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Original Article

Complications of autogenous bone harvesting from the anterior iliac crest for maxillofacial surgeries

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ABSTRACT

This study aimed to investigate the extent of complications and problems occurring in patients following autogenous bone harvesting from the anterior iliac crest for maxillofacial surgeries. The evaluation was conducted on 27 patients who had undergone autogenous bone graft surgery from the anterior iliac crest at two private clinics during the years 2010-2015. To assess postoperative complications, they were contacted and invited to participate in a follow-up session. Data were extracted from patient records and analyzed using SPSS software version 20 after collection. The average hospital stay for patients was reported as 3.5 days, with immediate post-operative limping present uniformly in all patients. The time it took patients to walk normally ranged from 14 to 75 days, with an average of 25 days. The time it took patients to return to normal activities (including sports) was assessed between 21 to 90 days, with an average of 45 days. The length of the surgical site scar ranged from 25 to 60 millimeters, with an average of 27 millimeters. The width of the scar was calculated between 1 to 3 millimeters, with an average of 1.5 millimeters. Patient satisfaction with the wound site was reported on a 1 to 10 VAS scale, with an average of 7. None of the patients experienced permanent gait impairment. Most post-operative complications were short-term, and in the long term, none of the patients had any noticeable problems. None of the patients suffered permanent deficits requiring reoperation or physiotherapy.

Keywords: Autogenous graft, Anterior iliac crest, Complications

Introduction

The tissue commonly used to replace lost bone tissue is bone itself. Bone grafting has been performed for centuries with varying degrees of success. The tissue that is grafted and intended to become part of the host is called a graft. Depending on the jaw bone defect, when there is a limited need for bone, intraoral sites are suitable, whereas if larger amounts of bone are needed, extraoral grafts are necessary. If forced to use extraoral grafts, the iliac crest is the most common site in orthopedic surgery and in craniomaxillofacial surgery. This is because it has the highest concentration of suitable bone-forming cells and sufficient cell volume, and also provides easy access and fewer complications at the donor site [1].

The success of this graft is higher compared to other grafts such as allograft, xenograft, and alloplast, because autograft includes

living cell elements and post-operative immunological complications do not occur since the antigens present in the graft tissue are not different from each other and the individual's immune system is not stimulated. Various donor sites for autogenous grafts, including iliac crest, tibia, fibrocartilage joint, calvarium, and rib have been reported in articles. Currently, the iliac crest is the preferred donor site in most centers due to easy access, low complications, suitable wound healing ability, and the possibility of harvesting sufficient tissue from both cortical and cancellous bone [2, 3].

The anterior iliac crest has advantages and disadvantages that have been extensively discussed and examined in various studies. Its advantages include: providing large amounts of cancellous bone for autogenous grafting, easier access compared to the posterior iliac crest, minimizing surgery and anesthesia time, and a high concentration of osteogenic progenitor or stem cells, which is itself a factor for osteogenesis [4].

Although harvesting tissue from the iliac crest is a common process in various medical fields, the complications and problems of the donor site are issues that need further investigation. Multiple complications reported following bone tissue harvesting from the iliac crest include chronic pain, loss of sensation in the area, wound at the operated site, gait disturbance, pathological fracture, bowel obstruction, bladder injury, hematoma, bleeding, hernia at the donor site, and instability of the sacrum and iliac bones [5].

Many variables affect the occurrence of such problems and complications. For example, the method and technique used play an important role in determining post-operative complications, which is being investigated. The anterior iliac crest is more accessible than the posterior iliac crest as a donor site because the donor and recipient sites are aligned, and there is no need to turn the patient during surgery. Therefore, bone tissue harvesting can be performed simultaneously, and less time is spent on the operation. However, it has two drawbacks: first, the outer and inner layers of the anterior iliac crest are as thin as a blade, which often makes it difficult to provide sufficient bone harvest. The other drawback is that there is a risk of fracture of the anterior part of the iliac, leading to long-term problems with walking and climbing stairs [3].

Some researchers have claimed that during graft surgery, there are fewer complications and problems after harvesting bone tissue from the posterior iliac region, and that gait irregularities do not occur, the patient can move earlier, and has less pain. The main disadvantage is the need to turn the patient during the operation, meaning the donor and recipient sites are not aligned, which prolongs the operation time [6].

