COMPLICATIONS ASSOCIATED WITH THE ILIAC CREST

ABSTRACT

The iliac crest is the most commonly used source of living bone for autogenous bone grafting. Iliac crest harvest yields cancellous bone that can serve as an osteoinductive and osteoconductive scaffold for healing bone defects. Furthermore, surviving cells in the graft may help to initiate bone growth until the host's own osteogenic cells can populate the graft. Graft material can be obtained from the iliac crest by both anterior and posterior approaches. Unfortunately, considerable morbidity is associated with iliac crest harvest. Complication rates up to 49% have been reported. Damage to blood vessels in the area can result in significant bleeding and hematomas. Damage to the nerves can lead to painful neuromas, numbness, and neuralgia. Damage to the bone can lead to joint disruption, fractures, subluxation, and even herniation of abdominal contents. Minimizing the amount of bone harvested can help reduce complications. In the future, improved synthetic materials will be available to replace the cancellous scaffold needed for bone grafting.

INTRODUCTION

Bone grafting is a common orthopedic procedure used to heal persistent bone defects. Such defects include difficult-to-heal lesions left by tumor growth, bone cysts, infection, trauma, or congenital malformation.[1,2] Grafting is also used in bridging joints for arthrodesis and for promoting union in pseudarthrosis or at the site of delayed union, nonunion, fracture, or osteotomy.[1-3]

Cortical bone is used mostly for fixation, while cancellous bone grafts are needed for osteogenesis.[3] Autogenous bone from the iliac crest is considered the gold standard graft material.[4] The iliac crest can yield moderate to large volumes of cortical and cancellous bone suitable for implantation,[4,5] and it contains living autogenous cells that provide osteogenic potential. Though the harvesting and grafting processes undoubtedly result in ischemia and considerable cell death, the cancellous bone in the graft serves as an osteoconductive scaffold, promoting ingrowth and adherence of the host's own osteogenic cells.[3,6] The ideal graft material has osteogenic, osteoinductive, and osteoconductive properties, since all 3 of these processes contribute to successful bone repair.[2,7]

Grafts can be harvested from the iliac crest by a variety of surgical techniques. The shape and makeup of the graft are determined by the required application. For example, grafts requiring cortical integrity and load-bearing ability, such as those being placed in an intervertebral location, can be shaped as either bicortical blocks or dowels, or as tricortical blocks (structured autografts).[8] In other cases, grafts can be fashioned as corticocancellous strips, morselized fragments, or even particulate cortico-cancellous or cancellous-only bone. Morselized grafts are used in environments that do not demand cortical integrity, such as the posterior and posterolateral (intertransverse process) spine.

Unfortunately, regardless of the shape or substance of the graft and the procurement method for harvest, the iliac crest graft harvesting procedure is associated with significant morbidity.[8] Major complications, which have

Anterior Approach	Posterior Approach
Damage to the acetabular fossa[7]	Injury to the superior gluteal artery[2,13]
Damage to the femoral head[7]	Damage to the cluneal nerves, which can lead to painful neuromas and numbness in the buttock[2,13]
Damage to the lateral femoral cutaneous nerve, often leading to meralgia paresthetica[2,13]	Sacroiliac joint disruption[2]
Iliac wing fractures[2,14]	Ureteral injury[15]
Retroperitoneal hematoma[13,16]	Bowel herniation[17]
Damage to the ilioinguinal nerve, which can lead to neuralgia[13]	Pelvic fracture[10]
Cosmetic deformity due to alterations in the superior contour[13]	Difficulty climbing stairs or rising from a chair[13]
Perforation of the peritoneum[13]	Subluxation and dislocation[13]
Herniation of abdominal contents[2,13]	

Table 1. Documented Complications of Autogenous Bone Donation Specific to the Approach

been reported at rates from 0.7% to 25%,[8] include infection, prolonged wound drainage, large hematomas, reoperation, pain lasting longer than 6 months, sensory loss, and unsightly scars. Subluxation, gait disturbances, sacroiliac joint destabilization, herniation of muscle and abdominal contents, pelvic or iliac fracture, and heterotopic bone formation have also been reported.[1,9,10] Minor complications, which are common with iliac crest graft harvest, include superficial infection, minor wound problems, temporary sensory loss, and mild or transient pain. An early retrospective study of donor-site morbidity reviewed 243 bone grafts, 90% of which were from the iliac crest.[11] Complications were found to occur at an overall rate of 29.2%. Later studies have reported donor-site complication rates ranging from 4% to 49%.[9]

