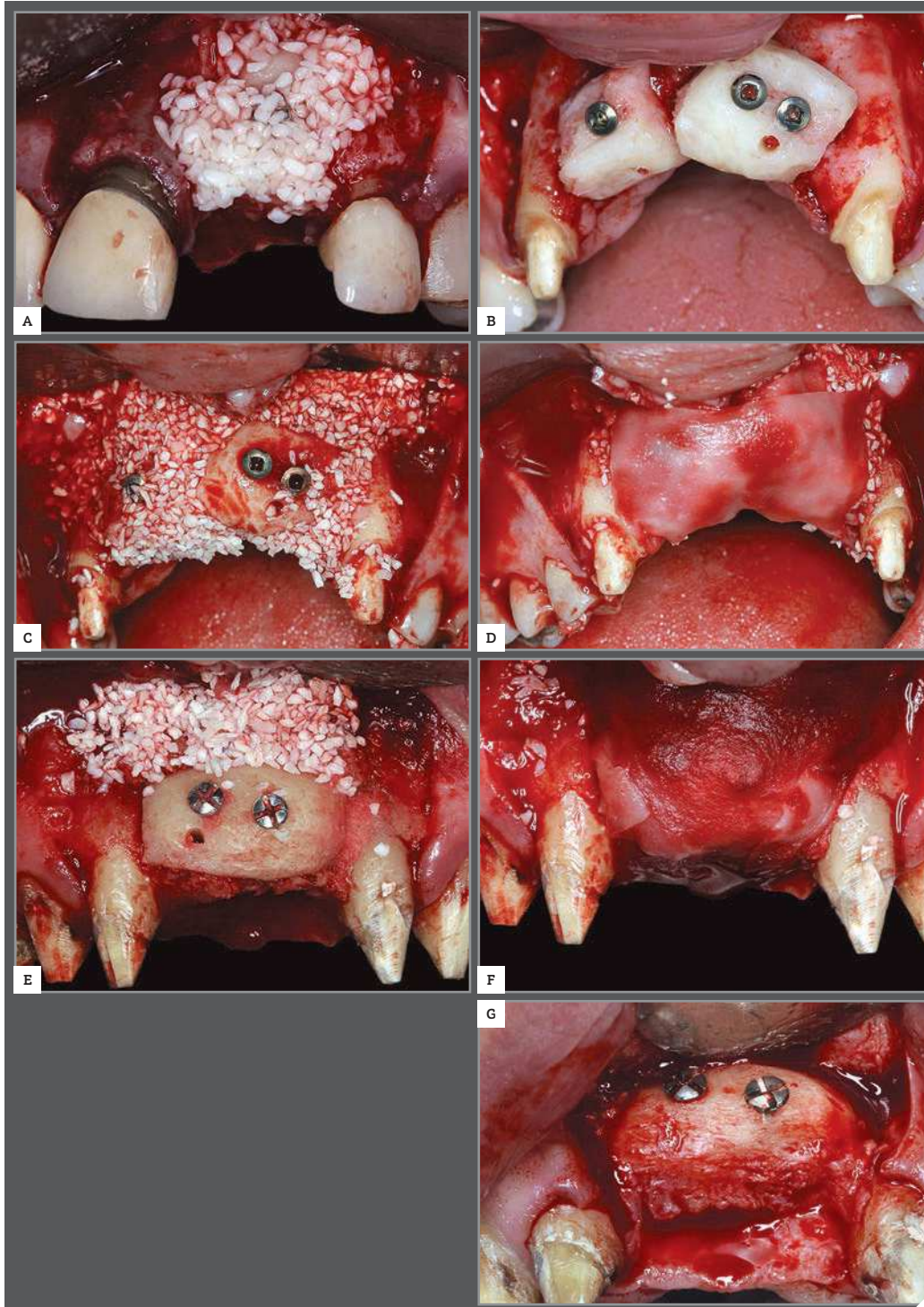


Figure 7A to 7G. Block bone grafts covered by lyophilized bovine bone (Lumina-Bone, Critéria) and resorbable collagen membrane (Lumina-Coat, Critéria).

