Journal section: Oral Surgery
Publication Types: Review

doi:10.4317/medoral.16.e210
http://dx.doi.org/doi:10.4317/medoral.16.e210

Bone regeneration using particulate grafts: An update

Amparo Aloy-Prósper [1], Laura Maestre-Ferrin [2], David Peñarrocha-Oltra [1], María Peñarrocha-Diago [3]

[1] Degree in Dentistry. Resident in the Master of Oral Surgery and Implantology. Faculty of Medicine and Dentistry. University of Valencia
[2] Master in Oral Surgery and Implantology. Medical and Dental School. University of Valencia. Valencia, Spain
[3] Associate Professor of Oral Surgery. Faculty of Medicine and Dentistry. University of Valencia

Correspondence:
Clínicas odontológicas,
Gascó Oliag 1,
46021 Valencia (Spain)
maria.penarrocha@uv.es

Received: 27/02/2010
Accepted: 26/08/2010

Aloy-Prósper A, Maestre-Ferrin L, Peñarrocha-Oltra D, Peñarrocha-Diago M. Bone regeneration using particulate grafts: An update. Med Oral Patol Oral Cir Bucal. 2011 Mar 1;16 (2):e210-4.
http://www.medicinaoral.com/medoralfree01/v16i2/medoralv16i2p210.pdf

Article Number: 16883 http://www.medicinaoral.com/

eMail: medicina@medicinaoral.com
Indexed in:
Science Citation Index Expanded
Journal Citation Reports
Index Medicus, MEDLINE, PubMed
Scopus, Embase and Emcare
Indice Médico Español

Abstract

Objective: A review is made of the publications on bone regeneration using particulate grafts, with an evaluation of the success of implants placed in such regenerated areas.

Material and Method: A Medline search using different key words was made of the articles published between 1999-2009 involving at least two patients subjected to grafting with autologous, homologous or xenogenic bone, non-bony substitutes, or a combination of these grafts for the placement of dental implants. Studies involving block grafting were excluded. A total of 11 studies were evaluated.

Results: These grafts are indicated in cases of small or peri-implant bone defects such as dehiscences and fenestrations, with the possibility of combining a barrier membrane. However, some authors have used particulate block grafts to secure vertical or horizontal increments of the alveolar process. In most of these cases, graft healing until implant placement lasted 6-9 months. The most frequent complications in the receptor zone were wound dehiscences with exposure of the membrane. In almost all cases, prosthetic loading of the implants took place more than three months after their placement. The implant survival rate varied from 90.9% to 100%, with an implantation success rate of 85.7% to 100%.

Conclusions: Although our sample is small, due to the difficulty of finding homogeneous studies, it can be concluded that particulate grafts are effective in correcting localized defects of the alveolar process. The complications of particulate grafting are few, and the success rate of implants placed in the reconstructed areas varies from 85.7% to 100%.

Key words: *Bone regeneration, particulate graft, dental implants.*

Introduction

An adequate bone volume is needed in order to guarantee the long-term success of dental implant placement (1,2). A range of factors such as dental infections, alveolar traumatisms, extractions or periodontal disease can give rise to localized or generalized bone defects of the alveolar process (3-5). In this context, bone grafts are an option for securing adequate bone volume and morphology (6,7). Particulate grafts have been used in cases of small or peri-implant defects such as dehiscences and fenestrations, and combination with guided bone regeneration (GBR) techniques is also possible (8-10). When the bone defect is moderate, some authors have used block cortico-cancellous bone in particulate form to secure vertical or horizontal increments of the alveolar process (11-13).

The present review examines the publications on bone regeneration using particulate grafts, and evaluates the results obtained, as well as the complications of the surgical technique and the survival and success rates of the implants placed in these regenerated areas.

Material and Method

A Medline search was made of the articles published between January 1999 and July 2009 involving patients subjected to particulate bone grafting for the treatment of peri-implant defects or for alveolar crest augmentation with a view to dental implant placement. Only full-text human clinical studies were considered. Studies involving block grafts were excluded.