COMPLICATIONS OF ILIAC CREST HARVEST

The anterior and the posterior aspects of the iliac crest are both commonly used donor sites for the harvest of autogenous bone grafts.[2,8] The choice of approach allows the surgeon to accomplish a harvest regardless of how the patient is positioned for the major surgical procedure; for example, the surgeon is likely to take an anterior iliac crest graft for an anterior procedure of the spine.[2,9] As with any surgery, adjacent nerves and muscles can be damaged. The structures at risk vary with the approach (Table 1). Though the anterior approach can yield up to 50 cc of uncompressed cancellous bone, the large osteotomies and extensive muscle stripping can lead to internal bleeds and persistent gait disturbances.[5] Nerves at risk include the lateral femoral cutaneous, iliohypogastric, and ilioinguinal.[12] Posterior iliac crest grafting can result in injury to the superior gluteal artery or the sciatic nerve if dissection is extended too close to the sciatic notch.[12] The surgeon must therefore be acutely aware of the nerves and blood vessels that may traverse the area in order to avoid damaging them during the harvesting procedure.

Serious damage to nearby structures rarely occurs during iliac crest harvest, but when such damage does occur it is often a consequence of the proximity of the iliac crest bone graft site to critical vascular and neurologic structures (Figure 1). The likelihood of such damage is related to the amount of soft tissue dissected during the harvest.[18] Factors that predispose the pelvic bone itself to damage include location of the donor site (iliac bone posterior to the posterior coronal plane of the sacroiliac joint being safer), extent of the donor site (full-thickness being riskier), and low bone density in the patient.[10,18] Estimates of the frequencies of complications vary considerably, partly because the distinction between major and minor complications is somewhat arbitrary.[19] Furthermore, patient populations and diagnoses differ from one study to another, as do surgical procedures, techniques, and study design.[4] Table 2 summarizes the reported rates of complications associated with iliac crest bone graft donations reported from selected studies from 1995 to 1999. In these studies, the rates of complications ranged from 8% to 49%.

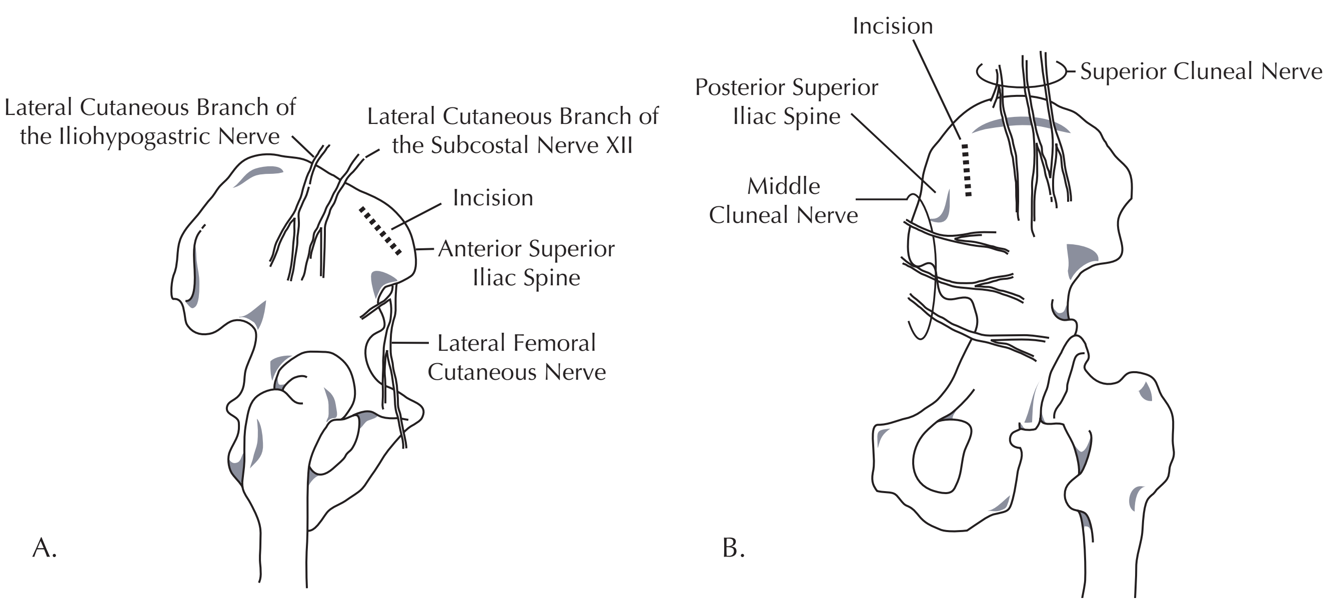

Figure 1. Critical structures that can be damaged during iliac bone graft harvest.
A. Lateral femoral cutaneous nerve traverses the pelvis anteriorly. Note suggested position of the anterior incision (indicated by dotted line) relative to this and the lateral cutaneous branches of the subcostal nerve XII and the ilio-hypogastric nerve.
B. Superior cluneal nerve traverses the iliac wing posteriorly, passing 7 to 12 cm from the posterior superior iliac spine. Note proximity of the suggested position of the posterior incision (indicated by dotted line) relative to this and the middle cluneal nerve.

