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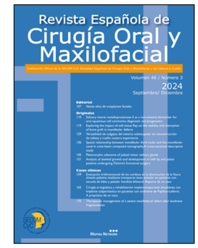

Original

Exploring the impact of soft tissue flap on the stability and resorption of bone graft in mandibular defects

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ABSTRACT

Background: Reconstruction of continuous mandibular defects is challenging due to the need for substantial bone volume and predictable long-term outcomes. Autologous bone grafts from the anterior iliac crest (ICG) are commonly used but are associated with unpredictable and irregular resorption, complicating prosthetic rehabilitation. The role of a recipient bed, restored with soft tissue flap under perimandibular soft tissue defects circumstances, remains unclear in graft resorption. This study aims to assess whether covering ICG with a vascularized soft tissue flap can impact postoperative resorption and density in mandibular defect reconstruction.

Patients and methods: This prospective study included 12 patients with continuous mandibular defects. Patients were divided into two groups: Group 1 (n = 6) received only ICG grafts, while Group 2 (n = 6) had ICG grafts covered with a free anterolateral thigh flap (ALTF). Inclusion criteria were tumors or high-velocity injuries leading to continuous defects, successful graft survival. Exclusion criteria included osteonecrosis (MRONJ/ORN), osteomyelitis, congenital disorders, non-continuous defects, non-union of the graft, age under 18 years, decompensated or sub-compensated concomitant somatic pathologies, incomplete documentation, a radiation history.

Surgical procedures involved standard preoperative planning using CT scans. ICG was harvested using conventional techniques and fixed with reconstructive plates or patient-specific implants. In Group 1, primary closure was possible without tension, while Group 2 required ALTF due to inadequate soft tissue coverage.Postoperative bone graft volume and density were measured using multi-slice CT scans and analyzed with Mimics Medical 23.0 software. Initial measurements were taken within one week postoperatively, with follow-up at 9 months. Statistical analysis included t-tests and Pearson correlation, with significance set at $p < 0.05$.

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Results: Initial mean graft volume was 8223.2 ± 4140.2 cm³, with no significant difference between groups (p = 0.767). Initial graft density was 526.3 ± 117.8 HU, also similar between groups (p = 0.862). After 9 months, graft volume decreased significantly in both groups. Group 1 showed a 31.7 % ± 16.4 % reduction to 5346.3 ± 2922.7 cm³ (p = 0.029), while Group 2 showed a 49.2 % ± 17.4 % reduction to 3441.7 cm³ (p = 0.022). The overall resorption rate was 40.4 % ± 18.6 % (p = 0.011). Graft density increased significantly in Group 1 by 21.0 % ± 10.5 % to 696.3 ± 204.9 HU (p = 0.019), while Group 2 showed a non-significant increase of 2.1 % ± 24.8 % to 541.9 ± 129.0 HU (p = 0.456). No significant correlations were found between initial volume, density, and resorption rate.

Conclusion: The study found significant postoperative resorption of ICG grafts in mandibular reconstruction, regardless of the use of a vascularized soft tissue flap. Although the flap did not significantly reduce resorption, it may still benefit graft survival and incorporation. Further research with larger samples and longer follow-up is needed to better understand the factors influencing graft resorption and to improve mandibular reconstruction outcomes.

Exploración del impacto del colgajo de tejido blando en la estabilidad y reabsorción del injerto óseo en defectos mandibulares

Palabras clave:

Defecto óseo, injerto óseo, reparación ósea, osteogénesis, cierre de heridas, diseño asistido por computadora (CAD).

RESUMEN

Antecedentes: La reconstrucción de defectos mandibulares continuos supone un reto debido a la necesidad de un volumen óseo sustancial y de resultados predecibles a largo plazo. Los injertos óseos autólogos procedentes de la cresta ilíaca anterior (ICG) se utilizan habitualmente, pero se asocian a una reabsorción impredecible e irregular, lo que complica la rehabilitación protésica. El papel de un lecho receptor, restaurado con colgajo de tejido blando en circunstancias de defectos del tejido blando perimandibular, sigue sin estar claro en la reabsorción del injerto. Este estudio pretende evaluar si la cobertura del GCI con un colgajo de tejido blando vascularizado puede influir en la reabsorción postoperatoria y la densidad en la reconstrucción de defectos mandibulares.