The patients were required to present defects as a result of atrophy, trauma or periodontal disease. The peri-implant defects, dehiscences and fenestrations, were required to have occurred at the time of implant placement. We excluded those studies involving defects resulting from tumor resection, congenital malformations or osteoradionecrosis, as well as dental defects, and those defects involving fenestrations and dehiscences caused by peri-implant disease, since the initial clinical situation would be different, and the results therefore would not be comparable.

The following key words were used in the Medline search: particulate bone graft; dental implants; autologous bone graft; bone graft materials; guided bone regeneration.

Articles were extracted from the following journals: Clinical Oral Implants Research; The International Journal of Oral and Maxillofacial Implants; Journal of Oral and Maxillofacial Surgery; Journal of Periodontology.

We identified 64 articles, of which 53 were excluded: in 21 of these latter publications particulate grafting was not used to treat peri-implant defects or achieve alveolar crest augmentation; in 14 cases particulate grafting was combined with block grafting; in four cases the peri-implant defects did not occur during implant placement; in 6 cases the full text was not available; and 8 publications were not human clinical studies. A total of 11 studies were thus finally evaluated (Table 1), with collection of the following data in each of them: year of publication, type of study, patient characteristics (inclusion/exclusion), type of intervention, and results.

Results and Discussion

Indications of particulate grafts

Particulate grafts fundamentally have been used in cases of small or peri-implant bone defects such as dehiscences and fenestrations, with the possibility of associating guided bone regeneration techniques (8-10, 14). However, when the bone defect is moderate, and the aim is to secure vertical or horizontal increments, some authors prefer block cortico-cancellous bone in particulate form, using the Tessier osseous microtome or bone mill (12,13). These grafts can be harvested from the chin, mandibular ramus, maxillary tuberosity or mandibular torus (9,12,13,15,16). Biocompatible membranes in turn can be used to avoid dispersion of the particles (9,12,13,15,16).

Brunel et al. (17) and Pieri et al. (16) do not use grafts in the following situations: smokers of over 10 cigarettes a day, severe liver or kidney disease, a history of head and neck radiotherapy, chemotherapy at the time of surgery, uncontrolled diabetes, active periodontal disease in the residual dentition, inflammatory or autoimmune disorders of the oral mucosa, poor oral hygiene, patient failure to cooperate, and any other disease condition contraindicating oral surgery.

In all the evaluated studies grafts were placed in both males and females, with no differences according to gender. The age range of the patients was 11-82 years.

Surgical procedure

Five studies (10,12, 14-16) used a combination of autograft with xenograft, hydroxyapatite or homologous bone. In the remaining 8 studies a single type of graft was used: autologous bone (8,10,13,14), homologous bone (11,14), bovine bone (10,18,19) or hydroxyapatite (17).

In two studies (13,15) the intraoral autologous grafts were obtained from the retromolar region, while in one publication the graft was harvested from the mandibular ramus (16). One study (12) used intraoral grafts from the chin, mandibular ramus, mandibular torus or maxillary tuberosity, and extraoral grafts from the iliac crest or tibia.

The surgical procedure used in the receptor zone was the same in all the examined studies in which vertical and/or horizontal alveolar crest augmentations were performed. A supracrestal incision with vertical releasing incisions were carried out, followed by the raising of a full thickness flap. The cortical layer was perforated

Table 1. Summary of studies reviewed.