Study	N*	Complication Rate	Complications
Banwart 1995[18]	261	39% minor 10% major 49% overall	*Minor:* transient scar or buttocks dysesthesia, prolonged aseptic wound drainage, superficial infection, broken drain *Major:* suture rejection with prolonged drainage, sterile seroma, scar requiring revision
Arrington 1996[2]	414	10% minor 5.8% major 15.7% overall	*Minor:* superficial infections, superficial seromas, minor hematoma *Major:* herniation of abdominal contents through massive bone graft donor sites, vascular injuries, deep infections at the donor site, neurologic injuries, deep hematoma formation requiring surgical intervention, and iliac wing fracture
Goulet 1997[19]	170	21.8% minor 2.4% major 24.1% overall	*Minor:* pain, wound problems such as stitch abscesses, minor drainage, keloid formation, and numbness *Major:* abscess formation, infection
Schnee 1997[20]	144	5.6% minor 2.8% major 8.3% overall	*Minor:* wound infection *Major:* hematoma, anterior superior iliac spine avulsion fracture and lateral femoral cutaneous nerve injury, closed wound infection
Sawin 1998[21]	300	21.3% minor 4.0% major 25.3% overall	*Minor:* chronic donor-site pain, wound complications, meralgia paresthetica *Major:* pneumonia, hematoma requiring evacuation, iliac spine fracture

**N indicates number of patients participating in study.*

Table 2. Reported Complications Associated With Iliac Crest Bone Graft Harvest (Selected Large-Scale Studies, 1995-99)

Large-Scale Reviews of Complications of the Harvest Procedure

The bone grafting procedure is increasingly common in orthopedic reconstructive surgery. More than a quarter of a million such grafts are now performed each year.[8] As a result, awareness of potential complications has risen, and several investigators have published a large-scale series of chart reviews documenting complication rates. Major studies published between 1995 and 1999 are reviewed here. Table 2 lists the types of complications associated with the iliac crest bone graft harvesting, as reported in these studies.

Banwart 1995: In order to examine the incidence and severity of complications associated with iliac crest bone graft harvesting, a chart review and independent survey were conducted on a consecutive series of 261 patients whose bone graft harvests were done by the same surgeon from 1983 through 1988. Complications were categorized as major or minor, with each of these categories subdivided into acute and chronic. Of the 180 patients who qualified for statistical analysis, major complications (those that lengthened hospital stay, required additional surgery, or caused significant disability), occurred in 18 patients (10%), 3 of whom had affected function, and included suture rejection with prolonged drainage, sterile seroma, and scar revision. Minor complications (those that responded to minimal treatment, healed without treatment, or that did not cause permanent disability) occurred in 70 patients (39%), and included transient scar or buttocks dysesthesia, prolonged aseptic wound drainage, superficial infection, and broken drain. Of the 70 minor complications, 20 were acute and 50 were chronic. Of the major complications, 3 were acute and 15 were chronic.[18]

Arrington 1996: Complications of iliac crest bone graft harvesting were categorized in a retrospective review of 414 consecutive cases from 1983 to 1993. Complications were classified as minor or major. Minor complications (those that required no further surgery) included superficial infections, superficial seromas, and minor hematoma. There were 41 minor complications, a rate of 10%. Major complications included herniation of abdominal contents through massive bone graft donor sites, vascular injuries, deep infections at the donor site, neurologic injuries, deep hematoma formation requiring surgical intervention, and iliac wing fractures. There were 24 major complications in this series, a rate of 5.8%.[2]

Goulet 1997: Functional outcomes and complications experienced by adult patients who underwent iliac crest bone grafting were evaluated to assess the effect of bone grafts in a group of 170 patients. In this study, minor complications occurred in 37 patients (21.8%) and included pain, wound problems (eg, stitch abscesses, minor drainage), keloid formation, and numbness. Major complications occurred in 4 patients (2.4%) and included 1 case of abscess formation and 3 cases of infection, all requiring rehospitalization.[19]