In the studied articles, assessing the extent of actual complications resulting from bone sample harvesting from the iliac crest is difficult, as different surgical methods are used for sample collection, and the incidence of complications has varied somewhat in different studies. These complications include pain, bleeding, sensory disturbance, gait disorder, aesthetic deformity, infection, abdominal hernia, and bowel obstruction.

To date, studies evaluating the extent of complications from iliac crest bone harvesting have been conducted with widely varying results. Different bone harvesting methods, variations in the volume of bone harvested from the graft recipient site, and different methods used to evaluate results can be considered as reasons for these differences [2, 7].

Given the contradiction in articles regarding complications and problems following bone harvesting from the anterior iliac crest, as well as the preference of maxillofacial surgeons for harvesting bone from this area, we decided to conduct a retrospective study to investigate the extent of complications and problems occurring after autogenous surgery. The results of this research, by examining the extent of post-operative complications and problems and exploring their causes, could be useful in preventing them in the future.

Materials and Methods

This is a descriptive study conducted retrospectively. The study population consisted of patients who visited 2 private clinics in Tehran between 2010-2015 and underwent autogenous bone graft surgery from the anterior iliac crest region by a single surgeon using a consistent surgical method and technique. Out of these 43 patients, 27 were eligible to participate in the study. Other patients were excluded from the study due to reasons such as the inability to recall events and providing contradictory accounts.

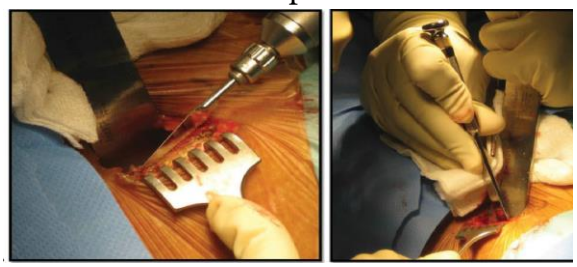
To collect the necessary information, they were contacted and invited to participate in a face-to-face follow-up session. The time taken to return to walking without cane assistance, the time taken to return to normal work activity (including sports), the level of satisfaction with the wound appearance aesthetically in the surgical area (from 0-10, where 0 is dissatisfaction and 10 is the highest level of satisfaction), the length and width of the wound in millimeters were measured using a ruler during the in-person session. Post-surgical complications including wound site sensitivity after surgery, bone tenderness in the operated area, wound dehiscence, wound infection, wound hypertrophy, hematoma or bleeding, pelvic bone deformity, and chronic pain were also examined. To adhere to ethical considerations, full consent was obtained from individuals for inclusion in the sample. Additionally, individuals' information will not be misused and will not be published anywhere.

Surgical technique

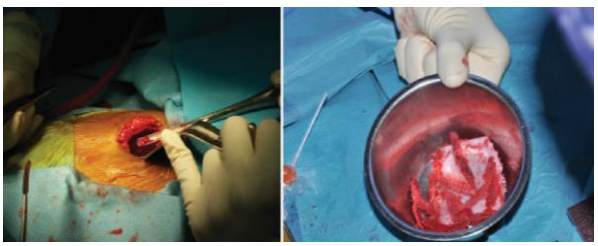
Bone tissue harvesting is performed from the thicker part of the ilium bone, specifically the area between the iliac tubercle and the superior part of the anterior iliac crest (ASIS). An incision parallel to and 1 cm below the iliac crest prominence is made to ensure that the wound does not lie on the iliac crest prominence. Monocortical bone harvesting is performed from the area between the iliac tubercle and 1 cm posterior to the anterior superior iliac spine (ASIS), and corticocancellous bone block harvesting is done with two horizontal and vertical cuts using osteotomes. After removing the corticocancellous bone block, additional cancellous bone tissue is removed with a curette if needed. The size of the bone tissue harvest depends on the amount of bone needed for repair and reconstruction at the recipient site. Following bone harvesting, intraoperative bleeding is controlled with bone wax. After iliac bone harvesting, the skin is sutured using non-absorbable threads **(Figure 1)**.

All patients were admitted to the hospital, and their surgeries were performed under general anesthesia. All patients received intravenous antibiotics during their hospital stay and oral antibiotics for 5 days after discharge. After 48 hours of complete bed rest, patients were not restricted in their activity but were advised to use a cane for walking in the following days.