Author (year)	Type of study	No. patients		Type of defect	Defect location	Type of graft	Donor site	% graft success	Nº implants	Nº graft sites	Time of implant placement	Follow-up (months)	% implant survival	% implant success
		F	M											
Von Arx y Wallkamm. 1999 (8)	Prospective	6	9	Dehiscence Fenestration	-	Autologous bone + Titanium mesh	-	-	20	20	Immediate	-	-	–
Brunel et al. 2001 (17)	Prospective	7	7	Not specified	13 Maxilla 1 Mandible	Hydroxyapatite+ Res. Mb (**)	-	-	14	14	Delayed	36	92,8	85,7
Block y Degen 2004 (11)	Prospective	11		Horizontal	Mandible	Alogenous bone	-	-	35	13	Delayed	24	90,9	–
Blanco et al. 2005 (14)	Prospective	12	7	Dehiscence Fenestration	24 Maxilla 2 Mandible	Autologous and/or Alogenous bone + Non-res. Mb (*)	-	-	26	26	Immediate	60	96´1	96´1
Simion et al. 2007 (15)	Prospective	6	1	Vertical	Mandible	Bovine bone + Autologous bone + Titanium mesh	Retromolar	100	27	10	Delayed and immediate	12	100	-
Louis et al. 2008 (12)	Retrospective	29	15	Vertical + Horizontal	16 Maxilla 29 Mandible	Autologous bone + hydroxyapatite + Titanium mesh	Chin Ramus I. Crest. (***) Tibia Symphysis Torus Tuberosity	-	-	45	Delayed	17,2	93,2	-
Hämmerle et al. 2008 (19)	Prospective	6	6	Horizontal	-	Bovine bone + Res. Mb (**)	-	91,6	-	12	Delayed	-	-	-
Trombelli et al. 2008 (13)	Case series	2		Horizontal Vertical	1 Maxilla 1 Mandible	Autologous bone + Titanium mesh	Retromolar	100	2	2	Delayed	36	100	-
Pieri et al. 2008 (16)	Prospective	9	7	Horizontal Vertical	10 Mandíble 9 Maxilla	Bovine bone + Autologous bone + Titanium mesh	Ramus mandibulae	-	44	19	Delayed	24	100	93,2
Canullo y Malagnino. 2008 (18)	Retrospective	10		Vertical	-	Bovine bone + Mb.no res(*)	-	100	24	10	Delayed and immediate	36	100	100

with a round or fissure drill in order to favor blood supply to the new bone. The graft particles were adapted to the receptor bone and were covered with a membrane affixed with titanium microscrews. Horizontal incisions were made in the periosteum to allow tension-free closure, followed by suturing. For the treatment of fenestrations or dehiscences, full thickness flaps were raised and the particulate bone graft was compacted over the defect, with the possible combination of bioabsorbable membranes, and final suturing.

In order to avoid gingival epithelial cell and connective tissue invasion over the defect, guided bone regeneration membranes were usually used. Barrier membranes were used in all the studies, with the exception of the publication by Block and Degen (11). These membranes were non-reabsorbable in 7 studies (8, 12-16, 18), and reabsorbable in three studies (10,17,19)

Postoperative treatment comprised antibiotics and systemic antiinflammatory medication during 7 days, and 0.1-0.2% chlorhexidine rinses. The sutures were removed after 10-15 days.

Graft success, millimeters of bone gained and superficial reabsorption

None of the evaluated studies established well defined bone graft success criteria. Louis et al. (12), in a retrospective study of 44 patients, recorded the complete loss of one graft, requiring repeat surgery. Their graft success rate was 96.8%. Hämmerle et al. (19) reported adequate bone volume in all their patients, except in one case where no bone increment was obtained during the graft healing phase. Their success rate was 91.6%. Trombelli et al. (13) and Simion et al. (15) achieved the bone volume needed for the posterior placement of implants, with a 100% success rate.

Five studies presented data on the amount of bone gained after grafting (11,12,15,18,19). Hämmerle et al. (19) described a series of 12 patients with an initial horizontal crest defect of 3.2 mm. These authors used a xenograft (Bio-Oss®) with a reabsorbable membrane. After 9-10 months, they recorded a crest width of 6.9 mm – the gain being statistically significant. Likewise, Block and Degen (11) studied the gain in width of crests measuring under 4 mm. Four months after allogenic bone grafting, the crest width was seen to measure over 5 mm. In the vertical dimension, Simion et al. (15), and Canullo and Malagnino (2008) placed protruded implants 4-7 mm from the alveolar crest and covered them with Bio-Oss® and a non-reabsorbable membrane. These authors reported a statistically significant gain in vertical bone height of 3.8 ± 1.2 mm and 5.3 ± 1.9 mm, respectively, after 6 and 8 months. In the vertical and horizontal dimensions, Louis et al. (12) published a study of 44 patients treated with a combination of autologous bone and hydroxyapatite grafting together with application of a titanium membrane. They recorded a mean bone gain of 13.9 mm in the mandible and of 12.8 mm in the upper maxilla.

