

# Anterior and Posterior Iliac Crest Bone Graft Donor Site Morbidities: A Comparing Retrospective Study

## Anterior ve Posterior İliak Kanat Kemik Grefti Donör Bölge Morbiditeleri: Karşılaştırmalı Retrospektif Çalışma

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### ABSTRACT

**Objective:** Autogenous bone grafts are frequently used in orthopedic surgery. The most common donor site for autogenous bone grafting is the iliac crest (IC). A number of complications have been reported after IC bone graft harvesting. The aim of this study was to compare anterior and posterior IC (AIC and PIC) harvesting site morbidities and postoperative subjective pain levels.

**Methods:** Eighty-seven patients were included in the study. Grafts were harvested from the posterior IC in 21 patients and from the AIC in 66 patients. We retrospectively reviewed all patients' preoperative demographics, types of graft obtained, scar dimensions (cm), and donor site complications. Pain level at harvesting site is evaluated with visual analog scale (VAS) score on a postoperative day 1, 7, 2 weeks, 4 weeks, 8 weeks, and final follow-up.

**Results:** There was no statistically significant difference between the groups with respect to the preoperative demographics, types ratio of graft obtained, the mean follow-up time, complications ratio, and the mean VAS scores on 28, 56, and final follow-up. The mean VAS scores on 1, 7, and 14 in the ICA group were significantly higher than in the ICP group. The mean scar dimension of the ICP group was significantly higher than of the ICA group.

**Conclusion:** The AIC and PIC are optimal donor sites for harvesting. There was no difference in perioperative and postoperative complications between the AIC and PIC donor sites. Autologous bone grafting from the PIC decreased pain at the donor site compared to the AIC for at least two postoperative weeks. However, the PIC donor site had a poorer cosmetic appearance.

**Keywords:** Bone graft, complication, iliac crest, visual analogue scale

### ÖZ

**Amaç:** Otojen kemik greftleri ortopedik cerrahide sıklıkla kullanılmaktadır. Otojen kemik grefti için en sık kullanılan verici bölge iliak kresttir (IC). IC kemik grefti alımından sonra birtakım komplikasyonlar bildirilmiştir. Bu çalışmanın amacı, anterior ve posterior IC (AIC ve PIC) donör bölge morbiditelerini ve postoperatif subjektif ağrı düzeylerini karşılaştırmaktır.

**Yöntemler:** Çalışmaya 87 hasta dahil edildi. Greftler 21 hastada posterior IC ve 66 hastada AIC'den alındı. Tüm hastaların preoperatif demografik özellikleri, elde edilen greft tipleri, skar boyutları (cm) ve verici bölge komplikasyonları retrospektif olarak incelendi. Hasat bölgesindeki ağrı düzeyi, postoperatif 1. günde, 7. günde, 2. haftada, 4. haftada, 8. haftada ve son takipte visual analog skala (VAS) skoru ile değerlendirildi.

**Bulgular:** Gruplar arasında ameliyat öncesi demografik özellikler, elde edilen greft tipleri, ortalama takip süresi, komplikasyon oranları, postoperatif 4. hafta, 8. hafta ve son takip VAS skoru ortalamaları açısından istatistiksel olarak anlamlı fark yoktu. AIC grubunda postoperatif 1. gün, 7. gün ve 2. hafta görsel analog skala skoru ortalamaları posterior IC grubundan istatistiksel olarak anlamlı derecede daha yüksekti. Posterior IC grubunun ortalama skar boyutu, AIC grubundan istatistiksel olarak anlamlı derecede yüksekti.

**Sonuç:** AIC ve PIC, greft almak için en uygun donör bölgelerdir. AIC ve PIC verici bölgeleri arasında perioperatif ve postoperatif komplikasyonlar açısından fark yoktu. Posterior IC'den otolog kemik greftlemesi, en az postoperatif iki hafta AIC'ye kıyasla verici bölgedeki ağrıyı azaltmıştır. Bununla birlikte, posterior IC verici alanı daha kötü bir kozmetik görünüme sahipti.

