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Morbidity From Iliac Crest Bone Harvesting

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Purpose: The iliac crest is the most common donor site for autogenous bone grafting in maxillofacial surgery. The aim of this study was to evaluate retrospectively the morbidity of bone harvesting from the inner table of the anterior iliac crest.

Patients and Methods: Sixty-five patients were recalled 1 to 4 years after iliac crest bone harvesting. The morbidity as well as the patient's satisfaction were evaluated by a survey of the medical record, a mail-in questionnaire, and a standardized physical examination.

Results: There was good acceptance of this bone harvesting procedure, and the morbidity was low.

Conclusion: Bone harvesting from the inner table of the anterior iliac crest is a good option for reconstructing bone defects.

Bone grafts are frequently used for reconstruction in maxillofacial surgery, for example, after cancer surgery, trauma, severe bone resorption, and for correction of congenital deformities. Autogenous bone is currently the best material for free bone grafting.[1] Because transplanted osteocompetent cells are responsible for much of the new bone formation at the recipient site, allogeneic or xenogeneic bone, and bone substitutes, are of inferior quality because they lack such cells.[1]

Potential donor sites include the anterior and posterior iliac crest, rib, calvarium, mandible (chin), tibia, and other sites that are used less frequently. The anterior iliac crest is the most common donor site, providing autogenous bone with the highest concentration of osteocompetent cells.[2] Some authors claim that the anterior iliac crest offers insufficient amounts of bone for maxillofacial surgery, and for this reason advocate the posterior ilium as donor site.[3,4]

A variety of complications associated with iliac crest bone harvesting have been reported, including chronic pain,[5] sensory loss,[5-9] hematoma,[9] seroma,[6] wound breakdown, contour defect,[5] hernia through the donor site,[10-12] gait disturbance, instability of the sacroiliac joints,[13] pathologic fracture,[14,15] adynamic ileus,[16] and ureteral injury.[17] However, the subjective experiences of the patients have rarely been described. The aim of this study was to evaluate retrospectively the morbidity after bone harvesting from the inner table of the anterior iliac crest, including the satisfaction of the patients.

Patients and Methods

Clinical Series

Sixty-five consecutive patients who had undergone iliac crest bone harvesting for a maxillofacial reconstruction in the period January 1991 through May 1994 at the Departement of Oral and Maxillofacial Surgery of the University Hospital Groningen participated in this study. Forty-three patients had undergone a preprosthetic augmentation of the maxilla or the mandible (group A), and 22 cleft lip and palate patients had undergone an alveolar bone graft (group B). Group A comprised 15 men and 28 women (mean age of 48 years; range, 21 to 65). Group B comprised 18 men or boys and four women or girls (mean age of 14 years; range, 9 to 26). In three patients, grafts from both the right and the left iliac crest were used in separate

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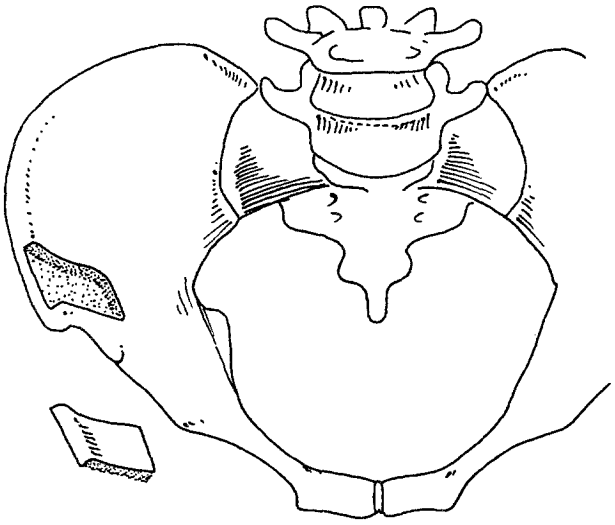

FIGURE 1. Superior view of the pelvis showing the donor site on the inner table.

sessions. The right iliac crest was used 62 times and the left six times.

