Alveolar Ridge Splitting Versus Autogenous Onlay Bone Grafting: Complications and Implant Survival Rates

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Purpose: *To compare the complications and implant survival rates of localized alveolar ridge deficiencies in the horizontal dimension reconstructed by alveolar ridge splitting (ARS) or autogenous onlay bone grafting (OBG).*

Materials and Methods: *Twenty-eight ARS and 28 OBG were performed. The survival rate of the all included implants was evaluated using the clinical and radiographical evaluation criteria of Misch et al. Temporary exposure of graft, mild infection, temporary paresthesia, and bad split were defined as minor complications; permanent exposure of graft, loss of graft, and permanent paresthesia were defined as major complications. Major and minor complications of ARS and OBG groups were statistically compared.*

Results: *When the minor and major complication rates are considered, there was not any statistically significant difference between OBG (*$P = 0.099$*) and ARS (*$P = 0.241$*) groups. The satisfactory survival rate of OBG group was 92% and was 100% in the ARS group, and the difference was not statistically significant (*$P = 0.116$*).*

Conclusion: *When reconstructing vertically sufficient but horizontally insufficient alveolar ridges, ridge splitting technique could shorten the treatment period, decrease postoperative swelling and pain, eliminate the need for a second surgical site, reduce the treatment cost, and ease the patient cooperation to the surgery. (Implant Dent 2017;26:284–287)*

Key Words: alveolar defect, alveolar ridge splitting, graft exposure, onlay bone grafting

Following loss of teeth, rapid bone resorption occurs in the transverse plane of the maxilla. A lack of adequate alveolar bone width for optimal implant placement is a frequently encountered and undesirable condition in the maxilla. A number of surgical procedures have been utilized to expand the resorbed thin alveolar crest, including alveolar ridge splitting (ARS) osteotomy for transverse expansion, horizontal alveolar distraction, bone grafting with xenografts, and guided bone regeneration alone or in combination with grafting materials.[1–4] There is currently no consensus on the ideal surgical method of transverse bone augmentation for maxillary implant placement.

Bone grafting techniques for alveolar reconstruction are well documented in the literature.[1,2] A number of different materials, such as autogenous grafts, allografts, xenografts, and alloplastic grafting materials, have been used. An autogenous bone graft is considered the gold standard for osseous reconstruction because it contains osteoinductive and osteoconductive components and does not produce immunologic reactions. Primary tension-free soft tissue closure and absence of infection are mandatory conditions for successful onlay bone grafting (OBG) procedures. The most common postoperative complication in intraoral OBG is incision dehiscence during the initial healing.

The classification of jaw resorption described by Cawood and Howell[4] in 1991 divides the resorption according to the anterior and posterior parts of the jaws. ARS is indicated for class III and IV shapes of both the anterior and posterior maxillary regions according to this classification. ARS is a particular option for augmenting horizontal defects comprising triangular V-shaped crests with adequate length. However, U-shaped crests cannot be reconstructed by this technique. This disadvantage has led surgeons to use intraoral block bone grafts from intraoral sources of membranous bone for OBG. Regardless of

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whether appropriate cases were selected and the correct methodology was achieved, the ARS technique has shown predictable outcomes in both jaws. The most important advantage of the ARS technique is the lack of requirement for a waiting period between the initial surgery and implant insertion. The simultaneous placement of the dental implant in the ARS procedure reduces the total treatment time compared with OBG. Although a number of clinical studies regarding OBG have been reported in recent years,[5–8] there is still a lack of information about the ARS technique.

The aim of this study was to compare the implant survival rates and complication rates after horizontal augmentation of the alveolar ridge with ARS versus autogenous OBG in the anterior maxilla.

Study Design

This retrospective clinical study was performed at the Department of Oral and Maxillofacial Surgery of Baskent University by analyzing past cases from historical records. This study was approved by the Institutional Review Board and Ethical Committee of the Baskent University.

Forty-eight patients (20 men and 28 women) with maxillary anterior alveolar crest width deficiency and a mean age of 44.8 years were included in this study between October 2011 and October 2012. Twenty-eight ARS procedures in 24 patients (11 men and 13 women; ARS group) and 28 OBG procedures in 24 patients (15 men and 9 women; OBG group) were performed. All autogenous bone blocks were harvested from the mandibular ramus in the OBG group.

The patients were selected using the following inclusion criteria: 3 to 4 mm of initial alveolar crest width and sufficient height from the tip of the alveolar ridge to the nasal floor.

The exclusion criteria were as follows: patients who had previously undergone the same surgery, patients who smoked more than 10 cigarettes a day, and patients with any of the following medical conditions: myocardial infarction within 3 months, previous heart surgery or angioplasty, diabetes mellitus, vitamin D deficiency, blood disorder or history of blood disorder (leukemia, lymphoma, von Willebrand disease, hemophilia, platelet disorder), periodontal disease, osteoporosis, use of bisphosphonates, and any other new or uncontrolled medical condition that would affect bone healing.