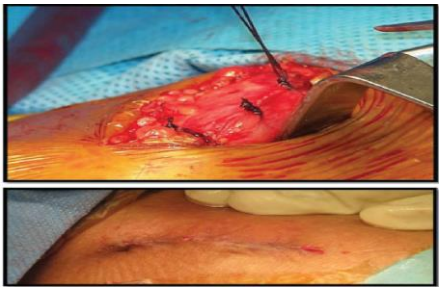
A) Incision parallel to the anterior iliac crest prominence



B) Bone harvesting using saw and osteotomes



C) Harvesting of cancellous bone tissue



D) Suturing the area using absorbable and subcutaneous sutures

Figure 1. Stages of iliac crest bone graft surgery

Results and Discussion

Out of the 27 patients examined, 17 (63%) were male and 10 (37%) were female. Bone graft harvesting from the iliac crest was performed in 25 patients (92.6%) for alveolar cleft treatment and in 2 patients (7.4%) for implant procedures. **(Table 1)**

Table 1. Relative frequency distribution of examined patients by gender and type of treatment

Gender	Number	Percentage
Female	10	37
Male	17	63
Type of Treatment	Number	Percentage
Alveolar Cleft	25	92.6
Implant	2	7.4
Total	27	100

Table 2. Variables examined in patients

Variable	Mean	Standard Deviation	Minimum	Maximum
Age (years)	20	3.8	18	32
Follow-up (months)	14	16.4	7	26
Hospital stay duration (days)	3.5	0.8	2	5
Time to normal walking (days)	25	19.6	14	75
Return to normal activities (days)	45	5.43	21	90
Scar length (mm)	27	9.8	25	60
Scar width (mm)	1.2	1.5	1	3
Satisfaction with wound site (VAS scale)	7	1.1	1	10

Based on **Table 2**, the following results were obtained:

- The youngest patient was 18 years old, and the oldest was 32 years old, with an average age of 20 years.
- The minimum follow-up time for patients was 7 months and the maximum was 26 months, with an average of 14 months.
- The shortest hospital stay was 2 days and the longest was 5 days, with an average of 3.5 days.
- All patients (100%) stated that they were able to walk with a limp immediately after surgery.
- The fastest time to return to normal activities, including sports, was 21 days and the longest time was 90 days, with an average of 45 days.
- None of the patients required physiotherapy sessions and none of the patients had permanent gait impairment (up to the time of the study).
- The shortest scar length was 25 mm and the longest was 60 mm, with an average of 27 mm.
- The narrowest scar width was 1 mm and the widest was 3 mm, with an average of 1.2 mm.
- The lowest satisfaction score for the wound site was 1 and the highest score was 10, with an average of 7.

Among the patients, none had permanent gait impairment at the time of the study. In the examination of complications, 3 patients reported infection at the wound site and 5 patients reported hematoma at the surgical site. None of the patients reported a history of tenderness at the incision site or bone, chronic pain (up to the time of the study), or wound dehiscence.

Considering these points, we designed a retrospective study to examine the complications resulting from bone harvesting from the anterior iliac crest. This study was

conducted on patients who visited 2 private clinics in Tehran during the years 2010 to 2015, and for this purpose, patient records and questions from the patients themselves were examined. Questions were asked about issues such as the duration of return to walking, length of hospital stay, time to return to normal activity, and patient satisfaction with the wound site aesthetically. The length and width of patients' wounds were also measured during the in-person session.

In this study, 27 patients were included, of which 25 patients were grafted for alveolar cleft treatment and 2 patients for implant treatment. 17 patients (63%) were male and 10 patients (37%) were female. The age of patients ranged from 18 to 32 years, with an average age of 20 years. The follow-up time for patients, based on the records in these patients' files, was evaluated between 7 to 26 months with an average of 14 months. The length of hospital stay for patients was calculated between 2 to 5 days with an average of 3.5 days. 100% of patients stated that they walked with a limp immediately after surgery. The time it took for patients to walk normally was reported between 14 to 75 days with an average of 25 days. The time it took for patients to return to their normal activities (including sports) was between 21 to 90 days with an average of 45 days, and according to patients' statements, none needed physiotherapy sessions and none of the patients suffered permanent gait impairment. The scar length at the surgical site was evaluated between 25 to 60 millimeters with an average of 27 millimeters. The scar width was between 1 to 3 millimeters with an average of 1.5 millimeters. Patients' satisfaction with their wound site was measured from 1 to 10 on the VAS scale.

In a study conducted by Manar Almaiman *et al*. [7] in 2013 to investigate the complications and problems of iliac crest bone graft surgery in 372 patients, 200 patients were male and 172 were female, with an age range between 21 to 63 years.