Pacientes y métodos: En este estudio prospectivo participaron 12 pacientes con defectos mandibulares continuos. Los pacientes se dividieron en dos grupos: El Grupo 1 (n = 6) recibió únicamente injertos de ICG, mientras que el Grupo 2 (n = 6) recibió injertos de ICG cubiertos con un colgajo anterolateral libre del muslo (ALTF). Los criterios de inclusión fueron tumores o lesiones de alta velocidad que dieran lugar a defectos continuos, y supervivencia satisfactoria del injerto. Los criterios de exclusión fueron osteonecrosis (MRONJ/ORN), osteomielitis, trastornos congénitos, defectos no continuos, no unión del injerto, edad inferior a 18 años, patologías somáticas concomitantes descompensadas o subcompensadas, documentación incompleta y antecedentes de radiación.

Los procedimientos quirúrgicos consistieron en una planificación preoperatoria estándar mediante TC. El ICG se extrajo mediante técnicas convencionales y se fijó con placas reconstructivas o implantes específicos para el paciente. En el Grupo 1, el cierre primario fue posible sin tensión, mientras que en el Grupo 2 se requirió ALTF debido a una cobertura inadecuada de los tejidos blandos. El volumen y la densidad del injerto óseo postoperatorio se midieron mediante TC multicorte y se analizaron con el software Mimics Medical 23.0. Las mediciones iniciales se tomaron a la semana del postoperatorio y el seguimiento se realizó a la semana siguiente. Las mediciones iniciales se realizaron una semana después de la intervención y el seguimiento se realizó a los 9 meses. El análisis estadístico incluyó pruebas t y correlación de Pearson, con un nivel de significación de $p < 0,05$.

Resultados: El volumen medio inicial del injerto fue de 8223,2 ± 4140,2 cm³, sin diferencias significativas entre los grupos ($p = 0,767$). La densidad inicial del injerto fue de 526,3 ± 117,8 UH, también similar entre los grupos ($p = 0,862$). Después de 9 meses, el volumen del injerto disminuyó significativamente en ambos grupos. El Grupo 1 mostró una reducción del 31,7 % ± 16,4 % hasta 5346,3 ± 2922,7 cm³ ($p = 0,029$), mientras que el Grupo 2 mostró una reducción del 49,2 % ± 17,4 % hasta 3441,7 cm³ ($p = 0,022$). La tasa global de reabsorción fue del 40,4 % ± 18,6 % ($p = 0,011$). La densidad del injerto aumentó significativamente en el Grupo 1 en un

21,0 % ± 10,5 % hasta 696,3 ± 204,9 UH (p = 0,019), mientras que el Grupo 2 mostró un aumento no significativo del 2,1 % ± 24,8 % hasta 541,9 ± 129,0 UH (p = 0,456). No se encontraron correlaciones significativas entre el volumen inicial, la densidad y la tasa de reabsorción.
Conclusiones: El estudio halló una reabsorción postoperatoria significativa de los injertos de GCI en la reconstrucción mandibular, independientemente del uso de un colgajo de tejido blando vascularizado. Aunque el colgajo no redujo significativamente la reabsorción, puede seguir beneficiando la supervivencia y la incorporación del injerto. Se necesitan más investigaciones con muestras más grandes y un seguimiento más prolongado para comprender mejor los factores que influyen en la reabsorción del injerto y mejorar los resultados de la reconstrucción mandibular.

INTRODUCTION

The application of non-vascularized bone grafts in facial reconstruction remains a widely used and effective approach, even with the increasing use of microvascular techniques. Grafting from intraoral and extraoral sources continues to be the first-choice method for bone augmentation in atrophic jaws and non-continuous defects. In cases of continuous mandibular defects, where substantial bone volume is required, grafts from the anterior iliac crest (ICG) are considered the preferred option among non-vascularized bone transplants[1,2].

Reconstruction of mandibular continuity defects using non-vascularized iliac crest grafts (ICG) has shown promising results, with a success rate of 67-95 % under favorable anatomical conditions following precise subperiosteal resections and in the absence of prior radiotherapy[3-6]. However, the significant and irregular resorption of these grafts during the postoperative period often leads to functionally unpredictable outcomes, and makes them less suitable for subsequent prosthetic rehabilitation. Although the bone regeneration and remodeling are well-studied, the factors influencing postoperative bone graft volumetric changes remain controversial and the mechanisms of this process are not clearly understood.

