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Evaluation of early bone recovery in grafted jaw with anterior iliac bone: a retrospective study

K. ÖZTÜRK[1*], S. KAHRAMAN[2], E. A. DELILBAŞI[2]

[1]Asst.Prof. PhD.DDS at Nuh Naci Yazgan University Faculty of Dentistry, Department of Oral and Maxillofacial Surgery, Kayseri,Turkey
[2]Prof. PhD.DDS at Gazi University Faculty of Dentistry, Department of Oral and Maxillofacial Surgery,Ankara,Turkey
[*] This study was conducted while the author was an assistant at Gazi University

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ABSTRACT

Aims Atrophic jaws make implant planning difficult due to the lack of bone, and this situation directs the surgeon to advanced surgical methods. Today, autogenous grafts are still the gold standard. The aim of this study was to evaluate the bone stability of horizontal bone grafts taken from the iliac crest.

Materials and metods Twenty patients receiving horizontal bone grafts were included in this retrospective cohort study. All patients were treated with bone harvested from the anterior iliac crest. The measurements were made by means of a caliper. Screw heads reference point taken. Resorption rate was followed up in a total of 188 edentulous areas.

Results Graft resorption rate was 34.66% (± 20.53), 32.42% (± 19.39) in the maxilla and 48.03% (± 22.34) in the mandible. It was observed that the average bone thickness increased from 2.38 mm to 7.22 mm.

Conclusions The result of the present study highlight that thicker block grafts, which were applied due to the expected resorption rate, result in a higher resorption rate after recovery. Therefore, by considering soft tissue margins, the importance of harvesting a sufficient, but not excessive, amount of grafting is underscored.

KEYWORDS Augmentation, Autogenous graft, Anterior iliac graft, Resorption

INTRODUCTION

Teeth have an important lifelong role in providing aesthetic, chewing, and speaking functions. The absence of any stimulus to the jawbone after the teeth are lost causes resorption in the jawbones. Resorption rate is 25-50% in the first year after tooth loss and this rate gradually decreases in the following years. In the literature, it is emphasized that resorption progresses faster in women compared to men and develops faster in the mandible than the maxilla (1,3).

A dental implant is a treatment option that has been used for a long time in the treatment of dental deficiency and its use is becoming more common day by day. The quality of hard and soft tissues plays an important role in the success of implant surgery, therefore the amount of bone in the edentulous area is determinant in implant planning. Advanced surgical treatments, such as reconstruction, may be needed for insufficient bone quantity (1,4). Graft materials used in oral surgery are classified into four categories, namely autogenous grafts, allogeneic grafts, xenogeneic grafts, and alloplastic materials. Among them, autografts are considered as the gold standard because of their osteogenesis, osteoconductive and osteoinductive properties (5,6).

There are various donor sites where autogenous bone graft can be obtained. It is divided into two regions, inside and outside the mouth (1,7). In such cases where resorption progresses, a large amount of bone is usually needed, and this directs the surgical intervention to the autogenous graft sources. Iliac, costochondral, calvarium, proximal-tibia and vascularized fibular grafts are common sources of extraoral autogenous grafts (7). Iliac bone grafts are widely preferred in oral surgery and it was firstly used in 1990 by Adell et al. for prosthetic rehabilitation of edentulous jaws (8). However, the absence of stimulation on the continuity of the bone may cause resorption of the graft (9). The introduction of iliac grafts before placing implants in reducing resorption after bone graft surgery can prevent graft resorption and the long-term success of implantation is similar to that of other surgical applications without augmentation (8-10).

This study aims to determine grafts resorption rate in patients augmented with iliac graft as well as the correlation between the bone thicknesses that were measured before and after augmentation and after the healing period.

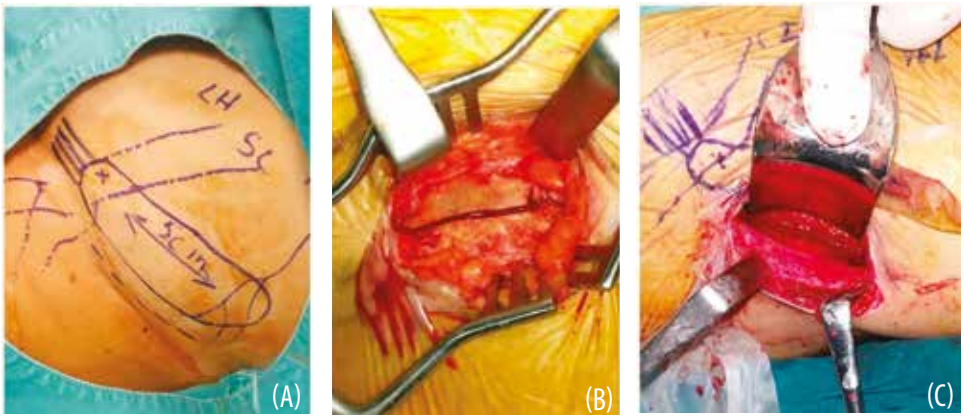

FIG. 1 Operation images of the donor area.
A) Pre-Incision Surgical Field.
B) Determination of graft limit.
C) After graft removal.

