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Augmentation procedures for deficient edentulous ridges, using onlay autologous grafts: An update

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Abstract

The purpose of this review was to analyze publications related to augmentation procedures using autologous onlay grafts and to evaluate the survival/success rates of implants placed in the augmented areas. An automated search was made in Medline, of clinical publications from 2002 to 2007, including at least 5 patients and with a minimum follow-up of 6 months. Ten papers were included. These suggested that grafts are indicated when the height of the alveolar crest is less than 5mm, or the width less than 4mm. The surface resorption of grafts protected by guided bone regeneration membranes was less than for unprotected grafts. Calvarial grafts suffered less resorption than did iliac grafts. The healing period of the graft until implant placement was, in most cases, 4-6 months. The most frequent complications in the recipient site were wound dehiscences. Prosthetic loading time was, in almost all patients, 3 months after implant placement. Implant survival rate ranged from 97.1% to 100%. Although, due to the difficulty in finding homogenous studies, the sample is small, we can conclude that autologous onlay block bone grafts are an effective procedure for alveolar crest augmentation; graft surface resorption is reduced when the grafts are protected by regeneration membranes; few complications arise from the procedure; and the success rate for implants placed in the reconstructed area is between 89.5 and 95.7%.

Key words: Bone regeneration, block graft, bone autograft, dental implants.

Introduction

In order to ensure the long term success of dental implants, it is necessary to have sufficient bone volume in sites to take the implants (1). Nevertheless, due to the frequency of localized or generalized bone defects of the alveolar ridge, as a result of atrophy, dental trauma, extractions or periodontal disease, a previous phase of reconstructive surgery is needed to regenerate such defects (2,3). To place the implants in the correct position and angulation, it is possible to increase the volume, in width and height, of the alveolar crest, thus obtaining predictable and acceptable restorative results (4). Bone grafts are a therapeutic option to correct anomalous intermaxillary relations and to obtain appropriate bone volume and morphology (5,6).

The aim of this review was to analyze publications related to autologous onlay graft augmentation procedures and to evaluate the results obtained with this type of graft, surface resorption of the grafted blocks, complications deriving from the surgical technique and the survival/success rates of implants placed in the augmented areas.

Inclusion criteria and search strategy

Publications indexed in Medline, published between January 2002 and December 2007, with at least five patients and a minimum follow-up of six months, were analyzed. Patients had to display bony defects as a result of atrophy, trauma or periodontal disease. Studies that dealt with defects brought about by tumor resection, congenital malformations or osteoradionecrosis were excluded, since the initial clinical situation would be different and the results non-comparable.

An automated search was carried out in PubMed, with the following key words: bone autograft; autologous block graft; autologous particulate graft; autologous bone graft; particulate bone graft; horizontal ridge augmentation; vertical ridge augmentation; 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*; *International Journal of Oral and Maxillofacial Surgery*; *Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontics*; *Journal of Oral Implantology*.

Ten studies were included (table 1) and the following data were taken: year of publication; type of study; details of the participants (inclusion/exclusion of patients); type of intervention and results.

Onlay indications

Vertically increasing alveolar crest by means of block grafts is indicated when the height of the residual crest is less than 5mm (Cawood and Howell class IV, V and VI) (7,8).

Horizontal increase is indicated when the width of the alveolar ridge is less than 4mm, or less than 5mm in aesthetic areas with high labial line (9). Barone et al. (10) made horizontal increases in atrophic maxilla with crest thickness of 2-3mm.

Chiapasco et al. (7,11) and Barone et al. (10) did not make grafts in the following situations: smokers of more than 10 cigarettes per day, severe renal or hepatic disease, history of head and neck x-ray, treatment with chemotherapy at the time of surgery, non-controlled diabetes, active periodontal disease in the residual teeth, diseases of the oral mucosa (such as lichen planus in areas to be treated), poor oral hygiene, non-collaborating patient, and any other pathological situation that contraindicates oral surgery.

In all studies, grafts were made in both men and women, with no differences with respect to gender. The age range of patients was from 18 to 76 years.

Surgical technique

Intraoral grafts were used in four studies (8,9,11,12), originating from chin or ramus mandibulae. The remainder were grafts of extraoral origin: Iizuka et al. (13) and Chiapasco et al. (7), used grafts from calvaria; whereas Barone et al. (10), Nelson et al. (14) and Molly et al. (15) used grafts from the iliac crest. Carinci et al. (16) compared grafts from calvaria and iliac crest.

The surgical procedure in the recipient site is similar in all the studies reviewed: supracrestal incision with vertical releasing incisions and raising of full thickness flaps, the cortical bone is perforated with round or fissure burs to favor blood supply to the new bone, the graft blocks are adapted to the defect site and fixed with titanium microscrews, horizontal incisions are made in the periosteum to allow closing without tension and suture.

Some authors (9,11) placed particulate autologous bone to fill the hollows between the block and the receptor bed or between two blocks. Barone et al. (10), instead of autologous bone shavings, placed a mixture of particulate porcine bone collagen.

