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Case report

GRAFT OF THE ILIAC CREST AND TOTAL IMPLANT FULL ARCH REHABILITATION: A MULTICASE REPORT

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ABSTRACT

The purpose of this study was to assess changes in bone volume after the block bone increase and placement of dental implants and further assess the aesthetic outcome. This case highlights the success of implant osseointegration and aesthetic oral rehabilitation 5 months after the maxillary graft with a corticocancellous block obtained from the iliac crest. This article was conducted through a literature review based on international epidemiological data. This study presents the case of two patients who benefit from this method of treatment that leads to jaw reconstruction and dental implant placement. The postoperative evolution of the patients was favourable, with the integration of the grafts of the iliac ridge and the dental implants. After the prosthetic loading, the masticatory and aesthetic function of the patients were restored. This jaw reconstruction method has proven effective, with a high degree of reliability and a significant improvement in patients' quality of life.

KEYWORDS: *bone regeneration, iliac crest graft, dental implants, maxillary reconstruction, full arch*

INTRODUCTION

Bone grafts are indicated in several cases: congenital and/or acquired defects, lack of teeth, post-traumatic resorption or loss of teeth, infections, infections and cancer. Due to inherent genetic, inductive and conductive qualities, self-transplants

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present the best material for grafts (1). Although current literature indicates several suitable sites for explanting (jaw bone and extra-oral sources such as ribs, skull, and tibia), most authors prefer explanting from the iliac crest for four major reasons:

Abundance of both sponge and cortical bone, easily adaptable to implant site;

Ease and subsequent speed of explantation;

The curvature of the iliac crest is very adaptable to the maxillary facial area;

Infrequent diseases.

The loss of the teeth causes bone resorption of the jaw, creating aesthetic and rehabilitative problems. Important atrophies can compromise facial aesthetics, particularly in cases where the simile reveals an uneven rapport between arches (2). Moreover, in This case, a non-harmonious rapport between teeth and gums or a limited opening of the oral cavity renders hygiene difficult and causes several problems.

Over the years, numerous techniques for treating maxillary atrophies, using grafts and transplants, have been proposed.

In 1980, Breine et al. (3) were the first to study the effects of these procedures. Later, Mish et al. began associating the correction and excellent results of three-dimensional maxillary defects with explant and grafting of cortical bone from the anterior-medial area of the iliac crest to elevate the maxillary sinus. Mish et al. (4) obtained a 99% survival rate after 8 years with implants inserted in grafts. After Mish et al., many others successfully proposed auto-explants from the iliac crest, with or without the maxillary sinus elevation or subsequent implant insertion. These later researches revealed that the procedure is safe (4).

TECHNIQUES

Deep incision explant

Many authors use this method when collecting large quantities of bone is necessary. The procedure requires the detachment of the gluteal muscles and the muscle of the medial hip wall (5). In the iliac crest, two incisions, one frontal and one posterior, are performed, followed by grafting. Undoubtedly, this procedure provides large quantities of bone; however, it is not free of important complications:

Abdominal hernias

Bleeding

In sito e peritoneal vascular damage

Worthy of note is the risk of fracture of the iliac crest and subsequent aesthetic problems. Several variants of this technique aim to limit muscle detachment and maintain the crest's conformation (6).

Lateral explants

This procedure requires the detachment of the gluteal muscles from the hip and four bone explants of a thinner section that may or may not interest the iliac crest (sub-crest). The surgery is relatively easy and rapid. Minor aesthetic problems are produced if the iliac crest is maintained. Postoperative pain, however, and impairment of deambulation are evident and long-lasting due to the detachment of the gluteal muscle and the tensor sideband. The risk of perforating the medial cortical hip wall and subsequent vascular damage, peritonitis and intestinal fissures or occlusions is not underestimated (7).

Medial explant

Similar to the lateral explant technique, the procedure involves postural muscles. The involvement of a postural muscle and not the gluteus (necessary for deambulation) makes many authors prefer this technique. Due to the minor adhesion of the periosteum compared to that of the lateral hip wall, the detachment of the postural muscles is easier. The same authors also report fewer complications, such as peritoneal bleeding, loss of sensibility and aesthetic problems (8). They note that pain and deambulatory problems are less severe and require less time to recover. The theoretical risk remains of a lesion of the lateral femoral cutaneous nerve because of its location on the medial iliac. The repositioning of both periosteum and abdominal muscles seems to reduce haemorrhaging and oedema due to the pressure exerted by the intestines (9).