Surgical Technique

The selected iliac crest was prepared and draped in the usual fashion, leaving the anterior part of the crest and the anterior superior ilac spine (ASIS) accessible. For esthetic reasons and to avoid possible irritation of the scar from tight-fitting clothes, the skin was stretched in a craniomedial direction over the iliac crest before the incision was made. In this fashion the resulting scar was located caudolateral to the iliac crest. The incision was started 1 cm behind the ASIS and continued posteriorly, following the iliac crest. It was carried down sharply to the midcrest, dividing the musculotendinous aponeurosis of the tensor muscle of the fascia lata and the oblique abdominal muscles, without transecting muscle fibers.

The bony ilium was exposed by two different techniques, depending on the patient's age. In adults the medial cortical plate was exposed directly by reflecting the iliac muscle subperiosteally (group A). In children, the cartilaginous cap, present on top of the ilium, was incised longitudinally and reflected medially, followed by reflection of the iliac muscle (group B). This procedure was done to keep the epiphysis of the immature iliac crest unviolated. After reflection of the iliac muscle, the donor site was exposed with a retractor.

A corticocancellous bone block was harvested by making two horizontal and two vertical cuts using osteotomes (Fig 1). The superior horizontal cut was made

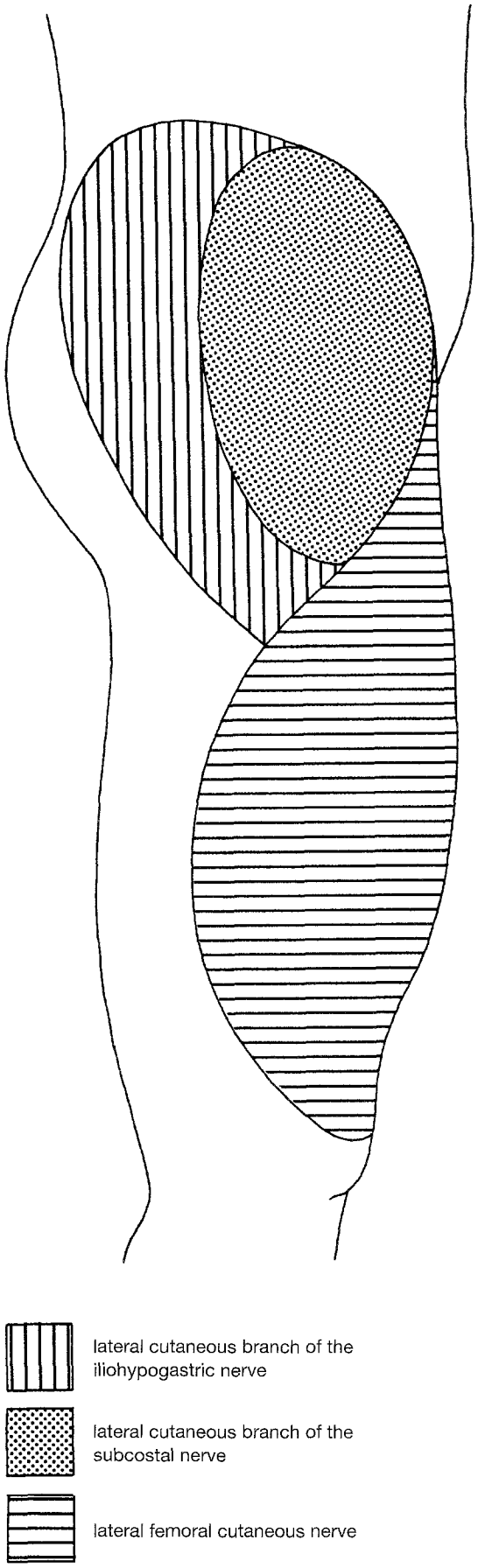

FIGURE 2. Dermatomes supplied by the nerves that can be damaged by bone harvesting from the anterior crest.

midcrestal. The inferior horizontal cut was made with a curved osteotome. After removal of the corticocancellous bone block from the inner table, additional cancellous bone was harvested with gouges and curettes. Care was taken not to perforate the lateral cortex.