The tissues surrounding the transplant play a crucial role in the success of bone grafting procedures, as demonstrated in numerous studies[1-7]. Additionally, these surrounding tissues impact the process of angiogenesis, facilitating the formation of vessels within the graft and influencing its incorporation[8,9]. However, grafts are often placed in conditions of perimandibular soft tissue deficit or low-quality tissues, which may be affected by radiotherapy or scarring. We hypothesize that adequate coverage of the ICG with a well-vascularized free soft tissue flap could influence its postoperative resorption in complex clinical conditions. Hence, the aim of the study is to evaluate the postoperative changes in volume and density of ICG, used for reconstruction of mandibular continuity defects in combination with a soft tissue free flap and to compare it with its solely application.

PATIENTS AND METHODS

The study included data from 12 patients with continuous mandibular defects that were reconstructed using ICG. The surgeries were performed at the Department of Maxillofacial Surgery and Innovative Dentistry Bogomolets National Medical University, between February 2020 and December 2023. The study was conducted in accordance with the ethical standards of the 1964 Helsinki Declaration and its subsequent amendments. The research protocol was reviewed and approved by the Bioethics Committee of Bogomolets Medical University (protocol #163).

The inclusion criteria for the study were patients with continuous mandibular defects caused by tumors or high-velocity injuries that underwent ICG reconstruction with successful graft survival, mandibular fragments union, and absence of infection sequelae. The exclusion criteria included the use of other reconstruction methods, defects caused by congenital disorders, osteonecrosis (MRONJ/ORN), osteomyelitis, non-continuous defects, non-union of the graft, age under 18 years, decompensated or sub-compensated concomitant somatic pathologies, a history of radiotherapy, lack of follow-up with a physician, incomplete clinical and radiological documentation.

The primary variables in the study were the graft's resorption rate during the postoperative period and the changes of its density. Additionally, the correlations between these variables, volume and density were analyzed.

The surgeries were performed under general anesthesia using standard surgical protocols via an extraoral approach. Preoperative computer simulations, based on computed tomography (CT) images, were conducted in all cases. Two surgical teams worked simultaneously at the recipient and donor sites

The ICG was harvested using conventional technique. The incision about 8 cm long was always started 2-3 cm posteriorly to iliac crest anterior spine. The osteotomies of iliac crest were performed using piezoelectric machine. The dimensions of cortico-cancellous graft were defined intraoperatively in accordance with existing mandibular defect.

Bone defects were initially prepared for ICG transplantation by removing fixators and performing debridement when necessary or by conducting primary resection in cases of existing oncological lesions. The defects were then reconstructed with ICG, fixated using either conventional reconstructive plates or patient-specific implants (PSIs) manufactured through direct laser sintering (DLSM). A minimum of three screws were inserted into the mandibular fragments on both sides of the defect, and, depending on its size, two or more screws were placed into the osseous graft. Intermaxillary fixation (IMF) was performed intraoperatively for occlusion fixation when necessary.

The study included two groups of patients. The first group consisted of six patients whose bone defects were reconstructed solely with ICG. In these cases, the state of surrounding skin and mucosa was appropriate for the primary closure; there were no large defects or defects that could not be primarily sutured without tension. The second group included six patients whose defects were reconstructed with ICG covered by a free anterolateral thigh flap (ALTF), which included skin, fat, and fascia. Microvascular reconstruction of mucosal and/or cutaneous defects was used if direct closure and/or local flaps could not provide the effective coverage of the bone graft. Antibiotic prophylaxis was instituted for 7 days postoperatively with penicillin and cephalosporin groups.

The measurement of linear bone defect length was conducted using multi-slice spiral CT images in Mimics Medical 23.0 software (Materialize, Belgium), employing standard measurement tools (Figure 1). Bone graft volume was assessed by segmenting the iliac crest on postoperative CT scans in the same software within 1 week after surgery and later after 9 months of follow-up (Figure 2). The density of the graft was also evaluated in the software based on the Hounsfield unit (HU) scale.