Bicortical explant with maintenance in situ of flat spongy bone

Periosteum and medial and lateral muscles are disassembled, and four osteotomies are performed on each side to

isolate two specular bone blocks, leaving a spongiosa lamina in situ (10). This procedure leaves the iliac crest intact, even if reduced in size. Deambulatory problems remain because of the detachment of the periosteum and muscle. The risk of fracture of the remaining iliac crest, however, exists.

The oblique explant of only spongy bone segments from the crest and repositioning the crest without muscle detachment is another technique, avoiding complications (11). The two incisions are divergent; one incision starts from the crest and is executed towards the bottom of the hip bone, and a second begins laterally and extends outwards. These two incisions allow the explant of marrow bone while maintaining the residual fragments of the crest, mostly cortical, integral through bone synthesis.

Explant of lateral cortical marrow bone

This surgical procedure calls for a crosswise, full-length incision of the hip bone starting laterally under the crest. This procedure leaves the bony cap crest attached to the periosteum and abdominal muscles. To effect the incision, scalpels and spoons are required to explant the cortical marrow segment. After the explant, the crest is returned to its original position. The surgery facilitates access to the hip, reduces postoperative complications, and preserves the crest. The detachment of the gluteo muscle often compromises deambulation (12).

Explant of cortical marrow medial bone with rotation of medial crest

This procedure begins with an incision in the iliac crest membrane and continues laterally and medially to create a bony cap attached to the abdominal muscles. The cap is rotated to detach the membrane and the iliac muscle from the medial side of the ileum. A successive incision is made from a bone segment containing both cortical and marrow bone. This segment is shaped from cortical and marrow flap (results of cortical hip disk) (13). The membrane and muscle are repositioned, and the iliac crest is repositioned and secured. This procedure, sparing the gluteal and abdominal muscles from detachment and sensibly reducing problems of postoperative pain and deambulation, provides large quantities of bone and preservation of the crest. According to several authors, this surgery also avoids the necessity of drainage as the entire area of the operation is closed.

The possible complications cited by the various authors are the fracture of the residual cortical bone and the subsequent formation of retroperitoneal bleeding and hematomas (14).

EXPLANT SURGERY: MONO-BICORTICAL EXPLANT

After sterilizing with iodopovidone, the operating site is delimited with sterile bandages, anaesthesia and vasoconstrictor infiltration (15).

An incision along the iliac crest is made for a length of 5-8 cm, starting at least 1 cm from the anterior point of the iliac and continuing toward the posterior iliac crest.

The subcutaneous incision includes the fascia lata and periosteum, using clamps to stop bleeding. The detachment of the periosteum exposes the explant site, giving particular attention to the iliac muscle.

The cortical bone segments are created with manual and oscillating saw blades, cutting the vertical incisions and then two parallel incisions to limit a box. The bone segment graft consists of the marrow section along the straight bone cuts. The segments should be stored in a physiologic solution before implantation. From the exposed area, spongy bone material can be collected using a surgical spoon. Intra-Osseo bleeding is controlled with collagen sponges or shaped fibrin and, if required, orthopaedic wax.

After drainage placement, the suturing follows the anatomical levels inversely, starting at the periosteum and fascia lata using resorbable sutures and separate stitches. The suturing continues on the subcutaneous level with rapid absorption sutures and finally on the cutaneous level with separate or continuous stitches (16, 17). It is crucial to observe several parameters prior to the first incision (Fig. 1):

- A distance of 1 cm from the anterior point of the iliac crest to avoid damage to the inguinal canal and the insertion of the sartorius muscle;
- Safety of the ileum-gastric nerve, assuring that it lays sideways on the crest;

- The length of the incision is proportional to the size of the explant, usually 5-8 cm; longer incisions must always follow the vertical direction.

With adequate clamping, the lower-level incisions are executed. Without damaging the iliac and gluteal muscles, the periosteum of the crest is carefully detached from the lateral and medial sections of the hip. It is useful to perform a wide divarication and tissue protection (Fig. 2, 3), followed by a manual evaluation of the graft (18).

The osteotomy can be made with manual or oscillating saws below the crest. The area is then delimited with two incisions of the desired width perpendicular to the iliac crest and terminates with the caudal portion resection to free the flap from the surrounding bone. A surgical spoon can be employed in the exposed area if more marrow bone is necessary. The explanted segment is preserved in a physiologic solution. The crest fragments are recomposed with plates and screws.