**Anahtar Kelimeler:** Kemik grefti, komplikasyon, iliak krest, visual analog skala

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## INTRODUCTION

Autogenous bone grafts are frequently used in orthopedic surgery for reconstruction of bony defects, augment bone healing, lengthen bones, treating malunion or nonunion, spinal fusion surgery, or performing arthrodesis. In the United States, approximately 500.000 autogenous bone grafting procedures are performed annually (1).

The best origin of the bone graft is the autogenous bone, which has osteoinductive, osteoconductive, and osteogenic properties (2). The autogenous grafts are nonimmunogenic and it's more biological than allogenic grafts (3). Various donor sites such as iliac crest (IC), proximal tibia, distal radius, olecranon and rib can be used for autogenous bone grafts (3). The most common donor site for the autogenous bone grafting is the IC (4). IC donor sites have many advantages such as easy accessibility, the ability of primary wound healing, and having a large volume of bone (5-9). In addition, the harvesting of bone and preparation of the recipient site can be done simultaneously (7). There are also a number of disadvantages in terms of harvesting from IC. Due to the distance between IC internal and external cortices is very low especially at anterior iliac crest (AIC), harvesting can be difficult and fracture of IC may lead to other complications such as long-term immobilization (8,9).

Autogenous bone graft volume at the IC donor site is enough for collecting of cancellous, cortical, or cortico-cancellous bone graft in the desired amount (5). However, a number of complications have been reported after AIC and posterior iliac crest (PIC) bone grafting. The reported complications were: prolonged pain, hematoma, seroma, infection, fracture, visceral complications, and paresthesia (6-10).

IC autogenous bone grafts can be harvested from AIC or PIC. The AIC is more accessible than the PIC but bone volume of PIC is greater than AIC (2,8). Preference the optimal approach for IC harvesting is a challenge for orthopedics surgeons. The aim of this study was to compare AIC and PIC bone grafting site morbidities and postoperative subjective pain levels. We wanted to define problems related to the donor sites of the IC.

## METHOD

This study was conducted as a retrospective clinical study. The study protocol was approved by the Şişli Hamidiye Etfal

Hospital Ethics Committee. Ethics committee approval and number was 1270. We identified 103 patients aged  $\geq 18$  years who underwent bone graft surgery between September 2013 and September 2017. Indications in our study for bone graft surgery included reconstruction of bony defects, fracture malunion or nonunion, spinal fusion surgery and performing arthrodesis. We included patients whose bone grafts were harvested from AIC or PIC. Our exclusion criteria were age  $< 18$  years, history of bone graft surgery before September 2013, history of pelvis or proximal femur fracture before September 2013, cognitive impairment, paresthesia of the pelvic region or lower limbs, leg-length discrepancy, and a follow-up period of less than 1 year. Additionally, 3 patients were lost to follow-up. At finally, 87 patients were included in the study. Grafts were harvested from the PIC in 21 patients (ICP group) and from the AIC in 66 patients (ICA group).

Data for this study were collected from patient's history, the digital data bank including operated patients' informations and outpatient clinic notes. Demographic information was collected retrospectively following consent that included age, gender, body mass index (BMI;  $\text{kg}/\text{m}^2$ ), smoking history, type of graft obtained from harvesting site (cancellous, bicortical, or cortico-cancellous), and scar dimension at harvesting site (cm). Subjective pain level at harvesting site is evaluated with visual analog scale (VAS) score on postoperative day 1 (PD 1), 7 (PD 7), 2 weeks (PD 14), 4 weeks (PD 28), 8 weeks (PD 56), and final follow-up. VAS scores were determined on a scale of 0-10. Complications were divided into: iatrogenic bicortical perforation of the iliac crest; donor site seroma; donor site hematoma; donor site superficial or deep infection; pelvic fracture; impaired wound healing; arteriovenous fistula; disturbance of gait; paralytic ileus; ureteral injury; herniation; meralgia paraesthetica; tenderness during palpation; difficulties at walking and difficulties at climbing stairs. Statistical comparisons were made for all variables between the groups and the results were evaluated. Scar dimension, tenderness during palpation, difficulties at walking, and difficulties at climbing stairs were evaluated only at the final follow-up.