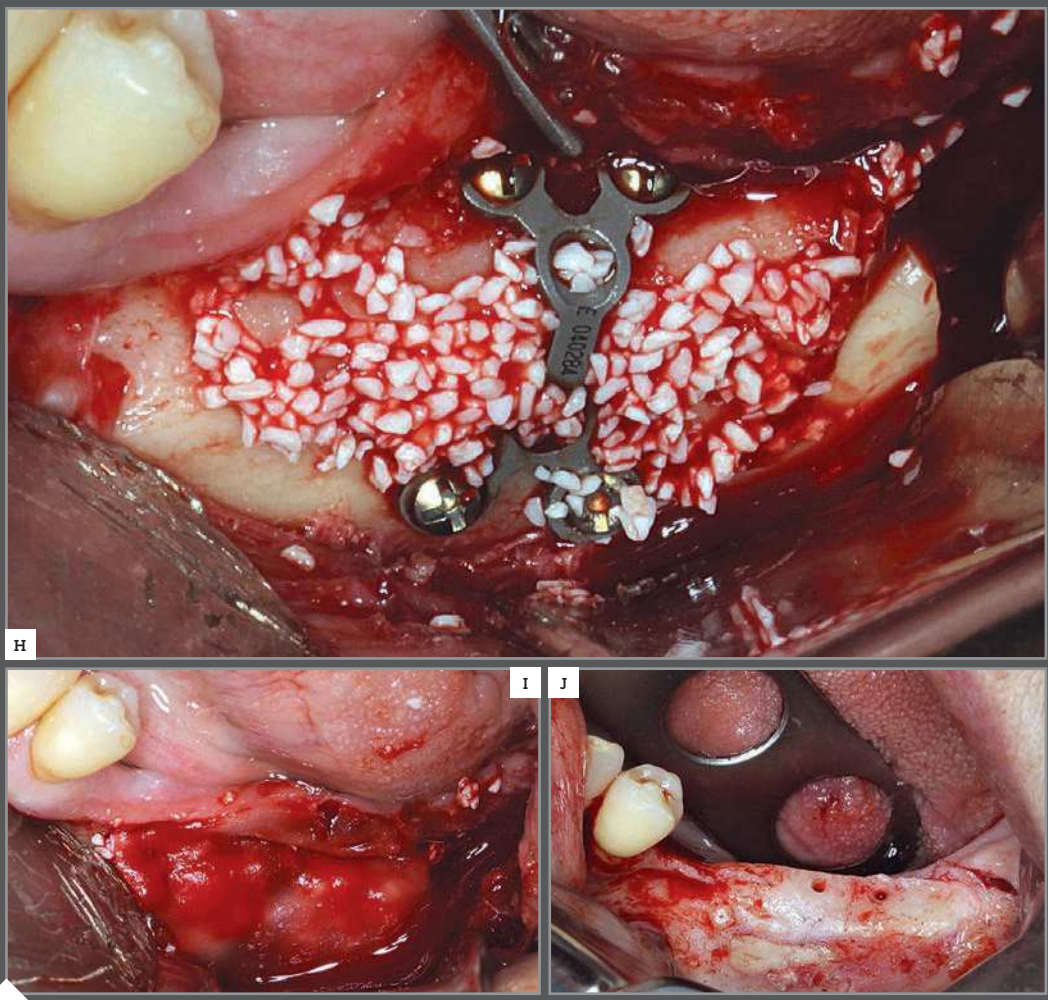


Figure 7H, 7I, 7J. Segmental osteotomy filled with lyophilized bovine bone and resorbable membrane (Lumina-Bone and Lumina-Coat, Critéria).