Fig. 1. *Anestesia and first incision*

Fig. 2. *Showing and clamping of iliac crest*

Fig. 3. *Showing and clamping of iliac crest*

Vascular intra-osseo hemostasis is done with collagenous sponges and compressed, and when necessary, orthopaedic wax (Fig. 4, 5) (19).

Before closing the exposed area, it is paramount to inspect accurately for bleeding to avoid complications; the suturing proceeds from the lowest level, periosteum and fascia lata, with separate stitches using slow absorption filament. The subcutaneous sutures should use rapidly absorbable filament (20). The cutaneous suturing can be either continuous or separate stitching, preferably intracutaneous, for better aesthetic results. After suturing, a compressive dressing to be removed after 24 hours, and ice packings are recommended.

Fig. 4. *Osteotomy and harvesting of the autologous graft*

Complications

Although relatively safe, this surgery carries both minor and major complications. The minor complications include pain, infections, accumulation of liquid and difficulty walking (21). Among the severe complications are nerve and vascular damage, fractures and hernias. The nerve damage usually interests three structures:

- The lateral branch of the cutaneous intercostal nerve;
- The lateral cutaneous branch of the iliohypogastric nerve;
- The lateral cutaneous femoral nerve.

This last complication generally occurs in those cases wh ere the nerve is situated along the medial anterior iliac crest and below the inguinal ligament, even if in 2,7% of the cases, the nerve runs above the inguinal ligament. This position of the nerve increases the risk of nerve damage, which, if permanent, causes muscle pain.

Postoperative pain and difficulty in walking is to be expected (22). The return to normal deambulation varies with the size of the explant, and the pain may vary from a few days to 2 weeks.

Fig. 5. *Osteotomy and harvesting of the autologous graft*

BONE GRAFT OPERATION

Once the explant is completed, the subsequent step is the grafting in the recipient site. After preparing the site with chlorhexidine and sterile cloths, anaesthesia and vasoconstrictors to control bleeding and postoperative pain, an incision is made along the mucosa geniena (Fig. 6), extending it perpendicularly and outwards to the free mucous in order to detach the periosteum and expose the bone.

The graft is secured location using screws (Fig. 7). Sometimes, dividing the box into smaller segments may be necessary to facilitate the reconstruction of irregular surfaces. Bone spurs and rough edges can be smoothed with a hand

drill. The eventual spaces between the alveolar and the graft should be filled with spongy bone segments (23).

Extending the incision to have sufficient tissue to close it may be necessary. The incision of the mucous membrane is closed with resorbable sutures (Fig. 8, 9) (24).