MATERIALS AND METHODS

For this retrospective cohort study the records of patients who had undergone graft surgery from the anterior iliac crest at the the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry between February 2014 and February 2017 were evaluated.
The study was conducted in accordance with the principles of the Declaration of Helsinki and the Ethics Commitee reviewed and approved the study protocol.
The following inclusion criteria were selected.

- ASA I and ASA II patients.
- Total or partial edentulism.
- Dental implant rehabilitation after bone augmentation.
- Augmentation in atrophic jaws by taking autogenous bone from the iliac crest and that had implant surgery after recovery.

Records of patients with missing data or in whom grafting was performed after cyst and tumor resection were excluded.

In our Department, the grafting procedures were performed with the autogenous graft obtained from the anterior iliac crest in edentulous areas larger than 3 teeth and evaluated by the same team (Fig. 1). All surgeries were performed under general anesthesia.
Records of patients included data such as demographic data (age, gender), systemic diseases, smoking habits, augmented jaw, sinus lift need, the pre-operative horizontal bone thickness of each site to be augmented and intraoperative bone thickness obtained after augmentation and the postoperative horizontal bone thickness measured during implant surgery, the number, diameter and length of implants used, as well as data about complete prosthesis type.
The measurements were made by means of a caliper. Screw heads reference point were taken. Resorption rate was followed up in a total of 188 toothless areas. Measurements were done by the same doctor; pre-operative (i.e. before augmentation), intra-operative (i.e. after augmentation), and postoperative (i.e. when implants were inserted) timing details were recorded (Fig. 2).

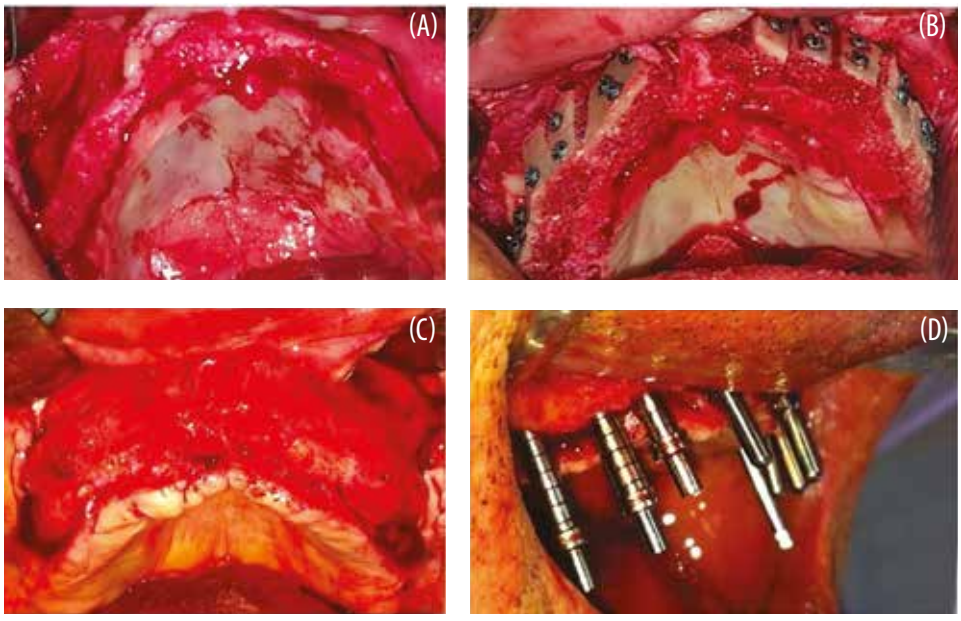

FIG. 2 Operator views of the recipient's site.
A) Pre-operation.
B) İntra-operation.
C) Post-operation.
D) after implant placement.

Statistical analysis

The data which was obtained in this study were analyzed with IBM SPSS Statistics Version 20 package program. It was helped by Shapiro Wilk's when investigating the normal distribution of variables. When interpreting the results, 0.05 was used as the level of significance; if $p < 0.05$, the variables did not occur due to the normal distribution, if $p > 0.05$, the variables arose from the normal distribution. When examining the differences between the binary groups, the Mann Whitney U test was used due to the variables not occurring from the normal distribution.