This study has been approved by Ethics Committee of our hospital. Informed consent was obtained from all patients included in the study. The study protocol was approved by the Şişli Hamidiye Etfal Hospital Ethics Committee. Ethics committee approval and number was 1270.

## Statistical Analysis

SPSS 15.0 for Windows 7 (IBM, Inc., Armonk, NY, USA) was used for the statistical analysis. Categorical variables are reported as numbers and percentages, while numerical variables are reported as means, standard deviations and minimum-maximum ranges. When the numerical variables provided the normal distribution condition, the independent two group comparisons were compared with Student's t-test, and when the normal distribution condition was not met, the Mann-Whitney U test was compared with the chi-square analysis. For all tests, statistical significance was defined as an alpha level of  $p < 0.05$ .

## RESULTS

The mean age of 87 patients included in the study was  $46.7 \pm 14.8$  (18-87) years, the mean BMI was  $29.8 \pm 3.8$  (22.8-37.6), and 55 patients (63.2%) were male. The mean follow-

up time was  $3.3 \pm 1.5$  (1-5) years. There was no statistically significant difference between the groups with respect to the mean age, male to female ratio, the mean BMI, smokers ratio, types ratio of graft obtained, the mean follow-up time, and complications ratio (Table 1) (Figure 1). The mean scar dimension was  $7.4 \pm 0.8$  cm in the ICP group and was statistically significant higher than in the ICA group ( $4.5 \pm 0.8$  cm).

Complications not found in any patient were iatrogenic bicortical perforation of the IC, donor site deep infection, pelvic fracture, impaired wound healing, arteriovenous fistula, disturbance of gait, paralytic ileus, ureteral injury, herniation, and meralgia paraesthetica.

The mean VAS scores on PD 1, PD 7, and PD 14 in the ICA group were statistically significant higher than in the ICP group ( $p < 0.001$ ) (Table 1). However, statistical analysis showed that there was no statistically significant difference