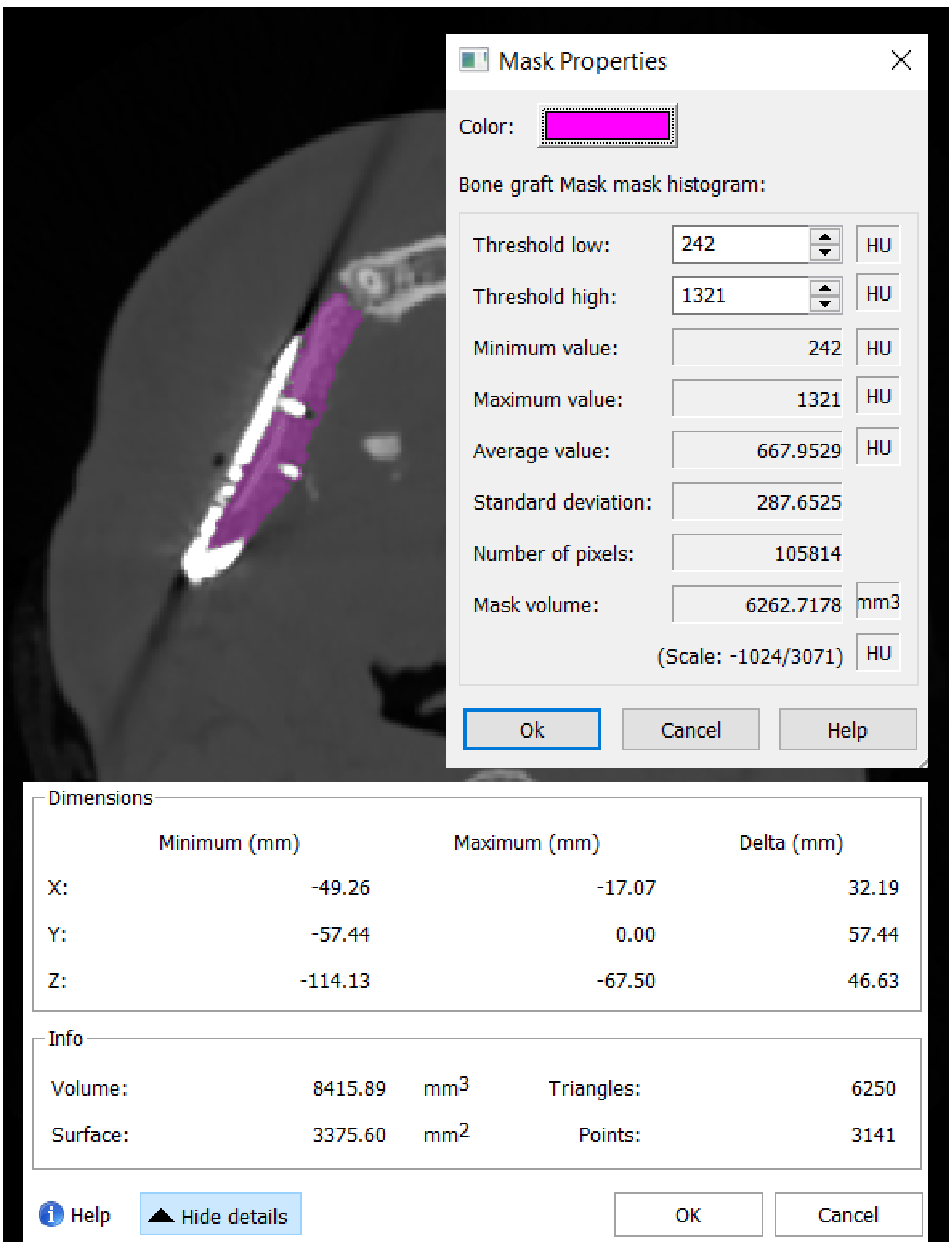

Figure 1. Measurement of graft density and volume (Mimics Medical 23.0 software).