The harvested bone was preserved in a cold saline solution (4°C). The amount of harvested bone in children was approximately 8.5 cm^3; in adults approximately 13.5 cm^3. The cartilaginous cap was reapproximated with resorbable sutures. After smoothing the bone and placement of Gelfoam (Upjohn, Kalamazoo, MI) in the bony cavity, the wound was closed in layers. A suction drain was used as a routine in children, and on indication in adults (n = 10).

After an immobilization period of 24 hours, the patients were guided in their rehabilitation by a physiotherapist, and were advised to walk with two crutches during the first 2 weeks and with one crutch during the next 2 weeks. All patients received routine antibiotics and steroids. Eight patients in group A received thrombosis prophylaxis. The hospitalization time averaged 5 days for both groups, with a range of 3 to 9 days. This time, without exception, was determined by the care needs of the recipient sites.

Evaluation of Donor Sites

Donor sites were evaluated using the follwing three methods: a survey of the medical record, a mail-in questionnaire, and a standardized physical examination. All records were examined for the type of surgical approach, perioperative and postoperative complications, pain at the donor site, administered drugs, patients' height and weight, and duration of hospital stay. The questionnaire contained multiple choice questions about duration and severity of postoperative pain at the donor site, meteorotropism, sensory loss, use of crutches, duration of subjective rehabilitation, the patient's perception of the surgical scar, comparison between postoperative symptoms at the donor and recipient site, and the patient's acceptance of the procedure. Pain severity was graded on a visual analog scale (0 representing no pain, 10 representing severe pain).

The physical examination on recall was restricted to the donor site area. The following parameters were assessed: contour defect, appearance and size of the mature scar, abdominal hernia, sensibility in the femoral, gluteal, inguinal, and pericicatrical region, and pathology of the sacroiliac joints. The tactile sensibility was tested by lightly brushing the skin with a wisp of cotton (the subject should be able to count the number of contacts with the eyes closed). Superficial pain was tested with a needle (the subject should be able to tell whether contact with the skin was made with a sharp or a dull instrument with the eyes closed). The sacroiliac joints were screened for pathology by means of a compression test, a distraction test, and the Menell test.[13,18,19]

Data were submitted for statistical analysis using the Statistical Package for the Social Sciences (SPSS). The following statistical procedures were used: chi-square, Student's *t*-test, Mann-Whitney *U*-test, and single regression analysis. Statistical testing was considered significant only when $P \leq .05$.

Results

Sixty-eight iliac donor sites were evaluated in 65 patients. All patients were examined by an independent investigator. The time from harvesting to evaluation ranged from 1 to 4 years.

In group A, 35 of 43 patients (81%) and in group B 19 of 22 patients (86%) did not have any postoperative complaints at the donor site.

Subjective Morbidity

According to 13% of the patients, the postoperative course was in accordance with their expectations (A: 18%, B: 4%), 71% stated that the postoperative course was better than expected (A: 64%, B: 83%), and 16% said that it was worse than expected (A: 18%, B: 13%). Of all patients, 53% had more symptoms in the mouth than in the iliac region (A: 47%, B: 65%), 21% had equal symptoms in both regions (A: 25%, B: 13%), whereas 26% had more symptoms in the iliac region (A: 28%, B: 22%). Eighty-two percent were satisfied with the scar (A: 86%, B: 77%), 15% found it acceptable (A: 12%, B: 18%), and 3% were dissatisfied (A: 2%, B: 5%). There was no correlation between the scar width and the patient's perception of the scar.

Postoperative pain at the donor site was experienced by 32 patients (A: 19, B: 13). In 15 patients the pain lasted less than a month (A: 6, B: 9), and in nine patients the pain lasted for 1 to 3 months (A: 6, B: 3). The postoperative pain severity averaged 2.2 in both groups.