4) Importance of buccal gap filling for immediate implants

Presently, immediate implant placement have become increasingly common and are considered the best alternative to replace a condemned tooth.²⁷

For many years, after a tooth was diagnosed as condemned, it was removed and a short period was allowed to pass (two to six months) before the next assessment. Should there be sufficient bone, implant placement was performed normally.^{2,3,9,21}

However, the vast majority of cases used to involve loss of buccal bone wall, resulting in thickness defect, which may compromise esthetics. In these cases, treatment comprehended block bone graft potentially combined with soft tissue graft for subsequent implantation.^{2,3,9,21,22}

Presently, there has been a paradigm shift and this type of treatment is only used when immediate implants are not an option, which is a minority of cases.

Predictability of immediate implant placement has increased considerably after the need to fill the buccal gap was acknowledged. Importantly, it was initially done with autogenous bone and, more recently, with biomaterial. It is known that the buccal bone plate of a condemned tooth generally measures

approximately 1 mm and tends to reabsorb after tooth extraction. Thus, atraumatic tooth extraction is performed and the implant is milled in the tooth socket, thereby creating a gap between the implant threads and the remaining buccal bone plate. This gap should be filled with osteoconductive material in order to stabilize the bone plate and consequently maintain the entire gingival outline.²⁷⁻³⁰

In cases when immediate implant torque is greater than 30 N/cm², immediate loading is also recommended; however, without allowing it to occlude. If this torque is not achieved, it is better to adapt a temporary tooth to the adjacent teeth.²⁷⁻³⁰

Whenever the buccal gap is adequately filled, regardless of its size, immediate implant placement has been shown to be more predictable and stable, with less morbidity and better esthetic outcomes (Fig 8).²⁷⁻³⁰

DISCUSSION

Oral rehabilitation by means of dental implants is considered a feasible, predictable and long-lasting alternative to treat partially or completely edentulous patients. However, clinical situations that hinder this type of rehabilitation are often encountered. In these cases, more complex surgical techniques, such as bone grafts, are required.^{6,8,20,21}