Schnee 1997: An analysis of harvest morbidity was performed as part of a study of 142 patients (144 operations) in whom autograft from iliac crest bone was harvested for anterior cervical fusion. In this study, complications were categorized as significant (major) or minor. Significant complications occurred in 4 cases (2.8%) and consisted of 2 cases of hematoma, 1 case of postoperative anterior superior iliac spine avulsion fracture and lateral femoral cutaneous nerve injury, and 1 case of closed wound infection. All 4 cases required reoperation. In 8 additional cases, minor wound infection or focal dehiscence occurred, giving an overall minor complication occurrence rate of 5.6%.[20] In this study the authors did not include pain in their categorization of harvesting complications.

Sawin 1998: As part of a retrospective review of 600 patients who underwent posterior cervical fusion graft, complications associated with rib and iliac crest donor sites were compared. Three hundred patients underwent the rib harvest procedure and 300 underwent iliac crest harvesting. The authors did not classify complications as major or minor, but for purposes of comparison, this paper considered major complications as those that required hospitalization or reoperation. For iliac crest donation, site morbidity consisted of chronic donor-site pain (52 cases), wound dehiscence (8 cases), pneumonia (7 cases), meralgia paresthetica (4 cases), hematoma requiring evacuation (3 cases), and iliac spine fracture (2 cases), for an overall complication rate of 25.3%.[21]

Case Reports of Disastrous Outcomes

A number of individual case history reports of severe complications after iliac crest harvesting have appeared in the literature. For example, 1 patient with thyroid-induced osteoporosis secondary to systemic lupus erythematosus suffered complete pelvic ring failure after posterior iliac crest bone graft harvesting.[10] A case of enterocutaneous fistula has been reported, with fecal material being expelled through the donor site on the 12th postoperative day. The patient had undergone a posterior iliac crest bone graft harvesting procedure.[9]

DISCUSSION

The frequency of complications with iliac crest harvesting can be reduced by harvesting no more bone than is necessary to complete the repair,[4] adhering to optimal surgical procedures, and being careful to respect the regional anatomy.[2,20] Using surgical incisions superior or inferior to the iliac crest has long been known to reduce the chances of nerve damage, painful scarring, hematoma, infection, and deformity.[18,22-24] The incidence of severe complications, such as fracture, instability, lateral femoral cutaneous nerve injury, and ilium herniations, can also be decreased with the use of small ilium wing bicortical plugs and limited inner table harvesting.[18] Minimizing dissection around the donor site can also reduce complications. For example, Younger and Chapman observed that if the surgical incision used to harvest the bone graft was the same incision used for surgery, the rate of complications was 17.9% higher.[11] The same observation was made in patients who underwent posterior spine fusions in which the same longitudinal incision used to expose the spine was used to harvest posterior iliac crest autograft.[19]

A study reviewing iliac crest donor-site morbidity associated with reconstructive foot and ankle surgery found that lower rates of major and minor complications have been associated with the use of hinged-crest techniques for harvesting smaller volumes of graft, or techniques that involve dissection of limited amounts of soft tissue.[4] This procedure typically requires only minimal soft-tissue dissection and removal of small to moderate volumes of bone. In this small series, only 1 complication, a hematoma/infection, occurred from 42 donor sites, giving an overall complication rate of 2.4%.[4] This suggests that the amount of soft tissue dissected and the volume of harvested graft are also variables associated with complications of the harvest procedure.[4] Careful dissection, hemostasis, and layered closure can reduce the incidence of hematoma formation and the risk for infection.[22,23]

Bone graft materials that do not involve the harvest of autogenous bone should be considered, particularly in osteopenic patients.[10] Donor-site complications could be avoided if appropriate alternate materials were available for grafting. Ideally, such materials should have appropriate structural properties and possess osteogenic, osteoinductive, and osteoconductive potential. Accomplishing this may require combining synthetic bone void fillers with living bone precursor cells, such as can be obtained from bone marrow aspirates.

Vitoss™ synthetic cancellous bone void filler, an ultraporous (90% interconnecting, multidirectional pores) bone void filler made from pure β-tricalcium phosphate, is a new bone graft material based on proprietary nano-particle construction. The structure of Vitoss resembles that of harvested cancellous bone in its porosity, allowing Vitoss to readily absorb and retain osteogenic cells and nutrients. Vitoss readily wicks blood and bone marrow aspirate. The open-pore architecture of Vitoss would support the growth of osteogenic intrinsic cells and in-migrating extrinsic cells through nutrient diffusion.

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