The period of subjective rehabilitation was shorter than a month in 52% of the patients (A: 49%, B: 61%), 1 to 3 months in 31% (A: 34%, B: 26%), 3 to 6 months in 9% (A: 9%, B: 9%), and 6 to 12 months in 1% (A: 0%, B: 4%). Seven percent stated that this period of rehabilitation was longer than a year (A: 8%, B: 0%).

To estimate the subjective acceptability of the bone harvesting, the patients were requested to judge the procedure using a number between 0 and 10, with 0 indicating "very bad experience" and 10 "no problems at all." The judgment averaged 8.4 in both groups. The following parameters had a significantly negative influence on the patient's judgment of the bone harvesting procedure when subjected to the

Mann-Whitney *U*-test and single regression analysis: the occurrence of postoperative complications, the pain level, chronic pain, and the subjective time of rehabilitation.

Early Morbidity

Two major complications occurred in group A. In one patient a right iliac crest fracture near the donor site occurred on the third postoperative day, which was caused by an accidental fall. The fracture was treated conservatively. After 3 weeks, she was free of symptoms. In another patient a deep vein thrombosis was diagnosed 2 weeks postoperatively. This patient had not received preoperative anticoagulants. After treatment of this complication, the further postoperative course was uneventful.

Five patients in group A had a wound hematoma at the donor site (7%), which was treated conservatively (n = 2) or evacuated surgically (n = 3). No significant relation could be found between the use of a drain and the occurrence of hematomas (Student's *t*-test). One patient developed a wound seroma that lasted for 2 months. This was treated by fluid aspiration. In three patients in group B, a wound breakdown occurred, caused by a suture that was left behind.

In group A, two patients did not use crutches, two patients used crutches for less than a week, and 11 patients needed crutches for an extended period. According to the patients, this was mainly related to wound pain, and not to muscle weakness. The patients in group B showed very few problems with walking postoperatively, illustrated by the fact that 18 patients did not use crutches at all, and the other four used crutches for less than a week. In group A, the average time of using crutches was significantly longer than in group B (Mann-Whitney *U*-test).

Late Morbidity

Chronic pain, defined as pain that existed longer than 6 months, occurred in seven patients in group A and in one in group B. Chronic pain was related significantly to the female gender. Meteorotropism (weather-dependent discomfort) at the donor site was experienced by nine patients in group A (21%), and by one in group B (5%). Permanent sensory loss, consisting of hypesthesia and hypalgesia, was observed in six patients. In two cases the sensory loss was located at the anterior part of the lateral buttock between the iliac crest and the greater trochanter, the skin area supplied by the lateral cutaneous branch of the subcostal nerve. In two cases, the sensory loss was located on the lateral thigh, the skin area supplied by the lateral femoral cutaneous nerve (Figs 2, 3). In two cases, hypalgesia was found in the pericicatrical region, most likely caused by transsection of local nerve endings. Sensory loss in the area supplied by the lateral branch of the iliohypogastric nerve was not found.[20] Half of the patients with sensory loss were unaware of it; none of them experienced any inconvenience from it.

The scar width ranged from 1 to 10 mm, with an average of 4.2 mm in both groups. A small contour defect at the donor site was found in one patient in group A and in five patients in group B. Relatively large contour defects were found in three patients, two in group A and one in group B. The patients in group B developed a significant contour defect more often, when both small and large defects were taken into account.

None of the patients developed a pathologic condition of the sacroiliac joints after surgery. One patient tested positive with the Menell-II test on the left side and the Menell-III test on both sides, indicating a pathologic condition of the left sacroiliac joint, and bilateral pathologic conditions of the lumbar vertebrae. However, her complaints of lower back pain were preexistent to the surgery for more than 15 years. Because the symptoms had not changed or worsened after the iliac surgery, the pathologic condition of her left sacroiliac joint most probably was also preexistent and not related to the bone harvesting from her right iliac crest.