In another study by Sainath Matsa *et al*. [8] in 2012 to evaluate complications related to tissue harvesting from the iliac crest bone for alveolar cleft bone grafting on 18 patients, including 12 men and 6 women, the average age of patients was 10 years.

In the study by Massimo Fasolis *et al*. [4] in 2012 to examine complications related to iliac crest bone grafting on 130 patients, 75 patients were female and 55 patients were male.

In a study conducted by Antonio Baron *et al*. [3] in 2012 to investigate complications related to bone harvesting from the iliac crest in the treatment of maxillary and mandibular atrophy, the research was conducted on 235 patients, 155 male patients, and 80 female patients, with an average age of 54 years reported for the patients.

A study by Shelly Abramowicz *et al*. [5] in 2012 to compare the anterior iliac crest approach versus the posterior iliac crest for alveolar cleft grafting was conducted on 239 patients (134 males and 105 females), and they reported the average age of the studied patients as 10 years.

In the study by Zaid Baqain [9] and colleagues in 2008 titled "Examination of complications of anterior iliac crest bone harvesting for alveolar bone grafting" conducted on 24 patients, the age range of patients was 10 to 13 years.

Cheng Chun [10] and colleagues conducted a study in 2014 to examine complications and problems associated with harvesting cancellous bone from the anterior iliac crest using a small incision technique. The study involved 40 patients with an average age of 10 years.

In a 2000 study by Eufinger and colleagues [11] to investigate complications and problems at the iliac crest bone graft donor site using open and closed surgical techniques, bone harvesting for alveolar cleft repair was performed on 52 patients aged 8 to 13 years.

A study by Sindet-Pederson and Enemark [12] in 1988, titled "Reconstruction of Alveolar Clefts with Mandibular or Iliac Crest Bone Grafts," involved 40 patients with an average age of 9 years.

Considering the average age of participants in these studies on alveolar clefts, the age range of patients was reported to be between 10 and

13 years. However, in our study, the average age of patients was calculated to be 20 years. The difference in results between this study and previous studies may be due to the age difference of patients when referred to the clinics under investigation.

The duration of hospital stay for patients in Manar Almaiman's study [7] was 2 to 5 days, and similarly, in Swan and Goodacre's study [1], it was assessed as 2 to 5 days. However, Sainath Matsa [8] reported 2 to 3 days in their study, while Massimo Fasolis [4] evaluated the average hospital stay as 4.5 days. Zaid Baqain's study [9] reported 2 to 4 days, Cheng Chun's study [10] calculated 3 to 6 days, and Balsam's study [13] assessed it as 2 to 6 days. Shelly Abramowicz's study [5] recorded 1 to 5 days, which was in line with studies by Heidrun Schaaf [6], Kessler [1], and Clarke [14], who reported 1 to 5 days.

In the present study, the duration of hospital stay was evaluated as 2 to 5 days, which aligns with Manar Almaiman's [7] and Swan and Goodacre's [1] studies and does not significantly differ from other mentioned studies. The slight difference in the number of days in some studies may be due to variations in surgeries performed on different patients, as the length of hospital stay is determined by the physician based on the type of surgery.

For example, in Constantinides' research [15], the duration of hospital stay differed between the two study groups due to the use of two different surgical techniques. In the first group, which underwent open technique surgery, patients stayed for 72 hours, while in the second group, which underwent closed technique surgery, the stay was calculated as 50 hours. Therefore, this factor can be one of the reasons for the variation in patients' hospital stay duration.

The time it took for patients to walk normally in Sainath Matsa's study [8] was recorded as 12 to 35 days, while in Manar Almaiman's study [7], it was 9 to 25 days. Antonio Barone [3] estimated 18 days for their study subjects and studies by Rawashdeh [16] and Nkenke [17] reported an average of 14 days. Zaid Baqain's study [9] recorded an average of 10 days. Swan and Goodacre's study [1] evaluated it at an average of 7 days, and Massimo Fasolis' research [4] calculated an average of 6 days.

In the present study, the time for patients to walk normally was reported as 14 to 75 days, with an average of 25 days. This difference in results could depend on factors such as the surgical method and technique, and the volume of bone harvested from the iliac crest. In this regard, Swan and Goodacre [1] concluded in their study that when harvesting bone from the iliac crest area, minimal soft tissue incision is required to open the ilium cartilage cap, which is a factor in reducing abnormal gait, termed "Gluteal gait." Based on this, one of the reasons for the difference in patients' walking time in various studies could be that this factor may have received less attention and precision in many performed surgeries.