Table 1. Statistical Comparisons of Demographic Data in the OBG and ARS Groups

	OBG (n = 24)	ARS (n = 24)	*P*
Age, y	44.5 ± 12.1	46.6 ± 12.3	0.549*
Sex, n (%)	—	—	0.247†
Male	15 (62.5)	11 (45.8)	—
Female	9 (37.5)	13 (54.2)	—

There were no significant differences between the OBG and ARS groups in terms of mean age and sex distribution.

All ARS and OBG procedures were performed by the same surgeon. The Bio-Oss (Geistlich, Wolhusen, Switzerland) hydroxyapatite bovine matrix graft material and Bio-Gide (Geistlich, Wolhusen, Switzerland) resorbable collagen membrane were used for the augmentation procedure in the ARS group. The same particulated graft material and membrane were used for the autogenous block graft to minimize graft resorption in the OBG group.

Implant placement was performed simultaneously with the initial procedure in the ARS group and at 6 months after the initial procedure in the OBG group. Implants with a width of 3.3 to 4.1 mm and length of 10 to 12 mm were used (ITI Bone Level; Straumann, Basel, Switzerland). All implants were loaded with a fixed prosthesis at 4 months after the surgery. The numbers of inserted implants in the ARS and OBG groups are shown in Table 1. The survival rates of all implants were evaluated using the clinical and radiographic evaluation criteria of Misch et al.[9] If the marginal bone loss was between 2 and 4 mm, the implant was accepted as having satisfactory survival. If the radiographic vertical bone loss was less than 4 mm (less than half of the implant body) without mobility, and the probing depth (mesial, distal, buccal, and palatal) was less than 7 mm with exudate history, the implant was accepted as having compromised survival. The implant was accepted as clinical failure with any of the following factors: pain upon function, mobility, radiographic bone loss of more than half of the implant length, or uncontrolled exudate.

Temporary graft exposure, mild infection, temporary paresthesia, and bad split (fracture of buccal bone) were defined as minor complications, whereas permanent graft exposure, graft loss, and permanent paresthesia were defined as major complications. The major and minor complications were compared between the ARS and OBG groups. Statistical analyses, including Pearson chi-square test, Fisher exact test, and Student *t*-test, were performed using SPSS software (Statistical Package for the Social Sciences; IBM, Corp, Armonk, NY). Values of $P < 0.05$ were considered statistically significant.

Table 2. Incidence Rates of Minor and Major Complications in the OBG and ARS Groups and Statistical Comparisons

Complications	OBG (n = 42)	ARS (n = 43)	*P*
Minor, n (%)	12 (28.6)	6 (14.0)	0.099*
Temporary graft exposure	6 (14.3)	1 (2.3)	0.058†
Mild infection	3 (7.1)	2 (4.7)	0.676†
Temporary paresthesia	3 (7.1)	—	0.116†
Bad split	—	3 (7.1)	—
Major, n (%)	2 (4.8)	—	0.241†
Permanent graft exposure	2 (4.8)	—	0.241†
Infection related to graft loss	—	—	—
Permanent paresthesia	—	—	—

When the minor and major complication rates are considered, there was not any statistically significant difference between OBG and ARS groups.

Table 3. Statistical Comparisons of Implant Survival Rates in the OBG and ARS Groups

	OBG (n = 42)	ARS (n = 43)	*P*
Survival classification, n (%)	—	—	0.116*
Satisfactory survival	39 (92.9)	43 (100.0)	—
Compromised survival	—	—	—
Failure	3 (7.1)	—	—

The satisfactory survival rate was 92% in the OBG group and 100% in the ARS group, with no significant difference.

RESULTS

The mean follow-up for the dental implants was 38.33 months in the ARS group and 31.6 months in the OBG group. A total of 42 implants were inserted into the augmented region in the OBG group, whereas 43 implants were inserted into the augmented region in the ARS group. There were no significant differences between the OBG and ARS groups in terms of mean age ($P = 0.549$) and sex distribution ($P = 0.247$). The demographic data for the patients in the ARS and OBG groups are listed in Table 1.

When the minor complication rates were considered, there was no significant difference between the OBG and ARS groups ($P = 0.099$; Table 2). The rate of temporary exposure of the augmented recipient site was 14.3% in the OBG group and 2.3% in the ARS group. Mild infection of the recipient site was observed in 7.1% of patients in the OBG group and 4.7% of patients in the ARS group, with no significant difference ($P = 0.676$). Temporary paresthesia was observed in 7.1% of recipient sites in the OBG group, compared with no temporary paresthesia in the ARS group ($P = 0.116$). A bad split occurred in 7.1% of recipient sites in the ARS group during the surgery. The minor complications did not affect the treatment prognosis, and the implants were inserted as planned.

When the major complication rates were considered, there was no significant difference between the OBG and ARS groups ($P = 0.241$; Table 2). The only major complication was permanent exposure of the recipient site in 2 patients in the OBG group, and the augmented grafts were lost in these 2 patients.