Spearman's Correlation Coefficient was used when examining the relationships between variables that did not arise from the normal distribution. When interpreting the results, 0.05 was used as the level of significance. If $p < 0.05$, there was a significant relationship and If $p > 0.05$, there was no significant relationship.

RESULTS

A total of 20 subjects, 11 men (55%) and 9 women (45%), were included in the study, with an age range of 22-73 years with an average of 45.7 (± 12.6) years of age (Table 1); of these, 18 patients were ASA I and 2 patients were ASA II, 4 patients were smokers, and 16 patients not.

Augmentation was performed in the maxilla in 16 patients (80%), in the mandible in 3 patients (10%) and in both the maxilla and the mandible in 1 patient (5%). It was observed that 13 of 17 patients who underwent augmentation in the maxilla had sinus lift while 4 did not have a sinus lift.

It was observed that 92 measurements were obtained from the right side of the jaws, while 96 measurements were obtained from the left side of the jaws. 161 measurements (86%) were taken from the maxilla, 27 measurements (14%) were taken from the mandible. Also, the type of prosthesis applied to the patients included 2 removable prostheses and 18 fixed prostheses. Furthermore, 5 implants were lost in 3 patients before prosthetic loading.

Pre-operative horizontal bone level measurement showed that minimum horizontal thickness was 0.5 mm and maximum horizontal thickness was 7 mm and average horizontal thickness was 2.38 (± 1.57) mm the (Table 1).

Intraoperative horizontal bone thickness taken after augmentation showed a minimum value of 1 mm, a maximum of 18 mm, and the average was 9.54 (± 2.38) mm (Table 1). During the recovery period after augmentation there was a minimum of 3 and a maximum of 6 months, implant operations were performed on an average of 3.65 (± 0.75) months. Post-operative horizontal bone levels recorded during implant operation showed a minimum of 1 mm, maximum 11.6 mm, average 7.23 (± 1.84) mm. According to these data, the graft resorption amount in the early period ranged from a minimum of 0.2 mm, a maximum of 7 mm, and an average 2.43 (± 1.37) mm (Table 1).

At least 2, and at most 8 implants were inserted in the 20 patients after augmentation. In total, 122 implants were used, having diameters ranging from a minimum of 2.9 mm to a maximum of 6 mm and averageis 4.09 (± 0.5) mm; lengths ranged from a minimum of 8 mm, maximum 13 mm, average 11.03 (± 1.31) mm (Table 1).

There is a statistically significant relationship between amount of graft resorption and intra-operative horizontal bone levels ($p < 0.05$). This relationship is medium-level and in the same direction ($r = 0{,}496$). As the value of intra-operative horizontal bone levels increases, the amount of graft resorption increases (Table 2).

There is a statistically significant difference between dental arches in terms of graft resorption rates ($p < 0.05$). The resorption rates of the maxilla are highly lower than those of the mandible: While the maxilla had an average of 32.42% (± 19.39) resorption, the mandible had 48.03% (± 22.34) and in total, an average of 34.66% (± 20.53) resorption (Table 3). When measurements were analyzed considering 6 areas, namely right posterior maxilla, left posterior maxilla, anterior maxilla, right posterior mandible, left posterior mandible and anterior mandible, measurements were taken from 41 teeth in the right posterior maxilla, 76 in the anterior maxilla, and 44 teeth in the left posterior maxilla; in the mandible, measurements were taken from 6 regions of the right posterior mandible, 7 in the left posterior mandible, and 14 in the anterior mandible.

Resorption rate had an average of 28.07% (± 15.26) in the right posterior maxilla, 34.26% (± 21.08) in the anterior,

	n	Min	Max	Mean	Median	Sd
Age	20	22,00	73,00	45,7000	47,00	12,63704
The amount of graft resorption	188	0,20	7,00	2,4346	2,50	1,37270
Which month did implants do post-operation?	20	3,00	6,00	3,6500	4,00	,74516
Pre-operative horizontal bone thickness	188	0,5	7,00	2,3849	2,00	1,57527
Intra-operative horizontal bone thickness	188	1,00	18,00	9,5444	9,55	2,38154
Post-operative horizontal bone thickness	188	1,00	11,60	7,2293	7,00	1,83733
Implant diameter	122	2,90	6,00	4,0996	4,20	,49616
Implant length	122	8,00	13,00	11,0328	11,50	1,30754
n: Total number, Min: minimum, Max: maximum, Sd: Standart deviation						

TABLE 1 Distribution chart of values.