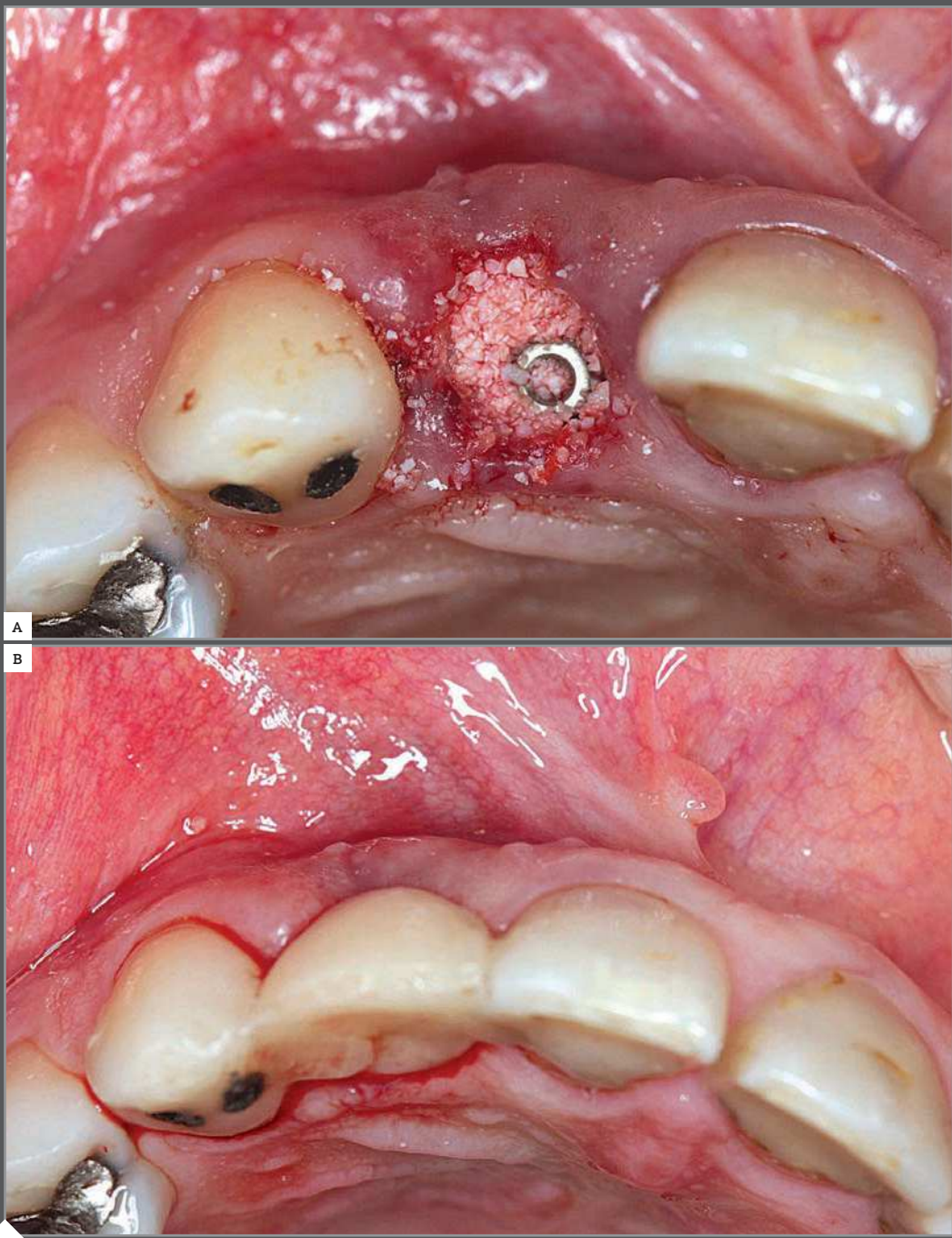
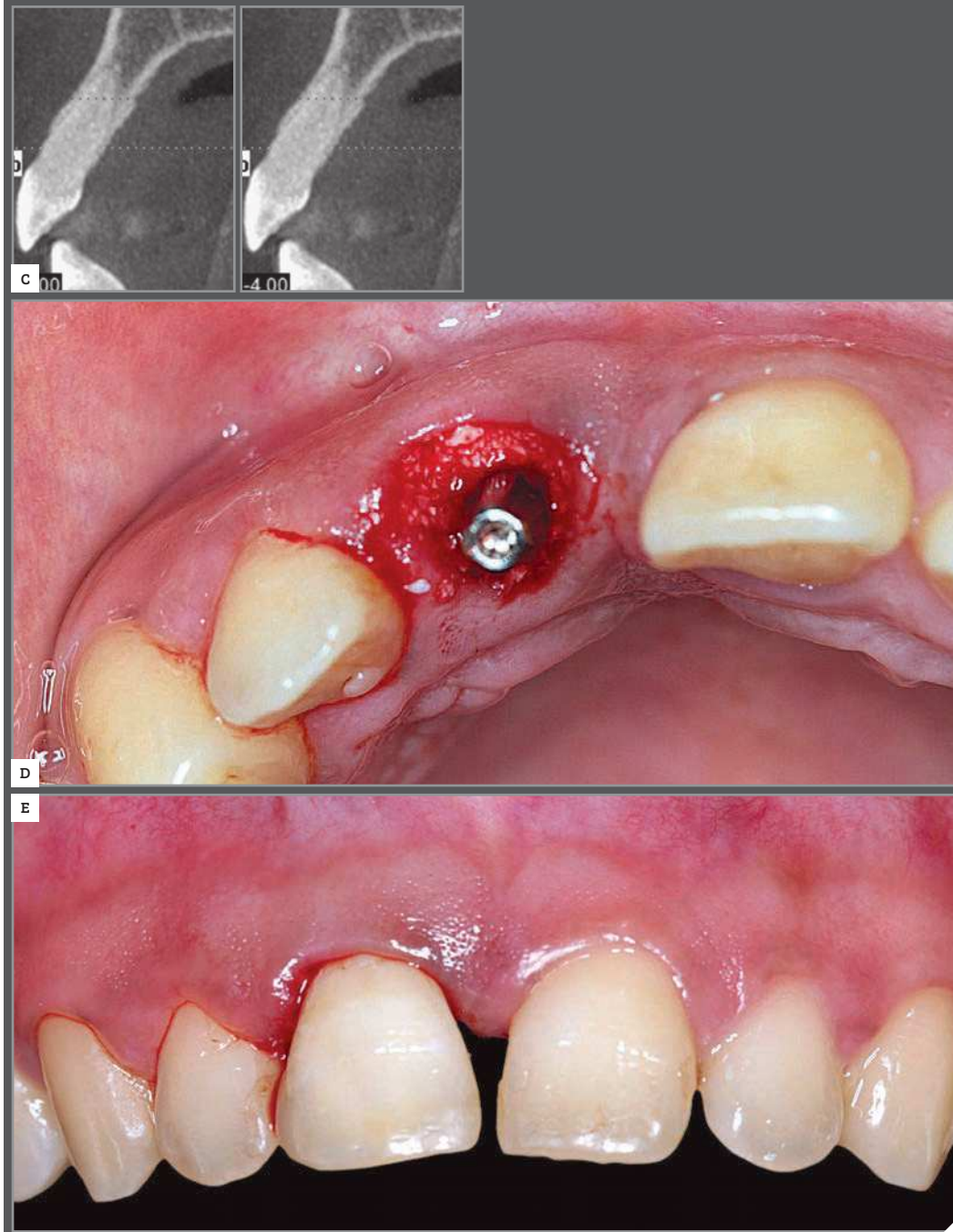