In the OBG group, 3 of 42 implants inserted into the augmented bone block failed, and the remaining inserted implants were accepted as satisfactory survival. In the ARS group, all of the inserted implants were accepted as satisfactory survival. The satisfactory survival rate was 92% in the OBG group and 100% in the ARS group, with no significant difference ($P = 0.116$; Table 3).

DISCUSSION

There are several advantages of the OBG procedure with autogenous bone grafts for alveolar reconstruction, such as preferred osteoconductive and osteoinductive features, sufficient bone graft volume, and suitability for all types of atrophic crest. However, the required second surgical region, morbidity of donor sites, and waiting period of 4 to 6 months for implant insertion are disadvantages of the OBG technique. Owing to the potential complications at the donor site and difficulty with the harvesting procedure, selected cases involving the maxilla may benefit from ARS osteotomy for immediate insertion of an endosseous implant.[10]

Overall, a literature search revealed that both human and animal studies on ARS have been conducted in a very inhomogeneous manner and are consequently difficult to compare with one another. Most of the identified human studies did not include a real control group, and no studies were designed as randomized controlled trials.[6,7,10,11]

A recently published literature review concluded that there is support for use of the ARS technique in the augmentation of horizontally deficient ridges with a mean ridge width of 3.37 mm.[12] A linear bone gain of 2.95 mm can be observed in the ARS technique with a complication rate of 0.9% to 26% (mean complication rate, 6.8%). The main complication of ARS was reported to be fracture of the buccal bone.[12] In our study, the complication rate was 14.0% after the ARS procedure, and similar to the previous literature, the main complication was fracture of the buccal bone (n = 3), followed by temporary graft exposure (n = 2).

In a previous study, bone block grafts were used in the augmentation of horizontal defects in a 2-stage approach, when the initial width of the ridge was a minimum of 3.2 mm.[13] A linear bone gain of 4.3 mm at the time of implant placement was seen with this approach, with a mean complication rate of 6.3% related to permanent graft exposure.[13] The main problem is tension of the oral mucosa and possible permanent exposure of the graft. In the present study, the permanent graft exposure rate was 4.8% and the temporary graft exposure rate was 14.3% in the OBG group, compared with a temporary exposure rate of the augmented region of only 2% in the ARS group. Even though there were no significant differences in the complication rates between the OBG and ARS groups, the ARS group had lower minor complication rates than the OBG group, and no major complications were encountered.

Previously reported implant survival rates ranged from 91.7% to 100% for implants placed in bone with the ARS technique with or without a guided bone regeneration procedure.[11,14–16] In the present study, the implant survival rate was higher than those in the previous reports for the ARS group (100.0%). In a previous review article, the survival rates of implants placed in reconstructed maxillae and mandibles using OBG procedures ranged from 60% to 100%, with a median value of 91.5%.[2] These data appear to demonstrate that high percentages of success for the reconstruction procedure and high survival rates of implants placed in the reconstructed areas can be expected with the OBG technique. In the present study, implant failure was observed in 3 of 85 implants, and all 3 failures were in the OBG group. The survival rate of the inserted implants was 92.9% in the OBG group, similar to the previous literature.

The main limitations of the present study are the small sample size and

short follow-up duration. It is also important to be aware of the clinical difference between survival and success rates. Only success rate data can reliably consider the complications associated with implant therapy. On October 5, 2007, the Pisa Consensus Conference in Italy (sponsored by the International Congress of Oral Implantologists) modified the James-Misch Health Scale and approved 4 clinical categories containing conditions for implant success, survival, and failure. The survival conditions for implants have 2 different categories: satisfactory survival, describing implants that have less than ideal conditions but do not require clinical management, and compromised survival, describing implants with less than ideal conditions that require clinical treatment to reduce the risk of implant failure. Implant failure is the term used for implants that require removal or have already been lost. The term implant success may be used to describe ideal clinical conditions. It should include a period of at least 12 months for implants serving as prosthetic abutments. The term early implant success is suggested for a span of 1 to 3 years, with intermediate implant success for 3 to 7 years and long-term success for more than 7 years. In the present study, the mean follow-up period was approximately 3.2 years in the ARS group and 2.7 years in the OBG group, representing early clinical results. Further studies with longer follow-up periods are warranted to evaluate the implant success rates after horizontal augmentation of the alveolar ridge with ARS versus autogenous OBG in the anterior maxilla.

Conclusions

When reconstructing vertically sufficient but horizontally insufficient alveolar ridges, ridge splitting technique could shorten the treatment period, decrease postoperative swelling and pain, eliminate the need for a second surgical site, reduce the treatment cost, and ease the patient cooperation to the surgery.

Disclosure

The authors claim to have no financial interest, either directly or indirectly, in the products or information listed in the article.

Approval

This study was approved by the Institutional Review Board and Ethical Committee of the Baskent University. (D-KA 16/05).

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