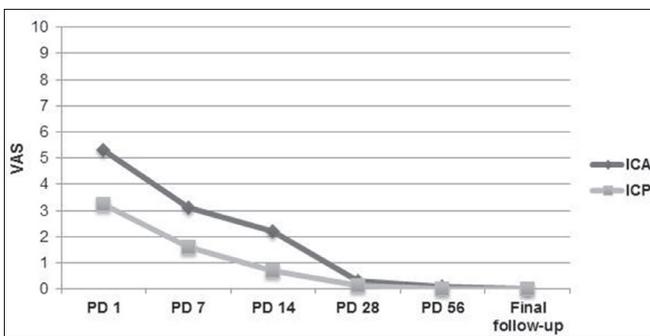
**Table 1:** Patients data

Variable	ICA group (n=66)	ICP group (n=21)	p
Age (years)	$46.4 \pm 14.9$ (18-87)	$47.6 \pm 15.0$ (18-84)	0.747
Male gender	41 (62.1)	14 (66.7)	0.707
BMI (kg/m <sup>2</sup> )	$29.7 \pm 3.6$ (23.5-36.8)	$30.2 \pm 4.4$ (22.8-37.6)	0.691
Smoking history	26 (39.4)	8 (38.1)	0.915
<b>Type of graft obtained</b>			
Cortico-cancellous	19 (28.8)	8 (38.1)	0.553
Bicortical	4 (6.1)	0 (0.0)	
Cancellous	43 (65.2)	13 (61.9)	
Scar dimension (cm)	$4.5 \pm 0.8$ (2-5)	$7.4 \pm 0.8$ (6-8)	<0.001
Follow-up (years)	$3.3 \pm 1.5$ (1-5)	$3.1 \pm 1.5$ (1-5)	0.578
<b>VAS score at harvesting site</b>			
PD 1	$5.32 \pm 0.71$ (4-6)	$3.24 \pm 0.54$ (2-4)	<0.001
PD 7	$3.11 \pm 0.68$ (2-5)	$1.62 \pm 0.67$ (1-3)	<0.001
PD 14	$2.23 \pm 0.55$ (1-3)	$0.71 \pm 0.46$ (0-1)	<0.001
PD 28	$0.30 \pm 0.50$ (0-2)	$0.14 \pm 0.36$ (0-1)	0.180
PD 56	$0.11 \pm 0.31$ (0-1)	$0.00 \pm 0.00$ (0-0)	0.122
Final follow-up	$0.00 \pm 0.00$ (0-0)	$0.00 \pm 0.00$ (0-0)	1.000
<b>Donor site complications</b>			
Seroma	8 (12.1)	3 (14.3)	0.722
Hematoma	7 (10.6)	2 (9.5)	1.000
Superficial infection	2 (3.0)	2 (9.5)	0.244
Tenderness during palpation	5 (7.6)	1 (4.8)	1.000
Difficulties at walking	14 (21.2)	2 (9.5)	0.337
Difficulties at climbing stairs	16 (24.2)	3 (14.3)	0.545

Values are expressed as means  $\pm$  standard deviations (mean  $\pm$  SD) and minimum-maximum ranges (min-max) or as numbers of patients (n) and percentages (%). BMI: Body mass index, VAS: Visual analogue scale, PD: Postoperative day, ICA: Anterior iliac crest group, ICP: Posterior iliac crest group



**Figure 1:** Postoperative AIC donor site minor complication  
AIC: Anterior iliac crest



**Figure 2:** The mean VAS rating at the harvest site. The pain was statistically more severe in the ICA group than in the ICP group on PD 1, PD 7, and PD 14 ( $p < 0.001$ ), with no significant difference in the mean VAS scores on PD 28, PD 56, and final follow-up  
VAS: Visual analogue scale, ICA: Anterior iliac crest group, ICP: Posterior iliac crest group

between the groups in the aspect of the mean VAS scores on PD 28, PD 56, and final follow-up (Figure 2).

## DISCUSSION

The most common donor site for autologous bone grafting is the IC. Determination of the donor site for harvesting

depends on the required bone volume, patient's recipient site, and the surgeons' preference (3,4). To avoid wasting extra time for bone harvesting procedure, orthopedic surgeons generally tends to select the donor site according to the patient's position on the operation table. Accordingly, if the spinal fusion with the posterior approach is planned, PIC is preferred for the donor site, however, AIC is preferred if the spinal fusion is planned with the anterior approach. Nevertheless, different harvesting sites have led to various complications associated with the donor sites (7-10). That the autologous bone grafting procedure is susceptible to occurring of various complications and morbidities necessitate the evaluating of the overall effectiveness of the procedures. Also, it is important to figure out different donor sites in terms of subjective pain, morbidity, quality, and quantity.

Hall et al. (11) conducted a comparative anatomic cadaver study. They indicated that the mean cancellous bone volume of the PIC site statistically greater than the AIC site. In another comparative fresh cadaver study, Engelstad et al. (12) found that the mean compressed cancellous bone volume of the PIC site significantly greater than of the AIC site. Chiodo et al. (13) reported that osteogenic and hematopoietic progenitor cell content differences between the donor sites. However, Takemoto et al. (14) investigated the mRNA levels of bone morphogenetic proteins and their receptors in the bone marrow of the different donor sites and they did not find any statistically significant differences between the three different donor sites. Marx et al. (15) reported that the yield of total nucleated, CD44+, and CD105+ cells was equal between the AIC and PIC. These results indicate that the qualitative choice more difficult than the quantitative choice between different donor sites.