Sometimes, guided bone regeneration barrier membranes are used to protect the graft blocks from surface resorption. McCarthy et al. (12) placed a collagen membrane to cover a defect between two blocks in one of their patients. Nelson et al. (14) used these collagen membranes in all their patients. Von Arx et al. (9) covered the onlays with a mixture of mineral bovine bone and blood from the patient, and a collagen membrane. Rocuzzo et al. (8) conducted a comparative study between two groups; in the first group block grafts of ramus of mandible were placed alone, and in the second group they were covered with a titanium mesh; the best results were obtained in the second group.

Post-operative care was identical in all patients: treat-

Table 1. Summary of studies reviewed.

Author and year	Type of study	N° patients	Defect location	Donor site	% graft success	N° implants	Time of implant placement	Follow-up (months)	% implant survival	% implant success
McCarthy, 2003 (*)	Prospective case series	17	Anterior maxilla	Mandibular symphysis	-	35	33 delayed 2 immediate	38.4	97.1%	-
Iizuka, 2004	Prospective case series	13	7 maxilla 6 mandible	Calvaria	100	42	31 delayed 11 immediate	19.6	100	-
Carinci, 2005	Prospective comparative	68	25 mand 32 max 11 both	47 Calvaria 21 Iliaca crest	-	-	Delayed	6 to 30	-	-
Nelson, 2006	Prospective case series	19	Maxilla	Iliaca crest	100	117	Delayed	18	100	-
Von Arx, 2006	Prospective cohort study	42	Maxilla and mandible	Chin and ramus mandibulae	-	-	Delayed	-	-	-
Molly, 2006 (**)	Retrospective comparative	18	Maxilla	Iliaca crest	-	85	Immediate	36 to 240	-	-
Rocuzzo, 2007	Cases and controls	23	Maxilla and mandible	Ramus mandibulae	-	24	-	6	-	-
Chiapasco, 2007 A	Prospective case series	6	Severely atrophic edentulous mandible	Calvaria	100	23	Delayed	12 to 36	100	95.7
Barone, 2007 (***)	Prospective case series	56	Maxilla	Iliaca crest	96.8	162	Delayed	6	-	94.9
Chiapasco, 2007 B (****)	Comparative prospective	8	Mandible	Ramus mandibulae	-	19	Delayed	38	100	89.5

(*) Seven patients received particulate bone graft.

(**) This study compared iliac block bone grafts with patients treated with titanium membrane without graft. The data reflected in the table refer only to the patients with grafts.

(***) 6 months follow-up after implant placement, but no follow-up after loading.

(****) This study compared onlay grafts and distraction osteogenesis, the data shown in the table refer only to patients with grafts.

ment with systemic antibiotics and antiinflammatories, rinsing with chlorhexidine, instructions not to use removable prostheses, and removal of sutures after 10-15 days.

Graft success, millimeters of bone gained and surface resorption

Well-defined success criteria were established in only the study by Barone et al. (10), these criteria were: absence of exposure and infection of the graft in the post-operative period, incorporation of the graft to the receptor bed, absence of radiolucent areas, bleeding of the grafted bone when removing the fixation screws, and possibility to place the dental implants. The authors obtained a success rate of 96.8% with these criteria.

Few studies reported data on the amount of bone gained after the graft. Chiapasco et al. (11) obtained an average vertical increase of 4.6mm with grafts harvested from ramus mandibulae and between 8 and 11mm with grafts from calvaria (7). In the horizontal plane, Von Arx et al. (9), gained an average width of 4.6mm with intraoral grafts covered with BioOss® and collagen membrane. Rocuzzo et al. (8) compared the increases achieved by onlay from ramus of mandible alone or protected by titanium mesh; the total average gain for the group of graft without membrane was 3.6mm and for the titanium mesh group 4.8mm, the difference being statistically significant. No study was found in which differences were described between results obtained with grafts in maxilla and mandible.

Regarding surface resorption suffered by grafts of intraoral origin, Chiapasco et al. (11) reported an average of 0.6mm before implant placement, in sites with grafts from ramus of mandible. In the study by Von Arx et al. (9) the average surface resorption was 0.36mm (equivalent to 7.2% of the original graft thickness). In another study (8), the resorption for the graft protected by titanium membrane was 13.5%, whereas for the graft without membrane it was 34.5% (statistically significant difference). Gielkens et al. (17) studied the possible protective effect of membranes against the surface resorption of the grafts. The authors made a systematic revision of controlled studies on animals and humans. They concluded that although the evidence is weak, barrier membranes show some preventative effect in graft resorption.

For calvarial grafts, the surface resorption observed by Chiapasco et al. (7) was from 0.3 to 1.2 mm. Iizuka et al. (13), after a follow-up of 19.6 months, found less than 0.5mm resorption in 12 of their 13 patients. Carinci et al. (16) concluded that calvarial bone reabsorbs less than iliac: the percentage of bony survival after 10 months for the calvarial graft was 83%, whereas for the iliac it was only 61%. The iliac crest graft lost most of the gained bone height in the first 6 months, but the bony

loss reduced to almost 0% as the process advanced. The calvarial graft had a low resorption rate at the beginning of the study, but showed a difference of only 10% compared with iliac after 30 months.