As regards superficial reabsorption of the particulate grafts, Simion et al. (15) and Canullo and Malagnino (18) reported an average absorption of 0.2±0.7 mm after 6-9.5 months, in sites with intraoral autologous grafts covered with Bio-Oss® and a non-reabsorbable membrane, and of 0.0±1.0 mm after 6-8 months with Bio-Oss® and a non-reabsorbable membrane.

Healing time

In the studies describing vertical or horizontal increments with particulate grafts, the implants were placed in second step surgery, allowing a prior graft healing period of 6-9 months (11-13, 15-17, 19). The exception is represented by Simion et al. (15) and Canullo and Malagnino (18), who placed the implants and the grafts in the same surgical step. In relation to horizontal mandibular augmentation, Block and Degen (11) placed the implants after a four-month healing interval. In the studies involving dehiscences or fenestrations (8,10,14), the particulate grafts were placed with the implants in the same surgical step. In 5 studies (12,13,15,17,18) biopsies were obtained of the implant receptor bone at the end of the graft healing period, and the histological study confirmed an adequate bone structure for implant placement.

The implants are to be placed once primary stability has been assured. Although it is possible to place grafts and implants simultaneously, in those cases where important vertical or circumferential increments are required it is advisable to first perform bone regeneration of the alveolar crest (6). The recommendation is a minimum of 4-5 mm of residual bone for graft and implant placement in a single surgical step (9). In 5 studies (8,10,14,15,18) the implants were placed at the same time as the grafts. Von Arx and Wallkamm (8), Blanco et al. (14) and Benić et al. (10) treated cases of dehiscences and fenestrations, while Simion et al. (15) and Canullo and Malagnino (18) treated patients with vertical crest defects.

Complications

Receptor zone

In most cases graft healing and consolidation occurred without problems. In the study published by Louis et al. (12), 23 membranes were exposed during the healing phase (43.7% in the upper maxilla, and 55% in the mandible), and 7 of them were removed. Nevertheless, all but one of the patients maintained enough bone for implant placement. Brunel et al. (17) and Blanco et al. (14), with 14 and 26 graft sites, respectively, recorded 6 and 3 membrane exposures during the graft healing phase, though in no case did removal prove necessary. Von Arx and Wallkamm (8) and Simion et al. (15), with 20 and 10 graft sites, respectively, each reported a single membrane exposure after three months, and both of them were removed.

Donor zone

In the study published by Simion et al. (15), one patient reported altered lower lip sensitivity after autologous bone harvesting from the retromolar region. This problem disappeared one month after the operation, however. There were no other complications in the reviewed studies.

Time to prosthetic loading

In most cases, prosthetic loading occurred at least three months after implant placement (10,16,17). Pieri et al. (16) loaded the implants of the mandible after three months, and in the upper maxilla after four months. Brunel et al. (17) and Benić et al. (10) in turn performed loading after 6 months – the latter author performing loading after three months in the case of transmucosal implants.

Implant survival and success

The implant survival rate ranged from 90.9% to 100% in the different studies (10-18).

As regards the success rate of the implants, not all the studies used well defined success criteria – thus making comparison difficult. Pieri et al. (16) based their data on the success criteria of Albrektsson (1986), with a success rate of 93.2% two years after loading (85.7% in the upper maxilla and 100% in the mandible). Brunel et al. (17) in turn used the criteria of Cutter and Ederer, reporting a success rate of 85.7% three years after loading. Other authors (10-13,15) reported a 100% success rate, though without specifying concrete success criteria.

Conclusions

Although our sample is small, due to the difficulty of finding homogeneous studies, it can be concluded that particulate grafts are effective in correcting localized defects of the alveolar process. The complications of particulate grafting are few, and the success rate of implants placed in the reconstructed areas varies from 85.7% to 100%.