IC donor site major complication rates described ranging from 2% to 8% in the literature and in a series of studies, major complications such as iatrogenic bicortical perforation of the iliac crest, donor site deep infection, pelvic fractur, impaired wound healing, and visceral complications have been reported perioperatively (7-10,16-21). However, none of the patients had any of these complications in our study. These results suggest that the harvesting can be collected from donor sites without major complication if surgical technical procedures are followed.

IC donor site minor complication rates described ranging from 9% to 40% in the literature (7-10,17-21). A retrospective review showed that PIC donor site has the lower risk of

minor complications than AIC donor site (7). Also, Edward and Michael (9) conducted a retrospective review that indicated the minor complication rate of PIC donor site was lower than the AIC donor site. However, Kessler et al. (8) reported that PIC and AIC donor site minor complication rates were similar. In our study, there was no statistically significant difference between the ICA and ICP groups for all complications.

Mauffrey et al. (22) found that the subjective pain from AIC donor site was higher than that at the proximal tibia or olecranon. In the literature, there was no study comparing the pain levels of AIC and PIC donor sites with VAS including postoperative two months and final follow-up. In the study of Ahlmann et al. (7), the variables related to pain were temporary pain and residual pain. They found that AIC donor site temporary and residual pain rates were 5% and 2%, respectively. In addition, PIC donor site group patients did not have temporary or residual pain in their study. In our study, the mean VAS score of ICA group statistically significantly higher than the mean VAS score of ICP group, on PD 1, PD 5, and PD 14. However, as the patients recovered, no statistically significant differences the mean VAS scores of groups, on PD 28 and PD 56. All patients' VAS scores were 0 on final follow-up. These findings suggest that the PIC should be preferred for the patients allowed to mobilization and rehabilitation in the early postoperative period.

In the literature, smoking history is evaluated in a few studies related to autogenous bone grafting. Sheyan et al. reported that the tobacco using rate was 40% in the patients who underwent bone grafting from AIC (17). We found that the rate of tobacco using is similar to their study and no statistically significant differences between ICA and ICP groups were found. We also evaluated the types of obtained graft and we found no statistically significant difference between the groups.

IC donor site scar dimensions are important for cosmetic appearance. In the literature, including the morbidity of IC donor sites, the variables related to cosmetic appearance were generally subjective and there were no objective measurements (7,19,21,23). The studies based on objective measurements of the scar dimensions did not compare the AIC and PIC donor sites scar dimensions, separately (18,20,24). At the final follow-up, we measured the scar dimensions of all patients in cm and the mean scar

dimension of ICP group was significantly higher than the ICA group. The reason for this result could be that the soft tissue thickness on the AIC donor site is less than the PIC donor site and this result implies that the ICP group patients have a poorer cosmetic appearance.

Despite our informative findings, this study had some limitations, including a retrospective study design, functional scale, the detailed consumption of analgesics, the bias of the patient's subjective tolerance to pain, and relatively small number of patients. In addition, there was no evaluation of graft quantity, of grafts' osteogenic, osteoinductive and osteoconductive effectiveness, of the VAS rating at the recipient site, and of bone union.

## CONCLUSION

In conclusion, to summarize, the AIC and PIC are optimal donor sites for harvesting. There was no difference in perioperative and postoperative complications between the AIC and PIC donor sites. The patients in the ICP group have less pain than those in the ICA group at least two weeks postoperatively. However, the PIC donor site had a poorer cosmetic appearance.

## Ethics

**Ethics Committee Approval:** The study protocol was approved by the Şişli Hamidiye Etfal Hospital Ethics Committee. Ethics committee approval and number was 1270.

**Informed Consent:** Informed consent was obtained from all patients included in the study.

**Peer-Review:** Externally and internally peer-review.

## Authorship Contributions

Concept: M.A.T., M.A.G., H.M.Ö., Design: M.A.T., M.A.G., H.M.Ö., Data Collection or Processing: A.H.O., S.E., Analysis or Interpretation: M.K., Literature Search: A.H.O., S.E., Writing: M.A.T.

**Conflict of Interest:** No conflict of interest was declared by the authors.

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