Long-Term Functional Outcome and Donor-Site Morbidity Associated with Autogenous Iliac Crest Bone Grafts Utilizing a Modified Anterior Approach

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Abstract

Prior studies and techniques for harvesting iliac crest bone have shown significant postoperative pain, disability, and poor cosmesis. This retrospective study was conducted to examine bone graft donor-site morbidity by evaluating functional outcomes in patients who have undergone a modified anterior harvesting approach. The medical charts and hospital records of 43 patients were retrospectively reviewed over a 6-year period. Demographic information, operative notes, laboratory results, and the American Society of Anesthesiologists (ASA) classification were recorded. All patients were evaluated retrospectively at a mean 41 months after bone-graft harvesting. Patients available for follow-up were asked to quantify their pain level at the donor-site on a visual analog pain scale (0-10). They also completed SMFA forms, as well as a survey pertaining to sensory deficits, gait disturbances, and cosmetic appearance. Forty-four patients met the inclusion criteria consisting of 25 males and 18 females, mean age 47 years (range, 22 to 80 years). A total of 32 (73%) patients were available for long-term follow-up at a mean of 41.3 months (range, 8 to 83 months). Eight (25%) of these patients reported minimal postoperative pain at time of follow-up. Three of 32 (9%) patients reported minor ambulation difficulty as a result of donor-site pain. Other minor complications included hypertrophic scar formation (7%) and hematoma/seroma (3%). There were no major complications reported, such as deformity at the crest site (0%) or infection (0%). SMFA scores demonstrated a mean dysfunction score of 48.5 (range, 41.8 to 71.1) and a bother index of mean 47.9 (range, 42.6 to 73.9). Utilizing the anterior approach in iliac crest bone harvesting provides an abundant supply of both cortical and cancellous bone, an aesthetically favorable scar, and decreased postoperative donor-site pain. There were very few complications seen in our cohort as compared to previous studies with very good long-term functional outcomes.

Bone grafts are commonly used in orthopaedic surgery in order to provide an osteogenic stimulus in fracture nonunion. They may also restore an adequate bone volume in the face of existing bone loss and facilitate osseous bridging across long-bone fracture sites.

Some factors the treating surgeon must consider prior to bone graft surgery include choice of donor site and potential donor site morbidity, previous surgical interventions, and the presence of patient comorbid conditions that may affect the procedure. The majority of autogenous cancellous bone grafts used for nonunion surgery are obtained from the iliac crest region, either anterior or posterior.

The method by which cancellous bone is obtained from the donor site may be influential in predicting donor-site morbidity. Normally, cancellous bone is obtained by creating a “trap door” bone window, allowing access to the inner tables of the iliac crest in an open harvesting technique. Minimally invasive techniques were developed in an effort to reduce the morbidity associated with iliac crest bone graft (ICBG). Two different minimally invasive techniques, one that uses a reamer and another that uses a trephine, were compared to a control group (traditional bone window open harvesting technique). The two minimally invasive techniques were found to be superior to the control method in pain assessments, operative time, and mean incision length.
While serious complications occur rarely with bone grafts, such as iliac fracture, minor complications consisting of cutaneous nerve damage, local wound complications, persistent pain, and skin and bony hypertrophy have been reported in retrospective series. Despite a trend toward the application of biomaterials, stem cells, and growth factors, autogenous bone grafts are superior to currently available commercial grafts, because of their unique osteoinductive and osteoconductive qualities.4

Preserving the iliac cortices during harvesting is thought to reduce postoperative pain at the donor site. However, when 60 patients were prospectively randomized and grafts collected either by the “outer-table” method (includes the outer cortex and the cancellous bone beneath) or by collecting only the cancellous bone within the cortices; no differences were found in terms of residual pain at the donor site after 2 years.5

The senior investigator (KAE) has utilized an anterior approach with removal of the inner table of the pelvis for harvesting bone graft from the iliac crest. This technique is believed to have led to fewer complications both major and minor, and less morbidity at the donor site, while maintaining the ability to obtain a large volume of cancellous autograft. Very little data exists assessing the effect of iliac crest bone grafts on patient function. This retrospective analysis was designed to assess the functional outcomes of patients who have undergone iliac crest bone graft harvesting utilizing one specific technique. Using the SMFA along with patient self-assessment, long-term patient function and morbidity were assessed.6

Methods and Patients

Following IRB approval, all clinical notes and medical records of patients who underwent iliac crest bone grafting were reviewed. All patients were treated by the senior investigator (KAE) at a university academic medical center from August 23, 1999, to November 4, 2005. Patients’ demographic information, including age, gender, education and employment status, as well as comorbidities and smoking history were obtained by retrospective chart evaluation. The American Society of Anesthesiology (ASA) classification, operative notes, and all complications related to iliac crest

![Figure 1](image-url)
were documented. In addition, estimated blood loss from the operative procedure as well as bone graft volume were recorded. The approach to the iliac crest graft site was the same for all patients in this study.