		Intra-operative horizontal bone thickness	Post-operative horizontal bone thickness	Pre-operative horizontal bone thickness
The amount of graft resorption	r	,496**	-,294**	-,068
	p	,000	,000	,357
	n	188	188	188
Intra-operative horizontal bone thickness	r		,650**	,108
	p		,000	,132
	n		188	188
Post-operative horizontal bone thickness	r			,154*
	p			,031
	n			188

r: Correlation coefficient; p< 0,05 statistically significant; n: total number of data
Note: The value 000 represents 0.0001.

TABLE 2 Correlation analysis regarding bone levels measurement values and graft resorption amount.

maxilla and 33.29% (± 19.57) in the left posterior maxilla; in the mandible the average was 43.19% (± 10.53) in the right posterior mandible, 57.33% (± 23.58) in the left posterior mandible, and 45.45% (± 25.18) in the anterior mandible.

DISCUSSION

Implant-supported prosthesis is used widely in partial and complete edentulous cases with sufficient bone volume (11). Implant-supported dental prostheses adequately meet the functional and aesthetic expectations of patients. Therefore, implant surgery has become a routine technique in dentistry. On the other hand, after trauma, infections, congenitally missing teeth or tooth extraction, three-dimensional resorption occurs in the alveolar bone, and this pathological or physiological resorption in the alveolar bone limits the indication for dental implants. Augmentation techniques are widely used before implant rehabilitation in acute atrophic jaws. A decrease in bone volume is higher in the first year after tooth loss, and resorption can be seen as up to 50% (11,12). Suitable bone volume for the implant can be obtained by performing reconstruction with vascularized or non-vascularized bone graft and tissue regeneration techniques in atrophic jaws (13).

Autogenous grafts combine osteogenesis, osteoinduction, and osteoconduction properties, and alternative grafting materials with these properties have not been developed yet. The most important feature for preferring autogenous grafts is that it does not cause an immunological reaction. However, factors such as graft amount, shape, and donor site complications limit the use of autogenous grafts (14). Among extraoral donor sites, the iliac bone is the one that provides the most ideal cortical and cancellous bone graft. A graft can be obtained from both anterior and posterior iliac crest. The surgical approach is a significant parameter in bone quality, together with donor field selection, and the amount of bone that is needed (15). The use of iliac crest bone grafts in oral and maxillofacial surgery is generally preferred in patients with cleft lip and palate, alveolar cleft operations, strengthening of bone defects after tumor or big cyst operations and severe alveolar crest atrophies to support prosthetic rehabilitation. However, this surgical procedure has risks of complication such as arterial bleeding, urethral damage, herniation, chronic pain, nerve injury, infection, fracture, and hematoma (13,16). In this study, no complications were recorded after surgeries performed in the iliac region.

Sakkas et al. stated that they observed successful improvement in 106 augmentation sites in their research which they performed augmentation in 38 patients with 116 iliac crests. They applied 187 implants to 106 augmented sites and a loss occurred in 2 implants during the postoperative 2-year follow-up period (17).

In our study, 122 implants were applied to 190 augmented

		Graft Resorption Rate								
		n	Mean	Median	Min	Max	Sd	Mean Rank	Mann Whitney-U	P
Augmented jaw	Maxilla	161	32,42	30,00	2,22	83,33	19,39	88,82	1259,5	0
	Mandible	27	48,03	50,00	3,45	87,50	22,34	128,35		
	Total	188	34,66	33,33	2,22	87,50	20,53			

n: total number of data, Min: minimum, Max: maximum, Ss: Standart deviation

TABLE 3 Mann Whitney U Test result regarding the difference between the jaws augmented in terms of graft resorption rates.