Figure 8A, 8B. Immediate implant placement in the region of tooth #12. Note that the implant was placed more palatally, creating space between the implant threads and the buccal bone plate. This gap was filled with lyophilized heterogenous material (Lumina-Porous, Critéria). Since the implant was not locked adequately in this case, a temporary tooth was adapted to adjacent teeth.



100

Figure 8C, 8D, 8E. Immediate implant placement in the region of tooth #11. The tomographic image displays the presence of buccal bone plate (1 mm). After performing implant placement palatally, the gap was filled with bio-material (Lumina-Porous, Critéria) and, since the implant was locked adequately, the patient's tooth was adapted as a provisional measure.

Achieving excellent results with bone graft remains a daunting challenge for professionals. Thus, it is important to stress that factors such as adaptation and fixation of the graft into the receptor site are extremely relevant, since they favor direct contact between the two surfaces, thereby offering continuity and, thus, promoting nutrition, revascularization and incorporation of the graft. Should the opposite occur, the reconstructive procedure will almost certainly fail, leading to greater economic, and more importantly, biological costs.

Emphasizing the importance of adaptation and fixation of the graft to the receptor site is not new. It dates back to the first, somewhat rudimentary, studies conducted by Phillips and Rahn^{24,26} and La Trenta et al.²⁵ These authors reported the need for rigid fixation of grafts in order to promote incorporation. They also stated that mobility would lead grafts to fail.

Filling the interfaces between block grafts, as well as covering them with lyophilized bovine bone and resorbable collagen membranes, also significantly favors more satisfactory results to be achieved with the use of bone grafts. Studies such as those conducted by Block et al,⁸ Maiorana et al,¹⁶ Cosso et al¹⁷ and Monje et al,¹⁵ all of which assessed the importance of this type of association, are unanimous in stating that this technique leads to less bone resorption, thereby providing surgeons with more confidence.

Nowadays, the number of cases that require very complex reconstructions has decreased thanks to recent advances in the field of immediate implant placement. For many years, the use of immediate implants was considered unpredictable and high-risk. However, there has been a paradigm shift and this is now considered to be the best alternative to replace a condemned tooth, with the implant being often loaded immediately.

Paradigm shift and changes in philosophies were determined by a number of changes in the use of immediate implants, including the following: the use of longer implants with a smaller diameter; implant placement palatally to enable the buccal gap to be filled with biomaterial and the buccal bone plate to stabilize; atraumatic extractions and flapless surgery; as well as immediate temporization.²⁷⁻³⁰ Taken together, these factors enable the stabilization of soft and hard tissues around these implants. Thus, it is possible to conclude that this is the best option when replacing a condemned tooth.