**Surgical Technique**

The approach to access the cancellous bone between the inner and outer iliac tables utilizes the first window of the ilioinguinal approach to the pelvis. A small 3 cm to 4 cm incision is made 1 cm posterior to the anterior superior spine. The incision is carried down the fascial interval between the external oblique and the tensor fascia lata. This intermuscular plane is taken down to the crest. The iliacus muscle is then elevated off the inner table of the pelvis, exposing the internal iliac fossa. With the abdominal musculature retracted, an osteotomy of the inner table is performed. An approximate 4x4 cm square is scored with an osteotome, and the cortical inner table removed (Fig. 1). This exposes the rich cancellous bed between the tables without violating the integrity of the crest. Furthermore, this internervous plane is devoid of cutaneous branches. The cancellous bone is harvested with the use of small gouges and curettes. Hemostasis is achieved with bone wax and gel foam. No drainage tube was utilized. The fascia is then repaired with an interrupted suture, and the skin and subcutaneous tissues closed in layers.

Patients were asked to complete a long-term functional outcome survey and self-assessment. The status of the scar, pain, paresthesia, bony hypertrophy, and gait disturbances related to iliac crest done site were determined during follow-up. SMFA forms, including the function and bother indices, were obtained at this time either in person or over the phone, statistically analyzed, and compared to a healthy control population. Dysfunction, current morbidities, and changes in smoking habits were also noted.

**Results**

Forty-three patients were identified as having undergone the aforementioned procedure over a period of 6 years in conjunction with surgery to treat an un-united fracture. Twenty-six males and 18 females with an average age of 47 years (range, 22 to 80 years) were included in this series. There were no intraoperative surgical complications, nor did any patient require a blood transfusion. The site of nonunion for the cohort included: the tibia (40%), humerus (20%), femur (18%), and with the remainder consisting of ulna (9%), fibula (4%), patella, and clavicle (Table 1). Bone grafts were all taken using the anterior approach, with an estimated average harvest volume of 27 cc (range, 10 to 40 cc), including the cortical bone. The average estimated blood loss from the index procedure with limb and crest site combined was 285 mL (range, 50 to 800 mL).

One patient developed a hematoma immediately postoperatively at the donor site but did not require drainage. There were no postoperative infections or intraoperative fractures of the ilium.

Thirty-two (73%) of 43 patients were available for long-term follow-up either over the phone (64%) or in person (36%) at a mean follow up of 41.3 months (range, 8 to 83 months). Eight patients had no available address or phone number, while four were unwilling to participate in the study. The questionnaire respondents possessed similar demographic information compared to the entire study sample. Seventeen males and 15 females responded; the mean age was 49.9 years (range, 22 to 80 years).

Patient complaints were noted in 8 of 32 (25%) patients questioned during long-term follow-up. These consisted of complaints of pain about the iliac crest donor site (10%, n = 3) and hypertrophic scar formation (7%, n = 2). Of the remaining three patients, one developed a hematoma, while the other two had complaints unrelated to the donor site. There were no postoperative donor site infections and no changes regarding bone hypertrophy as seen on radiographs. Two patients with no previous history of hypertrophic scar formation noticed a slight overgrowth of skin over the incision. They reported no motor or sensory deficits associated with the scar and that the scar was decreasing in size over time. The one patient who developed a hematoma postoperatively had no cosmetic or functional complaints during follow-up at 36 months. Thirty of 32 (94%) patients seen during long-term follow-up had healed index nonunions for which the graft was taken.

Twenty-three of 32 (72%) patients ambulated without difficulty at time of follow-up. Of the nine patients with ambulation difficulties, six (four tibia and two femur) reported their primary fracture as the source of pain and decreased mobility. The three remaining patients (two humerus and one tibia) reported donor-site morbidity leading to some functional difficulty. Of significance, these three patients were seen at a mean follow-up of 13 months. The authors of this report believe that maximal relief of pain is seen at one year; however, some patients may continue to improve after that point. The most frequent complaint, although minimal, reported by patients in the questionnaire was pain. The visual analog pain scale (VAS) at a mean of 41.3 months reported for the cohort was 1.7 on a scale of 1-10, where 10 represented the maximum pain. The

<table>
<thead>
<tr>
<th>Site</th>
<th>Number of Patients</th>
<th>Percent (N = 43)</th>
</tr>
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<tbody>
<tr>
<td>Tibia</td>
<td>18</td>
<td>40%</td>
</tr>
<tr>
<td>Humerus</td>
<td>9</td>
<td>20%</td>
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<tr>
<td>Femur</td>
<td>8</td>
<td>18%</td>
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<tr>
<td>Ulna</td>
<td>4</td>
<td>9%</td>
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<tr>
<td>Fibula</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Patella</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Clavicle</td>
<td>1</td>
<td>2%</td>
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**Table 1** Fracture Nonunion Site
SMFA questionnaire contained two parts: the dysfunction index and the bother index. Average scores for the general population are 50 with higher scores suggesting greater dysfunction. Scores demonstrated a dysfunction score of mean 48.5 (range, 41.8 to 71.1) and a bother index of a mean of 47.9 (range, 42.6 to 73.9). This indicated that patients were impacted by pain to a lesser extent than the general population by a difference of approximately 0.2 of one standard deviation. These results illustrate that, on average, patients undergoing ICBG using the anterior approach function have a functional level essentially equal to that of the general population. Three patients retained some minor donor-site morbidity, yet the majority of these patients returned to baseline function with little or no residual pain.