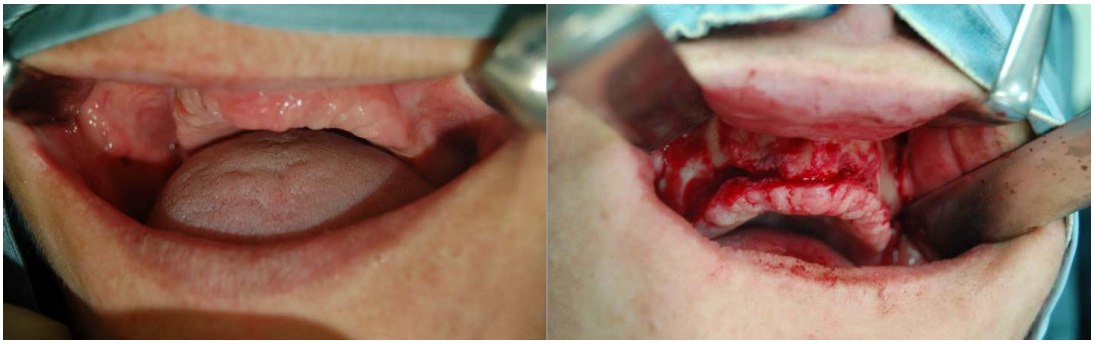

Fig. 6. *Preparation of the maxillary site*

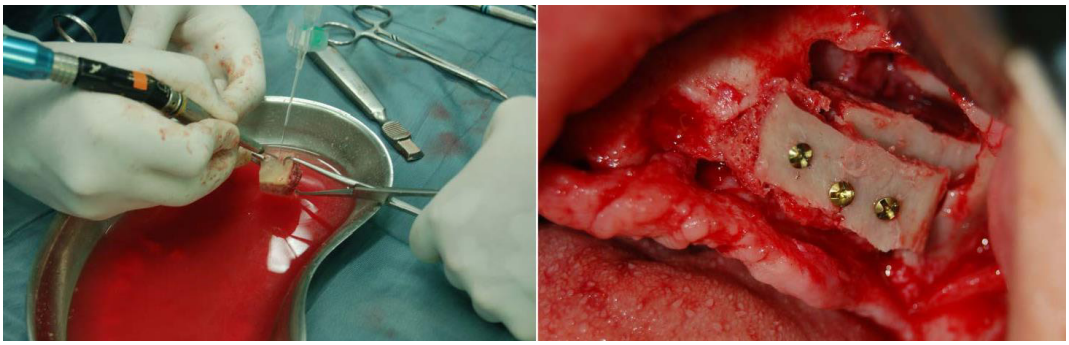

Fig. 7. *Preparation of bone graft and fixation with screw*

Fig. 8. *Suture of the flap*

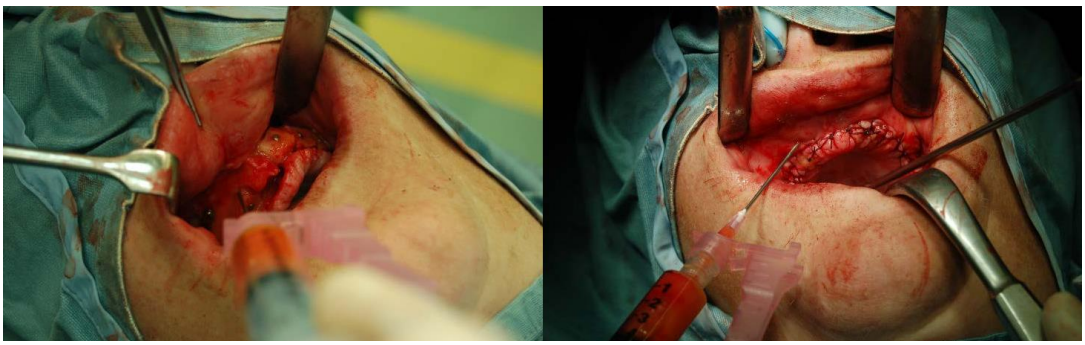

Fig. 9. *Suture of the flap*

INSERTION OF THE DENTAL IMPLANTS

After 4 months without complications, the graft's integration and volume maintenance are verified with X-rays (Fig. 10, 11). In order to insert the dental implants, it is necessary to prepare a wax model and a surgical bite plate.

The insertion can be done in the dentist's office. The oral cavity is rinsed with a 0.20% chlorhexidine solution, followed by an injection of anaesthesia and vasoconstrictors. A flap of the muco-periosteum is lifted in the grafted area, and the screws used to fix the graft are removed. At the same time, it is useful to check the graft's consolidation and state of maintenance.