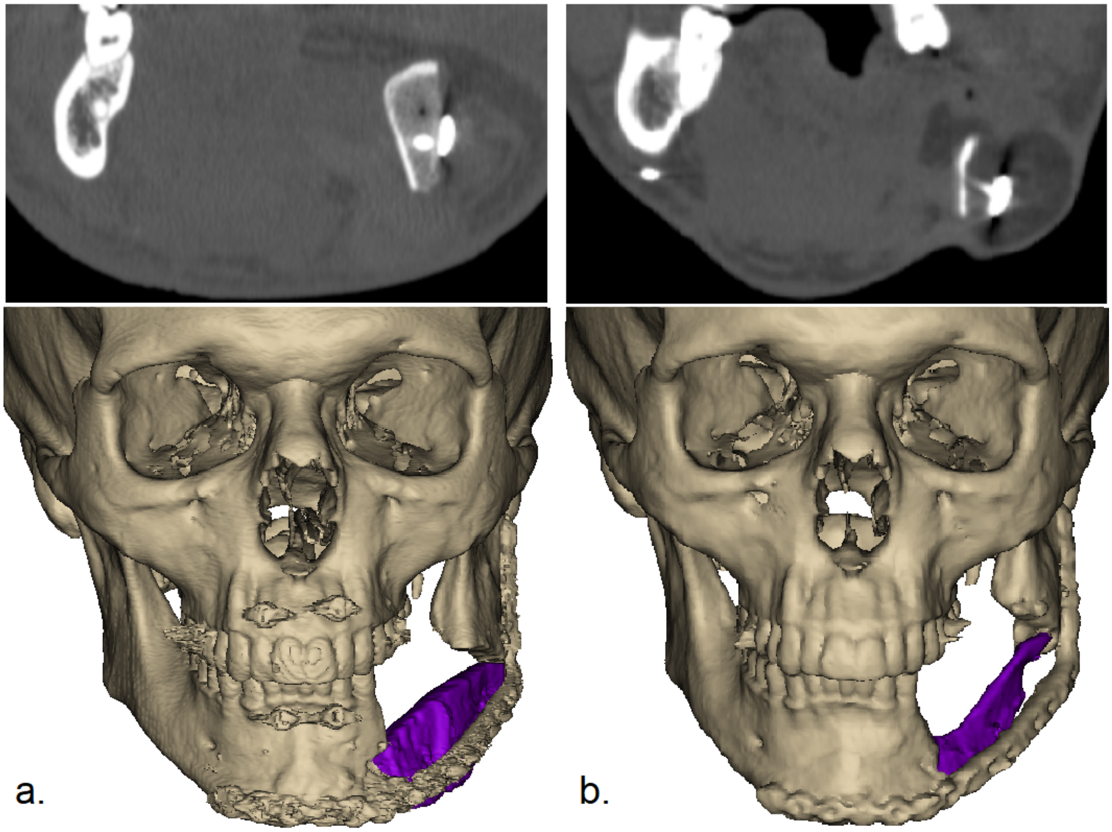

Figure 2. Graft volumetric changes on CT imaging and 3D reconstruction (Mimics Medical 23.0 software): (a) postoperative (initial) graft volume, (b) graft volume at the 9-month follow-up.

Statistical analysis included the calculation of mean ($\bar{x}$) and standard deviation (SD) for parametric values, and median (Me) and interquartile range (Q1-Q3) for non-parametric values. Quantitative data were analyzed using the independent and dependent samples t-test (Student's t-test) for parametric values and the Wilcoxon rank sum exact/signed-rank tests for non-parametric values. The correlations were determined using the Pearson correlation coefficient. Analysis was conducted using R-software version 4.2.2 with a significance level of $p < 0.05$.

The sample size calculation was based on the anticipated mean of postoperative resorption, described in the literature. Then, the range in the studies was from 23 to 60 %. We defined the average about 40 ± 5 % and has anticipated 20 % decrease in the main group. Thus, with the 0.05 I/II error rate at the power level of 80 %, 6 patients to each group (total –12) have to be included for adequate study power.

RESULTS

The mean length of the defects presented in the study was 5.5 ± 1.8 cm. In the first group, the median defect length was 4.7 cm (IQR 4.2-5.7). In the second group, the defect size did not significantly differ (p = 0.435), with a median length of 6.2 cm (IQR 3.5-7.1). The initial mean graft volume in patients included to the study was 8223.2 ± 4140.2 cm^3, with 7591.7 ± 3605.4 cm^3 in the first group and 8854.7 ± 4873.9 cm^3 in the second group (p = 0.767). The initial graft density averaged 526.3 ± 117.8 HU for the whole study sample, with the first group presented a density of 546.8 ± 163.9 HU and the second group 505.8 ± 51.6 HU (p = 0.862) (Table I).