Discussion

Pain is the most commonly reported complication of harvesting iliac crest bone grafts. Other complications of bone graft donor sites include: swelling, hematoma, inflammation, temporary or permanent parasthesia,7 pyogenic granuloma,8 incisional hernias,9,10 pelvic fracture, and chronic pain. Pain associated with autogenous ICBG has been a cause for concern for surgeons. This study was designed to assess the functional outcome of patients who have undergone bone graft procedures utilizing an anterior approach as outlined by the senior investigator (KAE). Our study showed that 10% of patients reported a mean visual analog pain of 1.7 out of 10. The ability to walk without pain as a result of donor-site pain was a concern among patients in our study; yet 72% of the patients ambulated without difficulty at the time of follow-up, and more importantly 29 patients (91%) reported no donor site pain or lack of function.

In a 48-month follow-up study of 134 patients, ICBGs were reported to be associated with pain at the donor site in 26.1% of patients, with a mean visual analog pain score of 3.8 out of 10.11 Our study demonstrated few patients (10%) reporting pain associated with the donor site. In addition, those who did report pain, stated less severity (1.7 vs 3.8 on VAS). The study by Silber and colleagues reported results at a maximum of 48 months of follow-up, whereas the present study obtained outcome results as far as 83 months postoperatively. However, assuming a consistent decrease in postoperative pain, this disparity in length of follow-up is not critically important. In addition, comparative long-term deficits reported included ambulation disability (12.7% vs 9%), difficulty in performing recreational activities (11.9% vs 8.6%), activities of daily living (8.2% vs 8%), and difficulty performing household chores (6.7% vs 2.3%). These differences were not found to be statistically significant.

Sasso and colleagues12 reported a prospective study of 202 patients that had undergone ICBGs. Thirty-three percent and 31% of patients reported pain after 1 and 2 years, respectively.12 There was, however, a consistent decrease in pain (scored 0 to 20) from a mean of 12.8 at discharge to 7.3 at 6 weeks and to 1.8 at 24 months. Our results are similar to those of Sasso and colleagues12 demonstrating minor donor-site morbidity; however, this paper utilized both anterior and posterior approaches to harvest the graft.

The limitations of this study include its retrospective nature and inherent bias. Also the ability to differentiate the ambulatory difficulties as a result of donor-site pain versus lower limb injury was critical in order to properly identify direct graft-site morbidities. Patients treated for lower limb injuries were asked to identify the cause of ambulation difficulty as either the graft site or their initial injury. This led to three patients citing donor-site morbidity as the cause of their diminished ambulation. Although 73% of the study sample were able to reply and fill out the questionnaires, we did not obtain a baseline SMFA and SF-36 at the time of surgery. This diminishes our ability to compare the cohort to their percent return to baseline health and functional status. However, we did use a control healthy population to assess what percentage of patients and to what degree they returned to this baseline healthy status. However, our study did not analyze these results compared to those using a different approach for graft harvest. In addition, patient self assessment was the basis of the outcome evaluation in this study. While patients were able to describe their current functional status, physical examination findings were not able to be recorded.

Conclusion

Using the anterior approach for bone graft harvest from the iliac crest is a safe procedure with optimal patient satisfaction and a decreased incidence of donor-site pain compared to the existing literature. Although bone graft complications occurred less frequently than in other reports, the potential morbidity of iliac crest bone harvesting still persists. As results with bone graft substitutes approach the success rates achieved with autogenous grafts, appreciation of the risks and costs associated with iliac crest bone grafts will become increasingly important. In the interim, autogenous iliac crest bone grafts are well recognized as the gold standard in promoting restoration of lost bone volume.

Acknowledgment

The authors would like to thank Stephen Sims, M.D.

Disclosure Statement

The authors did not receive grants or outside funding in support of their research or preparation of this manuscript. They did not receive payments or other benefits or a commitment or agreement to provide such benefits from a commercial entity. No commercial entity paid or directed, or agreed to pay or direct, any benefits to any research fund, foundation, educational institution, or other charitable or nonprofit organization with which the authors are affiliated or associated. Kenneth A. Egol, M.D., is an unpaid consultant to Exactech,
Inc., has received institutional support from Biomet, Smith & Nephew, Stryker, and Synthes, and participates in stock ownership of Johnson & Johnson.

References