sites, and in 3 patients, 5 of 122 implants were lost during the osseointegration process.
In the study of Sbardone et al., in 14 patients, 32 iliac crest grafts were placed in the maxilla and mandible. In Computerized Tomography (CT) scans which took place after 1 year, an average of 35-51% resorption was reported to occur in 42% of the maxilla and 59% of the mandible (14).
In the study of Sjöström et al., the rate of graft resorption in the atrophic mandible, which was performed with 46 patients after iliac bone onlay grafting, was reported as 37% (10).
In a retrospective study published by Sbardone et al., the iliac bone graft used in the onlay grafting of atrophic maxilla and the symphysis region grafts were compared and at the 1-year follow-up the following results were recorded: 45% resorption in the maxilla augmented with iliac bone, 51% in the mandible augmented with iliac bone, and 35% in the maxilla augmented with symphysis bone; no findings were specified since augmentation with symphysis bone was not performed in the mandible (18).
In the present study, while augmentation was in progress in the maxilla in 16 patients (80%), augmentation was performed in the mandible in 3 patients (15%) and also, augmentation was performed in both the mandible and the maxilla in 1 patient (5%). It was observed that the resorption rate was 32.32% in the maxilla and 48.03% in the mandible, with a total average of 34.66%. These rates are the healing rates during the early implant placement period, and long-term follow-up results to compare with the literature are needed.
Fasolis et al. applied 187 implants to 106 augmentation fields and a loss occurred in 2 implants during the postoperative 2-year follow-up period (19).
In our study, 122 implants were applied in 190 augmentated sites, and in 3 patients, 5 out of 122 implants were lost during the osteointegration process.
In the study of Sbardone et al., in 14 patients, 32 iliac crest grafts were placed in the maxilla and mandible and Computerized Tomography (CT) scans taken after 1 year, an average of 35-51% resorption was reported, 42% in the maxilla and 59% in the mandible (14).
In the study of Sjöström et al. (2013), the rate of graft resorption in the atrophic mandible after iliac bone onlay grafting, which was performed on 46 patients, was reported as 37% (10).
In our study, the finding that as the intra-operative horizontal thickness of the grafted bone increases, the expected amount of resorption increases, shows that grafting performed in excessive amounts does not significantly change the post-operative horizontal bone level. This result suggests that resorption may continue at the bone margin of the graft until vascularization is achieved.
In another retrospective study, Sbardone et al. published a post-operative evaluation of implants placed after autogenous grafting and implants placed in normal bone..
In the study, buccal and palatal bone thicknesses were measured and a 3-year resorption rate is shown. It was stated that resorption was 4.6 ± 0.9 mm in the buccal bone and 3.8 ± 0.8 in the palatal bone. It was also reported that resorption in the non-grafted group was 3.2 ± 1.2 mm in buccal bone, and 2.1 ± 0.9 mm in the palatal bone. Implant survival rate at the 3-year follow-up was 99.1% in the grafted group, and 98.9% in the non-grafted group (20).
Since our study includes early post-augmentation (until implant) records, there are no long-term results and information on implant survival could not be observed. The rate of implant loss due to lack of osseointegration before prosthetic loading is 4%.
In the treatment of large horizontal defects in maxillofacial surgery, ramus and symphysis mandible regions are preferred sources of autogenous corticocancellous bone graft (21,22). A systematic analysis conducted by Cordaro et al. did not provide a conclusion that a particular augmentation technique is superior to others (23).
Some authors state that the bone graft from the thick cortex and high-density calvarium and mandible provide better stability in block graft preference when it is compared to thin cortex and low-density iliac crests (24-26).
Breeze et al. reported that the failure rate was higher in calvarium and iliac crest grafts than mandibular ramus grafts. The authors suggest that bilateral ramus grafts can be used as an alternative to extraoral grafts when large amounts of bone grafts are required (27).
Intraoral bone grafts taken from mandibular symphysis, mandibular ramus, and maxillary tuberosity provide a good treatment option for alveolar crest enlargement and the amount of bone that is available for the graft is sufficient for defects which are up to three-tooth widths (28). Retromolar and symphysis bone grafts are especially recommended in cases involving the reconstruction of defects inclusing a large number of teeth deficiencies in the mandible (27).
In this study, a comparison of different donor sites other than the iliac crest cannot be presented due to inadequate records. The study has also inadequacies in terms of long-term implant survival rates. The prominent finding in this study is that as intra-operative horizontal bone levels increase, so resorption increases. The results of the study show that after grafting, an implant with an average diameter of 4.09 mm (0.5) and an average length of 11.03 mm (1.31) can be used. Thanks to the bone increase, it was determined that fixed prosthesis could be applied to 18 patients who did not have fixed prosthesis indication, and 2 patients who could not even use a removable denture, could receivea implant-supported removable prosthesis. It shows that the results of grafting were successful in terms of function and life quality of the patients. Additionally, we think that excessive grafting to reduce the rate of resorption in autogenous grafts does not change the amount of bone that remained after healing, and excessive grafting may jeopardize soft tissue healing.

CONCLUSIONS

As a result, autogenous graft operations are popular despite all their risks and resorption rates. Although the recipient site to be used in the treatment varies according to the size of the defect and the decision of the patient-doctor, we believe that further studies are needed to provide evidence-based information.

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