The time it took for patients to return to normal work activities (including sports) was reported as 25 to 45 days in Manar Almaiman's study [7], while Sainath Matsa [8] evaluated an average of 40 days. Shelly Abramowicz's study [5] recorded 40 days, Zaid Baqain's study [9] reported an average of 30 days, and Swan and Goodacre's research [1] reported an average of 28 days. Joshi's study [18] assessed it as 25 days, and Massimo Fasolis's research [4] calculated an average of 20 days.

In the present study, we evaluated the time for patients to return to normal work activities (including sports) between 21 to 90 days, with an average of 45 days. Considering the results obtained from this research and other studies, the difference among them may be related to the varying average age of the subjects in different studies. For example, the time to return to normal work activities differs between young children and adults.

The length of patients' wounds in Shelly Abramowicz's study [5] was between 20 to 45 millimeters, and the width was between 1 to 2 millimeters. Heidrun Schaaf's study [6] reported an average wound length of 8 millimeters and an average width of 1.5 millimeters. Swan and Goodacre's study [1] evaluated an average wound length of 60

millimeters, while Kessler's research [2] calculated the wound length between 35 to 50 millimeters and the width between 4 to 8 millimeters. In Eufinger's study [11], the first research group using the open surgical method reported an average wound length of 60.3 millimeters and width of 7.7 millimeters, while the second group using the closed surgical method reported a wound length of 24.2 millimeters and width of 4.9 millimeters. In our study, the scar length was calculated between 25 to 60 millimeters, with an average of 27 millimeters, and the scar width between 1 to 3 millimeters, with an average of 1.2 millimeters. The difference in results calculated in various studies and the present study may be due to differences in the type of surgery and the amount of bone harvested needed in each surgery, which affects the length and width of the wound in individuals. The level of patient satisfaction with the appearance of the wound scar in our study was evaluated using a 1 to 10 VAS scale, with an average of 7. This was in line with Massimo Fasolis's study [4], which estimated patient satisfaction with the wound site at an average of 7.38 on the VAS scale. In Antonio Baron's study [3], all patients were satisfied with the appearance of their wound scar, except for one dissatisfied patient. Heidrun Schaaf's research [6] reported an average satisfaction rate of 92% among patients regarding their wound scar, while the remaining patients were not fully satisfied aesthetically due to the long incision. Other studies also reported complete patient satisfaction with the wound site.

Considering past studies and the present study, similar results were obtained with no significant difference. In this regard, Mannar Almaiman's research [7] stated that using the conventional method of subcutaneous sutures can, to some extent, explain successful results and increase patient satisfaction with the wound site.

None of the patients experienced permanent gait impairment (at the time of the study). In examining complications, 3 patients reported infection at the wound site, and 5 patients reported hematoma at the surgical site. None of the patients reported a history of tenderness at the incision site or bone, chronic pain (up to the time of the study), or sensory changes at the wound site.

In this study, no bone fractures were reported in the surgically treated area of the subjects under investigation. However, in most of the studies mentioned, each reported one case of bone fracture as a post-operative complication in their study subjects.

Conclusion

This research showed that short-term post-operative complications include pain, wound infection, bleeding, or bruising around the operated area. The time frame for short-term complications was evaluated as 1 to 3 months after surgery. Long-term complications, including iliac bone fracture, non-union or malunion of the bone in the operated area requiring reoperation, surgical site scarring, or prolonged pain and infection in patients, were calculated with a time frame of up to 1 year for these long-term complications.

In our study patients, most post-operative complications were short-term, and in the long term, none of the patients had any noticeable problems or suffered permanent deficits requiring reoperation or physiotherapy. Considering the present study and similar studies, it can be concluded that the rate of post-operative complications and the difference in results between this research and other mentioned studies may be related to the surgical technique and the amount of bone harvested from the iliac crest. These are among the reasons that can play a role in the success of treatment and the low complication rate of surgery.

Another difference between this study and past studies is the difference in the average age of the subjects under investigation, which may be one of the reasons for the difference in results obtained compared to previous studies.

Finally, considering this study and other past studies, the anterior iliac crest remains a suitable area for bone harvesting for grafts in the maxillofacial region, and the rate of post-

operative complications varies according to the reasons mentioned in the discussion.
Although future advancements in bone substitution may well change this trend and result in terms of complication rates.
For further investigations, a long-term prospective study could provide up-to-date and useful information regarding complications following bone harvesting surgery.

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