The measurement of these parameters 9 months postoperatively showed significant changes. In the first group, the graft volume decreased by 31.7 % ± 16.4 %, resulting in a final volume of 5346.3 ± 2922.7 cm^3 (p = 0.029). In the second group, the volume decreased more intensively by 49.2% ± 17.4%, with a final volume of 3441.7 cm^3 (IQR 2685.8-3964) (p = 0.022). In the overall study cohort, the resorption of the transplants averaged 40.4% ± 18.6% (p = 0.011) (Table II).

The density of the transplants also changed, showing an increase in most of the patients. In the first group, graft density increased by 21.0 % ± 10.5 %, and reached a mean value of 696.3 ± 204.9 HU (p = 0.019). In the second group, the bone graft density averaged 541.9 ± 129.0 HU, reflecting a general increase of 2.1 % ± 24.8 % (p = 0.456). However, in two out of six cases in the second group, the density decreased on 22.5 % and 36.0 %. Overall, the graft density tended to increase by 11.6 % ± 20.7 %, but this change was not significantly different from the initial values (p = 0.605) (Table III).

We decided to examine the correlations between initial graft volume, resorption rate, and density changes (Table IV). Given that the groups did not significantly differ in initial volume and density, the analysis was conducted within both patient groups combined (12 grafts). There was no significant association between initial bone volume and resorption rate (R = -0.101, 95 % CI -0.638 to 0.502, p = 0.756), nor between graft density and resorption rate (R = -0.284, 95 % CI -0.737 to 0.347, p = 0.372) or density change (R = -0.055, 95% CI -0.61 to 0.535, p = 0.863). Additionally, no significant influence of volume on density was observed (R = -0.545, 95 % CI -0.852 to 0.0424, p = 0.067); however, the statistics suggest that a larger sample size might reveal a potential association.

Table I. Initial characteristics of the grafts.

	Defect's Length (cm)			
	Group 1 (ICG)	Group 2 (ICG + ALT)	W-value	p-value*
	5.7	5.4	16	0,805
	4.2	7.1		
	8.9	7.0		
	5.1	7.1		
	4.3	3.4		
	3.7	3.5		
Mean (x̄)	5.3	5.6		
SD (±)	1.9	1.8		
Median (M)	4.7	6.2		
IQR (Q1-Q3)	4.2-5.7	3.5-7.1		
	Both groups			
Mean (x̄)	5.5			
SD (±)	1.8			
	Graft's Initial Volume (cm3)			
	Group 1 (ICG)	Group 2 (ICG + ALT)	t-value	p-value **
	4791.0	9738.9	-0,298	0,767
	4015.0	17478.7		
	14006.0	9527.0		
	8415.9	7838.0		
	8201.2	4005.6		
	6120.8	4539.9		
Mean (x̄)	7591.7	8854.7		
SD (±)	3605.4	4873.9		
	Both groups			
Mean (x̄)	8223			
SD (±)	4140			
	Graft's Initial Density (HU)			
	Group 1 (ICG)	Group 2 (ICG + ALT)	t-value	p-value **
	331.6	540.9	0,175	0,862
	651.4	426.8		
	532.5	521.4		
	667.9	558.4		
	725.1	529.2		
	372.3	458.2		
Mean (x̄)	546.8	505.8		
SD (±)	163.9	51.6		
	Both groups			
Mean (x̄)	526.3			
SD (±)	117.8			

**Wilcoxon rank sum exact test. **Independent T-test.*

Table II. Graft Volume Change.

	Group 1 (ICG)				
	Initial (cm3)	9 months (cm3)	Resorption (%)	t-value	p-value*
	4791.0	2823.0	41.1	-2.500	**0.029**
	4015.0	2129.0	47.0		
	14006.0	9271.8	33.8		
	8415.9	5836.8	30.6		
	8201.2	8184.0	0.2		
	6120.8	3833.3	37.4		
Mean ($\bar{x}$)	7591.7	5346.3	31.7		
SD (±)	3605.4	2922.7	16.4		
	Group 2 (ICG+ALTF)				
	Initial (cm3)	9 months (cm3)	Resorption (%)	z-value	p-value**
	9738.9	3402.4	65.1	-2.293	**0.022**
	17478.7	10034.0	42.6		
	9527.0	2685.8	71.8		
	7838.0	3964.0	49.4		
	4005.6	2289.9	42.8		
	4539.9	3480.9	23.3		
Mean ($\bar{x}$)	8854.7	4309.5	49.2		
SD (±)	4873.9	2867.5	17.4		
Median (M)	8682.5	3441.7			
IQR (Q1-Q3)	4539.9-9738.9	2658.8 - 3964			
			Both Difference (%)	W-value	p-value***
Mean ($\bar{x}$)			40.4	116	**0.011**
SD (±)			18.6		