Healing time

Delayed implants were placed in most of the studies, leaving a graft healing time of 4-6 months (9,10,11,13) or 6 months (7,16). Nelson et al. (14) placed the implants after a healing period of 3 months; they took biopsies from receptor bone and histologic analyses confirmed that the bone structure was appropriate for the placement of the fixations.

In two studies (12,13) implants were placed simultaneously with the block grafts only in those patients where the residual bone provided suitable primary stability: McCarthy et al. (12) placed immediate implants in 2 patients and one implant failed, whereas Iizuka et al. (13) obtained a survival rate of 100%. Molly et al. (15) placed immediate maxillary implants in all cases, and obtained a cumulative implant failure rate, after 15 years, of 13.3% in the anterior and 22.8% in the posterior regions.

González-García et al. (6), concluded that predictability for implant survival is greater when placed at second surgery, once the grafts are correctly consolidated. In contrast, Peñarrocha et al. (18) published a case in which the mandibular alveolar process was reconstructed using block grafts harvested from the mandible. The grafts were stabilized by the implants themselves passing through the graft. The implants were clinically and radiographically successful after 2 years.

Complications

Donor site

When the graft originates from the mandibula, there were several cases with paresthesias of the area innervated by the inferior alveolar nerve. In particular, in the study by McCarthy et al. (12), in 17 patients treated, there were 4 cases with paresthesias at the donor site (chin). In the study by Chiapasco et al. (11), 3 of the 8 patients with mandibular grafts, suffered postsurgical paresthesia, this was transitory in two cases, and in another it remained present after three years. Rocuzzo et al. (8), detected temporary paresthesia, without anesthesia or dysesthesia, in one of their 23 patients.

When the bone was obtained from iliac crest, the most frequent complications were pain and walking difficulties, these were generally slight and transitory (10,16). In the study by Barone et al. (10) a patient presented a hematoma at the donor site, which was resolved by drainage. In the same study, of the 56 patients treated, 6 referred pain one week after surgery, but after 2 weeks no patient had pain nor difficulty in walking.

Iizuka et al. (13) treated 13 patients with calvarial grafts,

Carinci et al. (16) 47 patients and Chiapasco et al. (7) 6 patients. Only in the last study (7) it was reported a complication: a superficial infection at the donor site, which healed by second intention after the curettage of the wound.

Recipient site

In the majority of cases there were no problems with graft healing and consolidation. In a study by Rocuzzo et al. (8) 6 grafts incorporated satisfactorily into the native bone; in 3 there was discoloration of the bone surface, the external area was eliminated with a drill and bone added; 2 grafts suffered greater than 50% resorption, and one graft became completely detached when working the implant bed.

In some cases, wound dehiscences are mentioned: Iizuka et al. (13) described 4 cases of dehiscences with infection in the zone, local antiseptics were applied and three cases evolved favorably, the other was resolved with a mucosal graft. Barone et al. (10) found 4 cases of dehiscence: 3 between the 3rd and 5th weeks, it was necessary to remove the 3 grafts completely; the another occurred after 3 months and was resolved with a soft tissue graft. Chiapasco et al. (11) also described a case of dehiscence with exposure and partial loss of the graft. In the study by Von Arx et al. (9) four dehiscences appeared, these reepithelialized spontaneously in 2-4 weeks, which occurs frequently when resorbable membranes are used.

Prosthetic loading time

Prosthetic loading of implants was in most cases made 3 months after implant placement (11,13,14,16). McCarthy et al. (12) and Barone et al. (10) loaded the implants after 6 months, whereas Molly et al. (15) did so after 8 months. In another study (7), atrophic jaws were immediately loaded with overdentures, achieving an implant success rate of 95.7%.

Implant survival and success

Among the different studies, the implant survival rate varied between 97.1% and 100%. In studies on maxilla the survival rates were 97.1% (12) and 100% (14); and in the mandible 100% (7,11). Iizuka et al. (13) made grafts in maxilla and in mandible, obtaining a global implant survival of 100%.

Regarding graft origin, the percentages are as follows: calvaria 100% (7,13); intraoral: 97.1% (12) and 100% (11); and for iliac crest: 100% (14).

With respect to implant success, none of the studies establish well-defined success criteria, consequently the comparisons are difficult. The studies which do report a success rate are the following: Chiapasco et al. (7), 95.7%; Barone et al. (10), 94.9%; and Chiapasco et al. (11), 89.5%.

Conclusion

Although the sample is small, due to the difficulty in finding homogenous studies, we can conclude that autologous onlay block bone grafts are an effective procedure for alveolar crest augmentation. Graft surface resorption is reduced when protected with regeneration membranes; few complications arise from the graft procedure, and the success rate for implants placed in the reconstructed areas is between 89.5% and 95.7%.

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