FINAL CONSIDERATIONS

All aforementioned factors together, when executed adequately and including adaptation and fixation of the graft to the receptor site, combined with the use of biomaterial and membranes, optimize the results of bone reconstruction. Immediate implant placement, associated with filling of the buccal gap with biomaterial, has been shown to be feasible and predictable in terms of decreasing, or even preventing, large-scale reconstructions.

REFERENCES

- Nóia CF, Rodríguez-Chessa JG, Chaves Netto HDM, Ortega-Lopes R, Mazzonetto R. Relación entre éxito y fracaso en los procedimientos implantológicos: análisis retrospectiva de 06 años. *Acta Odontol Venezolana*. 2010;48(4):1-6.
- Nóia CF, Chaves Netto HDM, Ortega-Lopes R, Rodríguez-Chessa JG, Mazzonetto R. Uso de enxerto ósseo autógeno nas reconstruções da cavidade bucal. Análise restrospectiva de 07 anos. *Rev Port Estomatol Cir Maxillofac* 2009;50(4):221-5.
- Mazzonetto R. Reconstruções em Implantodontia: protocolos clínicos para o sucesso e previsibilidade. Nova Odessa: Napoleão; 2008.
- Mazzonetto R, Chaves Netto HDM, Nascimento FFAO, Ortega-Lopes R, Nóia CF. Enxertos ósseos em Implantodontia. Nova Odessa: Napoleão; 2012.
- Nóia CF, Ferreira-Nóia C, Marques TR, Pinto JMV, Ortega-Lopes R. Influência do gênero e da idade no processo de reparo ósseo. Estudo radiográfico prospectivo em 30 pacientes. *ImplantNews*. 2012;9(6a-PBA):189-94.
- Keller EE, Eckert SE, Tolman DE. Maxillary antral and nasal one-stage inlay composite bone graft: preliminary report on 30 recipient sites. *J Oral Maxillofac Surg*. 1994;52(5):438-47.
- Becktor JP, Isaksson S, Sennerby L. Survival analysis of endosseous implants in grafted and nongrafted edentulous maxillae. *Int J Oral Maxillofac Implants*. 2004;19(1):107-15.
- Block MS, Kent JN, Kallukaran FU, Thunthy K, Weinberg R. Bone maintenance 5 to 10 years after sinus grafting. *J Oral Maxillofac Surg*. 1998;56:706-14.
- Cordaro L, Torsello F, Accorsi Ribeiro C, Liberatore M, Mirisola di Torresanto V. Inlay-onlay grafting for the three-dimensional reconstruction of the posterior atrophic maxilla with mandibular bone. *Int J Oral Maxillofac Surg*. 2010;39:350-7.
- Acocella A, Bertolai R, Nissan J, Sacco R. Clinical, histological and histomorphometric evaluation of the healing of mandibular ramus bone block grafts for alveolar ridge augmentation before implant placement. *J Cranio-Maxillo-Fac Surg*. 2010;38(2):22-30.
- Ryu HS, Namgung C, Lee JH, Lim YJ. The influence of thread geometry on implant osseointegration under immediate loading: a literature review. *J Adv Prosthodont*. 2014;6(6):547-54.
- Wentaschek S, Scheller H, Schmidtmann I, Hartmann S, Weyhrauch M, Weibrich G, et al. Sensitivity and specificity of stability criteria for immediately loaded splinted maxillary implants. *Clin Implant Dent Relat Res*. 2014 Dec 23.
- Lemes HD, Sartori IA, Cardoso LC, Ponzoni D. Behaviour of the buccal crestal bone levels after immediate placement of implants subjected to immediate loading. *Int J Oral Maxillofac Surg*. 2015;44(3):389-94.
- Nóia CF, Oliveira NK, Ferreira-Nóia C, Ortega-Lopes R, Mazzonetto R. Utilização da crista ilíaca nas reconstruções ósseas da cavidade oral: relato de caso. *Rev Dental Press Periodontia Implantol*. 2011;5(2):74-82.
- Monje A, Monje F, Hernandez-Alfaro F, González-García R, Suarez F, Galindo-Moreno P, et al. Horizontal bone augmentation using autogenous block grafts and particulate xenograft in the severe atrophic maxillary anterior ridges. *J Oral Implantol*. 2014. No prelo.
- Maiorana C, Beretta M, Batista Grossi G, Santoro F, Scott Herford A, Nagurski H, et al. Histomorphometric evaluation of anorganic bovine bone coverage to reduce autogenous grafts resorption: preliminary results. *Open Dent J*. 2011;25(5):71-8.
- Cosso MG, Brito RB Jr, Piattelli A, Shibli JA, Zenóbio EG. Volumetric dimensional changes of autogenous bone and the mixture of hydroxyapatite and autogenous bone graft in humans maxillary sinus augmentation. A multislice tomography study. *Clin Oral Implants Res*. 2014;25(11):1251-6.
- Kuhl S, Gotz H, Brochhausen C, Jakse N, Filippi A, d'Hoedt B, et al. The influence of substitute materials on bone density after maxillary sinus augmentation. A microcomputed tomography study. *Int J Oral Maxillofac Implants*. 2012;27(6):1541-6.