* *Dependent T-test. ** Wilcoxon signed-rank test. *** Wilcoxon rank sum exact test*

Table III. Graft Density Change.

	Group 1 (ICG)				
	Initial (HU)	9 months (HU)	Difference (%)	t-value	p-value*
	331.6	537.3	38.3	2.732	**0.019**
	651.4	848.4	23.2		
	532.5	604.4	11.9		
	667.9	904.4	26.1		
	725.1	869.3	16.6		
	372.3	413.8	10.0		
Mean ($\bar{x}$)	546.8	696.3	21.0		
SD (±)	163.9	204.9	10.5		
	Group 2 (ICG + ALTF)				
	Initial (HU)	9 months (HU)	Difference (%)	t-value	p-value*
	540.9	654.9	17.4	0.771	0.456
	426.8	348.5	-22.5		
	521.4	611.6	14.7		
	558.4	410.7	-36.0		
	529.2	634.5	16.6		
	458.2	591.0	22.5		
Mean ($\bar{x}$)	505.8	541.9	2.1		
SD (±)	51.6	129.0	24.8		
			Both Difference (%)	t-value	p-value **
Mean ($\bar{x}$)			11.6	-0.519	0.605
SD (±)			20.7		

* *Dependent T-test. ** Wilcoxon signed-rank test.*

Table IV. Correlations between graft volume and density.

	Graft's volume impact on density change					Graft's density impact on volume change				
	Initial graft's volume (cm3)	**Density change (%)**	Correlation coefficient (R)	95% CI	p-value*	**Initial graft's density (HU)**	**Resorption (%)**	Correlation coefficient (R)	95% CI	p-value*
	4791.0	62.0	-0.545	-0.852	0.067	331.6	41.1	-0.284	-0.737	0.372
	4015.0	30.2		-0.0424		651.4	47.0		-0.347	
	14006.0	13.5				532.5	33.8			
	8415.9	35.4				667.9	30.6			
	8201.2	19.9				725.1	0.2			
	6120.8	11.1				372.3	37.4			
	9738.9	21.1				540.9	65.1			
	17478.7	-18.3				426.8	42.6			
	9527.0	17.3				521.4	71.8			
	7838.0	-26.5				558.4	49.4			
	4005.6	19.9				529.2	42.8			
	4539.9	29.0				458.2	23.3			
Mean ($\bar{x}$)	8223.2	25.9				526.3	40.4			
SD (±)	4140.2	14.8				117.8	18.6			
	Graft's volume impact on volume change					**Graft's density impact on density change**				
	Initial graft's volume (cm3)	**Resorption (%)**	Correlation coefficient (R)	95% CI	p-value*	**Initial graft's density (HU)**	**Density change (%)**	Correlation coefficient (R)	95% CI	p-value*
	4791.0	41.1	-0.101	-0.638	0.756	331.6	62.0	-0.055	-0.61	0,863
	4015.0	47.0		-0.502		651.4	30.2		-0.535	
	14006.0	33.8				532.5	13.5			
	8415.9	30.6				667.9	35.4			
	8201.2	0.2				725.1	19.9			
	6120.8	37.4				372.3	11.1			
	9738.9	65.1				540.9	21.1			
	17478.7	42.6				426.8	-18.3			
	9527.0	71.8				521.4	17.3			
	7838.0	49.4				558.4	-26.5			
	4005.6	42.8				529.2	19.9			
	4539.9	23.3				458.2	29.0			
Mean ($\bar{x}$)	8223.2	40.4				526.3	25.9			
SD (±)	4140.2	18.6				117.8	14.8			

* *Dependent T-test.*

DISCUSSION

The study was conducted with a focus on the osteogenetic phases of bone regeneration and the remodeling process[8]. During bone engraftment, blood vessels sprout into the transplant from the recipient bed[9]. According to the study by Ferretti et al. (2016)[10], which highlighted the successful reconstruction of mandibular defects using compressed milled corticocancellous bone grafts, the distance from the soft tissue bed to the graft is crucial for angiogenesis and achieving positive outcomes. In contrast, the distance to the bone margins, which characterizes the defect's length, is considered insignificant.