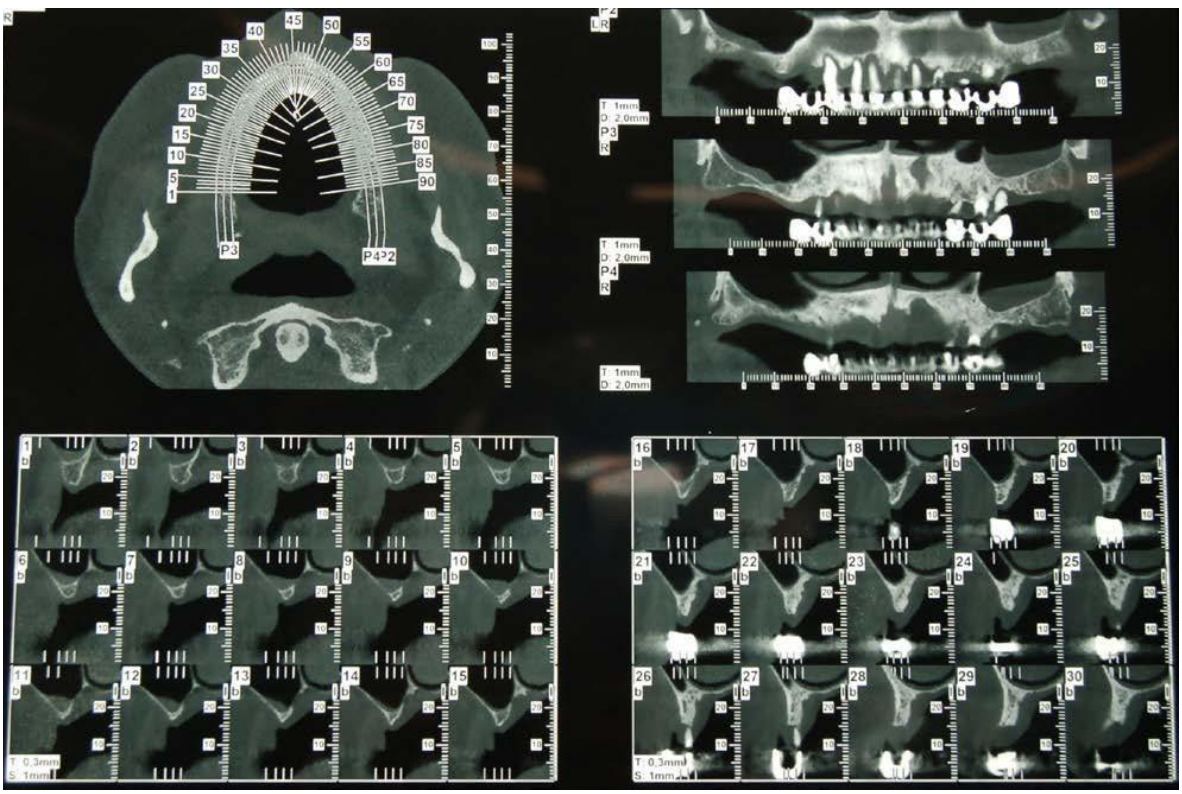

Fig. 10. *Case 1: preoperative Tc Conebeam*

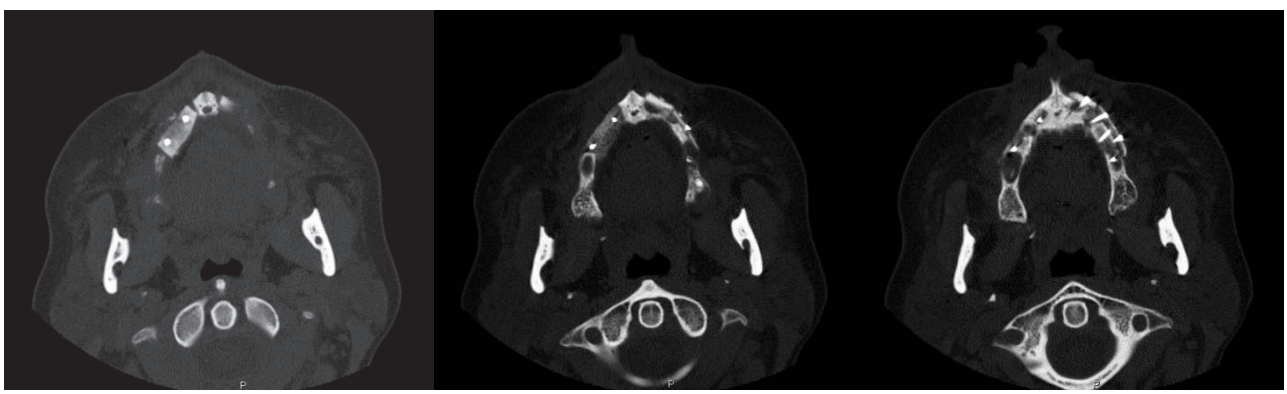

Fig. 11. *Coronal section of CBCT which demonstrated the fixed graft*

The implant site is prepared using a drill of increasing dimensions and irrigating with a physiologic solution. When the dental cavity is ready, the implant is screwed into place (Fig. 12) using a rotating instrument and finished manually. Before suturing, a plug screw should be used to protect the thread of the dental implant (25).

Healing and maturation of bone require about 3 months. The prosthesis phase can then begin. When the complete adaption of the peri-implant tissue and a satisfactory aesthetic result is reached, the procedure may be considered optimally terminated (26) (Fig. 13, 14).