19. Kuhl S, Brochhausen C, Gotz H, Filippi A, Payer M, d'Hoedt B, et al. The influence of bone substitute materials on the bone volume after maxillary sinus augmentation. A microcomputed tomography study. *Clin Oral Investig*. 2013;17(2):543-51.
20. Richart D, Slater JJ, Meijer HJ, Vissink A, Raghoobar GM. Maxillary sinus lift with solely autogenous bone compared to a combination of autogenous bone and growth factors or (solely) bone substitutes. A systematic review. *Int J Oral Maxillofac Surg*. 2012;41(2):160-7.
21. Triplett RG, Schow SR. Autologous bone grafts and endosseous implants: complementary techniques. *J Oral Maxillofac Surg*. 1996;54:486-94.
22. Ortega-Lopes R, N6ia CF, Chaves Neto HDM, Andrade VC, Cidade CPV, Mazzonetto R. Otimiza7ao em reconstru7ao total de maxila atrav6s da modifica7ao estrutural do enxerto e diminui7ao do intervalo cir6rgico. *ImplantNews*. 2012;9(3):383-92.
23. Ortega-Lopes R, Chaves Netto HDM, Nascimento FFAO, Kluppel LE, Stabile GAV, Mazzonetto R. Reconstru7ao alveolar com enxerto 6sseo aut6geno e malha de tit6nio: an6lise de 16 casos. *ImplantNews* 2009;6(6):673-7.
24. Phillips JH, Rahn BA. Fixation effects on membranous and endochondral onlay bone-graft resorption. *Plast Reconstr Surg*. 1988;82(5):872-7.
25. LaTrenta GS, McCarthy JG, Breitbart AS, May M, Sissons HA. The role of rigid skeletal fixation in bone-graft augmentation of the craniofacial skeleton. *Plast Reconstr Surg*. 1989;84(4):578-88.
26. Phillips JH, Rahn BA. Fixation effects on membranous and endochondral onlay bone graft revascularization and bone deposition. *Plast Reconstr Surg*. 1990;85(6):891-7.
27. Rieder D, Eggert J, Krafft T, Weber HP, Wichmann MG, Heckmann SM. Impact of placement and restoration timing on single-implant esthetic outcome: a randomized clinical trial. *Clin Oral Implants Res*. 2014. No prelo.
28. Al-Sabbagh M, Kutkut A. Immediate implant placement: surgical techniques for prevention and management of complications. *Dent Clin North Am*. 2015;59(1):73-95.
29. Chrcanovic BR, Albrektsson T, Wennerberg A. Dental implants inserted in fresh extraction sockets versus healed sites: A systematic review and meta-analysis. *J Dent*. 2015;43(1):16-41.
30. Narang S, Narang A, Jain K, Bhatia V. Multiple immediate implants placement with immediate loading. *J Indian Soc Periodontol*. 2014;18(5):648-50.