The anterolateral thigh flap (ALTF) was chosen for soft tissue defect replacement and ICG coverage based on previous study results[7], where ALTF combined with bone grafts was successfully used in the reconstruction of mandibular combat-related defects. This approach significantly increased the graft's survival rate, bringing the results of ICG application closer to those observed under ideal initial conditions. Additionally, ALTF has a low donor site morbidity, even when compared to other regional and free flaps, minimizing the additional burden on the patient's condition additionally to bone grafting[11,12].

It is worth mentioning that a substantial number of studies have focused on postoperative graft resorption. However, these studies typically examined volume changes in grafts used for augmenting atrophic jaws rather than in the reconstruction of continuous defects, which could potentially influence the results. Therefore, according to a study by Vermeeren et al. (1996)[13] with a five-year follow-up, resorption amounted to 44-50% of the initial volume. In a similar follow-up period, Cansiz et al. (2020)[14] reported a 28 % resorption rate for ICG. Other studies, such as those by Johanson et al. (2001)[15], Sbordone et al. (2009)[16], and Lumetti et al. (2014)[17] demonstrated a wide range of resorption, from 28 % to 51 % within 6-12 months postoperatively. The largest range was reported by Chiapasco et al. (2011)[18] with a resorption rate of 12-60 %. One of the few studies that explored the resorption process in the context of continuity defects was conducted by Rana et al. (2011), which showed a volume loss ratio of 23.7 %[19].

Overall, in our study, we obtained results consistent with those of our colleagues, with a resorption rate of 40.4 % ± 18.6 %, and no significant differences between the groups. We did not extend the follow-up period beyond 9 months due to the clinical focus of the study and the lack of interest in further volume loss in these cases. Typically, after the control tomography at 6-9 months postoperatively, patients begin prosthetic treatment and no longer require graft assessment. Based on our experience, grafts are stable and ready for implant integration after this period, aligning with Wolff's law[20]. Dreiseidler et al. (2016) also supported this view, limiting their follow-up period to 4 months[21]. Therefore, in our opinion, resorption assessment is meaningful only until the start of dental rehabilitation.

In the study, the graft's density increased predictably by 11.6 % ± 20.7 %, in contrast to the volume. No significant differences were found between the two groups ($p < 0.05$); however, in two cases within the second group, the density unexpectedly decreased, which affected the overall mean density rate. Overall, we did not find correlations between graft density and resorption rate ($p < 0.05$), although alternative findings have been reported in the literature. For instance, Donovan et al. (1993)[22] hypothesized that bone density could influence its resorption. This hypothesis was supported by Lumetti et al. (2014)[17], who demonstrated that the resorption rate is negatively related to bone density. Additionally, unlike some studies[15] we did not find correlations between graft volume and its resorption intensity ($p < 0.05$).

The main limitations of this study include the small sample size and the absence of a comparison with bone grafts from alternative sources. Additionally, the measurements of defect length, graft volume, and density were performed once by a single individual, which could cause bias. Furthermore, the study was conducted at a single institution, which limits its external validity.

CONCLUSION

Autologous bone grafts from the anterior iliac crest possess a high and unexpectedly variable resorption rate during the postoperative period. This study did not reveal a significant difference between the group treated solely with ICG and the group treated with ICG in combination with a soft tissue anterolateral thigh flap. Therefore, the impact of soft tissue flap placement in the recipient bed on the bone graft resorption rate remains unclear, unlike its impact on graft survival. In the first group, the grafts underwent significant densification, while in the second group, changes in density were inconsistent. No correlations were found between the initial graft volume, density, resorption rate, and changes in density. Further studies with a larger sample size are recommended to obtain more significant and generalizable results.

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PUBLICATION ETHICS

The research protocol was reviewed and approved by bioethics committee of the Bohomolets National Medical University (protocol N. 163).

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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