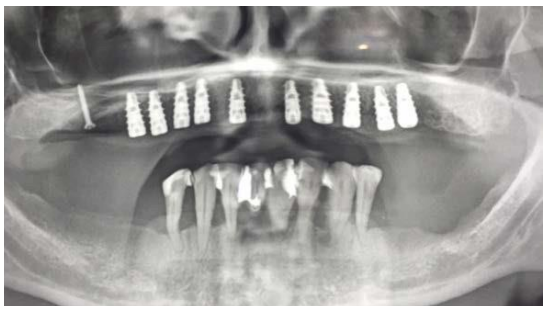

Fig. 12. *Rx-Orthopanoramic postoperative with multi-implants inserted in graft*

Fig. 13. *Extra-oral view of full-arch rehabilitation.*

Fig. 14. *Intra-oral view of full-arch rehabilitation.*

CONCLUSIONS

Our case report and the literature review highlight that therapy for the reconstruction of important maxillary defects should be thoroughly studied and planned before selecting the best therapeutic options for each case.

In our option, the most important parameters to consider are:

The extension and form of the defect;

The subsequent determination of the site to collect the graft;

We have not experienced a significant loss of bone graft volume during the healing process; therefore, iliac crest grafts are a valid and successful solution today.

REFERENCES

1. Acocella A, Nardi P, Tedesco A, Beninati F, Giannini D. Innesto di cresta iliaca anteriore: tecniche e complicanze. *Minerva Stomatologica.* 2003;52(441-453.
2. Castagnola M, Sacco R, De Micheli L. "Innesto di cresta iliaca e rialzo del seno mascellare nella ricostruzione delle gravi atrofie posteriori. *Italian Oral Surgery* 2010;9(4):181-187.
3. Breine U, Branemark PI. Reconstruction of alveolar jaw bone. An experimental and clinical study of immediate and preformed autologous bone grafts in combination with osseointegrated implants. *Scand J Plast Reconstr Surg.* 1980;14(1):23-48. doi:https://doi.org/10.3109/02844318009105733
4. Misch CE, Dietsh F. Endosteal implants and iliac crest grafts to restore severely resorbed totally edentulous maxillae--a retrospective study. *J Oral Implantol.* 1994;20(2):100-110.
5. Sjostrom M, Sennerby L, Nilson H, Lundgren S. Reconstruction of the atrophic edentulous maxilla with free iliac crest grafts and implants: a 3-year report of a prospective clinical study. *Clin Implant Dent Relat Res.* 2007;9(1):46-59. doi:https://doi.org/10.1111/j.1708-8208.2007.00034.x
6. Sjostrom M, Sennerby L, Lundgren S. Bone graft healing in reconstruction of maxillary atrophy. *Clin Implant Dent Relat Res.* 2013;15(3):367-379. doi:https://doi.org/10.1111/j.1708-8208.2011.00368.x
7. Burgess M, Leung M, Chellapah A, Clark JR, Batstone MD. Osseointegrated implants into a variety of composite free flaps: A comparative analysis. *Head Neck.* 2017;39(3):443-447. doi:https://doi.org/10.1002/hed.24609
8. Mohlhenrich SC, Kniha K, Elvers D, et al. Intraosseous stability of dental implants in free revascularized fibula and iliac crest

bone flaps. *J Craniomaxillofac Surg.* 2016;44(12):1935-1939. doi:https://doi.org/10.1016/j.jcms.2016.09.011