References

References with links to Crossref - DOI

1. Buser D, Dula K, Hess D, Hirt HP, Belser UC. Localized ridge augmentation with autografts and barrier membranes. Periodontol 2000. 1999;19:151-63.
2. Peñarrocha-Diago M, Gómez-Adrián MD, García-Mira B, Ivorra-Sais M. Bone grafting simultaneous to implant placement. Presentation of a case. Med Oral Patol Oral Cir Bucal. 2005;10:444-7.
3. Hoexter DL. Bone regeneration graft materials. J Oral Implantol. 2002;28:290-4.
4. Sorní M, Guarinós J, García O, Peñarrocha M. Implant rehabilitation of the atrophic upper jaw: a review of the literature since 1999. Med Oral Patol Oral Cir Bucal. 2005;10 Suppl 1:E45-56.
5. Esposito M, Grusovin MG, Coulthard P, Worthington HV. The efficacy of various bone augmentation procedures for dental implants: a Cochrane systematic review of randomized controlled clinical trials. Int J Oral Maxillofac Implants. 2006;21:696-710.
6. González-García R, Naval-Gías L, Muñoz-Guerra MF, Sastre-Pérez J, Rodríguez-Campo FJ, Gil-Díez-Usandizaga JL. Preprosthetic and implantological surgery in patients with severe maxillary atrophy. Med Oral Patol Oral Cir Bucal. 2005;10:343-54.
7. Chiapasco M, Zaniboni M, Boisco M. Augmentation procedures for the rehabilitation of deficient edentulous ridges with oral implants. Clin Oral Implants Res. 2006;17 Suppl 2:136-59.
8. Von Arx T, Wallkamm B, Hardt N. Localized ridge augmentation using a micro titanium mesh: a report on 27 implants followed from 1 to 3 years after functional loading. Clin Oral Implants Res. 1998;9:123-30.
9. McAllister BS, Haghighat K. Bone augmentation techniques. J Periodontol. 2007;78:377-96.
10. Benić GI, Jung RE, Siegenthaler DW, Hämmerle CH. Clinical and radiographic comparison of implants in regenerated or native bone: 5-year results. Clin Oral Implants Res. 2009;20:507-13.
11. Block MS, Degen M. Horizontal ridge augmentation using human mineralized particulate bone: preliminary results. J Oral Maxillofac Surg. 2004;62:67-72.
12. Louis PJ, Gutta R, Said-Al-Naief N, Bartolucci AA. Reconstruction of the maxilla and mandible with particulate bone graft and titanium mesh for implant placement. J Oral Maxillofac Surg. 2008;66:235-45.
13. Trombelli L, Farina R, Marzola A, Itro A, Calura G. GBR and autogenous cortical bone particulate by bone scraper for alveolar ridge augmentation: a 2-case report. Int J Oral Maxillofac Implants. 2008;23:111-6.
14. Blanco J, Alonso A, Sanz M. Long-term results and survival rate of implants treated with guided bone regeneration: a 5-year case series prospective study. Clin Oral Implants Res. 2005;16:294-301.
15. Simion M, Fontana F, Rasperini G, Maiorana C. Vertical ridge augmentation by expanded-polytetrafluoroethylene membrane and a combination of intraoral autogenous bone graft and deproteinized anorganic bovine bone (Bio Oss). Clin Oral Implants Res. 2007;18:620-9.
16. Pieri F, Corinaldesi G, Fini M, Aldini NN, Giardino R, Marchetti C. Alveolar ridge augmentation with titanium mesh and a combination of autogenous bone and anorganic bovine bone: a 2-year prospective study. J Periodontol. 2008;79:2093-103.
17. Brunel G, Brocard D, Duffort JF, Jacquet E, Justumus P, Simonet T, et al. Bioabsorbable materials for guided bone regeneration prior to implant placement and 7-year follow-up: report of 14 cases. J Periodontol. 2001;72:257-64.
18. Canullo L, Malagnino VA. Vertical ridge augmentation around implants by e-PTFE titanium-reinforced membrane and bovine bone matrix: a 24- to 54-month study of 10 consecutive cases. Int J Oral Maxillofac Implants. 2008;23:858-66.
19. Hämmerle CH, Jung RE, Yaman D, Lang NP. Ridge augmentation by applying bioresorbable membranes and deproteinized bovine bone mineral: a report of twelve consecutive cases. Clin Oral Implants Res. 2008;19:19-25.