9. Shayesteh YS, Khojasteh A, Siadat H, et al. A comparative study of crestal bone loss and implant stability between osteotome and conventional implant insertion techniques: a randomized controlled clinical trial study. *Clin Implant Dent Relat Res.* 2013;15(3):350-357. doi:https://doi.org/10.1111/j.1708-8208.2011.00376.x
10. Blake F, Bubenheim M, Heiland M, Pohlenz P, Schmelzle R, Gbara A. Retrospective assessment of the peri-implant mucosa of implants inserted in reanastomosed or free bone grafts from the fibula or iliac crest. *Int J Oral Maxillofac Implants.* 2008;23(6):1102-1108.
11. Meloni SM, Tallarico M, De Riu G, et al. Guided implant surgery after free-flap reconstruction: Four-year results from a prospective clinical trial. *J Craniomaxillofac Surg.* 2015;43(8):1348-1355. doi:https://doi.org/10.1016/j.jcms.2015.06.046
12. Lopez GD, Hijji FY, Narain AS, Yom KH, Singh K. Iliac Crest Bone Graft: A Minimally Invasive Harvesting Technique. *Clin Spine Surg.* 2017;30(10):439-441. doi:https://doi.org/10.1097/BSD.0000000000000556
13. Suchomel P, Barsa P, Buchvald P, Svobodnik A, Vanickova E. Autologous versus allogenic bone grafts in instrumented anterior cervical discectomy and fusion: a prospective study with respect to bone union pattern. *Eur Spine J.* 2004;13(6):510-515. doi:https://doi.org/10.1007/s00586-003-0667-z
14. Shao MH, Zhang F, Yin J, Xu HC, Lyu FZ. Titanium cages versus autogenous iliac crest bone grafts in anterior cervical discectomy and fusion treatment of patients with cervical degenerative diseases: a systematic review and meta-analysis. *Curr Med Res Opin.* 2017;33(5):803-811. doi:https://doi.org/10.1080/03007995.2017.1284050
15. Nandi SK, Roy S, Mukherjee P, Kundu B, De DK, Basu D. Orthopaedic applications of bone graft & graft substitutes: a review. *Indian J Med Res.* 2010;132(15-30.
16. de Freitas RM, Susin C, Spin-Neto R, et al. Horizontal ridge augmentation of the atrophic anterior maxilla using rhBMP-2/ACS or autogenous bone grafts: a proof-of-concept randomized clinical trial. *J Clin Periodontol.* 2013;40(10):968-975. doi:https://doi.org/10.1111/jcpe.12148
17. Schmitt CM, Doering H, Schmidt T, Lutz R, Neukam FW, Schlegel KA. Histological results after maxillary sinus augmentation with Straumann(R) BoneCeramic, Bio-Oss(R), Puros(R), and autologous bone. A randomized controlled clinical trial. *Clin Oral Implants Res.* 2013;24(5):576-585. doi:https://doi.org/10.1111/j.1600-0501.2012.02431.x
18. Stellingsma K, Raghoebar GM, Visser A, Vissink A, Meijer HJ. The extremely resorbed mandible, 10-year results of a randomized controlled trial on 3 treatment strategies. *Clin Oral Implants Res.* 2014;25(8):926-932. doi:https://doi.org/10.1111/clr.12184
19. Chiapasco M, Di Martino G, Anello T, Zaniboni M, Romeo E. Fresh frozen versus autogenous iliac bone for the rehabilitation of the extremely atrophic maxilla with onlay grafts and endosseous implants: preliminary results of a prospective comparative study. *Clin Implant Dent Relat Res.* 2015;17 Suppl 1(e251-266. doi:https://doi.org/10.1111/cid.12191
20. Fretwurst T, Wanner L, Nahles S, et al. A prospective study of factors influencing morbidity after iliac crest harvesting for oral onlay grafting. *J Craniomaxillofac Surg.* 2015;43(5):705-709. doi:https://doi.org/10.1016/j.jcms.2015.03.023
21. Kuik K, Putters TF, Schortinghuis J, van Minnen B, Vissink A, Raghoebar GM. Donor site morbidity of anterior iliac crest and calvarium bone grafts: A comparative case-control study. *J Craniomaxillofac Surg.* 2016;44(4):364-368. doi:https://doi.org/10.1016/j.jcms.2015.12.019
22. Shaw KA, Griffith MS, Shaw VM, Devine JG, Gloystein DM. Harvesting Autogenous Cancellous Bone Graft from the Anterior Iliac Crest. *JBJS Essent Surg Tech.* 2018;8(3):e20. doi:https://doi.org/10.2106/JBJS.ST.17.00068
23. Hettwer W, Horstmann PF, Bischoff S, et al. Establishment and effects of allograft and synthetic bone graft substitute treatment of a critical size metaphyseal bone defect model in the sheep femur. *APMIS.* 2019;127(2):53-63. doi:https://doi.org/10.1111/apm.12918
24. Azi ML, Aprato A, Santi I, Kfuri M, Jr., Masse A, Joeris A. Autologous bone graft in the treatment of post-traumatic bone defects: a systematic review and meta-analysis. *BMC Musculoskelet Disord.* 2016;17(1):465. doi:https://doi.org/10.1186/s12891-016-1312-4
25. Lemos CA, Ferro-Alves ML, Okamoto R, Mendonca MR, Pellizzer EP. Short dental implants versus standard dental implants

placed in the posterior jaws: A systematic review and meta-analysis. *J Dent.* 2016;47(8-17. doi:https://doi.org/10.1016/j.jdent.2016.01.005

26. Albrektsson T, Johansson C. Osteoinduction, osteoconduction and osseointegration. *Eur Spine J.* 2001;10 Suppl 2(Suppl 2):S96-101. doi:https://doi.org/10.1007/s005860100282