A higher Quetelet index (weight-height ratio) related significantly to postoperative complications when all patients were taken into account (Student's *t*-test). Only tendencies could be found by evaluating the two groups separately. A higher Quetelet index also related significantly to an increased time of using crutches, when taking all patients into account as well as when taking only the patients in group A into account (Mann-Whitney *U*-test). There was a tendency for less postoperative complications in group B, as well as less chronic pain (one in group B vs seven in group A); these findings, however, reached no significance. Also, no significant relations could be found between patient's age and the observed morbidity.

Discussion

Most of the patients had no complaints about their surgical scar (98%), and found that the postoperative course was better than they had expected (71%). The average judgment of the procedure was very high. A low morbidity was observed from bone harvesting from the inner table of the anterior iliac crest, comparable with the results of previous studies of this donor site. From this study it appears that split-thickness bone harvesting from the inner table of the anterior iliac crest is a well-accepted procedure with relatively low morbidity.

Other procedures for bone harvesting from the iliac crest have been advocated. In our opinion, each of

these offers significant disadvantages. The posterior approach has the risk of instability of the sacroiliac joints, and the necessity of turning the patient during surgery, which is a well-known risk factor for line or tube displacement.[12,13] The lateral approach has the disadvantage of an increased risk for postoperative gait disturbance.[1,3,5,6,15,21-24] Full-thickness grafting results in a large contour defect and risks the serious complication of abdominal hernia through the donor site.[10,11,24,25]

In the current study, harvesting from the inner table of the anterior iliac crest provided sufficient quantities of bone for the planned reconstruction in all patients. Other advantages of this donor site are the easy accessibility, the high ratio of cancellous to cortical bone, and the high concentration of osteoblasts, which induces additional bone growth at the recipient site.[1,2] This bone harvest, however, has the disadvantage of the need for a separate donor site with its inherent morbidity.

Pathologic conditions of the sacroiliac joints, hernia through the donor site, adynamic ileus, and urethral injury were not observed. Gait disturbance as a possible late complication was not assessed in the physical examination, because it is difficult to differentiate between acquired- and preexistent pathologic conditions for such a common symptom in a retrospective study. Moreover, gait disturbance after bone harvesting from the inner table is only a minimal and temporary inconvenience.[1,3,5,6,15,21-24]

Pelvic surgery, as well as postoperative immobilization, are accompanied by an increased risk for postoperative deep vein thrombosis.[26] It has become known that administering preoperatively and postoperatively anticoagulants reduces the risk for deep vein thrombosis from over 40% to below 10%.[26] Despite the fact that anticoagulants were not given on a routine basis to all patients, we found a deep vein thrombosis in only one of the patients at risk (2.3%). An accurate estimate of the true incidence, however, is impaired by the frequent absence of clinical features in proven cases of deep vein thrombosis.[26] We therefore advise routine prophylaxis.

It is a striking finding from this study that the sensory loss encountered in a few patients caused no inconvenience. Presumably this would not have been the case if the sensory loss had not consisted solely of hypesthesia and hypalgesia, but also of causalgia (better known as meralgia paresthetica if it concerns the lateral thigh), which is a very painful complication.[7-9,13,27]

Besides the often-described sensory loss in the distribution of the lateral femoral cutaneous nerve, we also found sensory loss in the area corresponding with the lateral cutaneous branch of the subcostal nerve in two cases. Sensory loss in the distribution area of the lateral cutaneous branch of the subcostal nerve has often been falsely attributed to damage of the lateral femoral cutaneous nerve. Damage to the lateral cutaneous branch of the subcostal nerve described only a few times in the literature, has never been properly explained.[1,3,21,22,28] Sharp injury of the lateral cutaneous branch of the subcostal nerve during bone harvesting from the anterior iliac crest is more likely to occur than sharp injury of the lateral femoral cutaneous nerve, because of its anatomic course. The lateral cutaneous branch of the subcostal nerve crosses the iliac crest about 5 cm behind the ASIS, whereas the lateral femoral cutaneous nerve courses across the anterior first centimeter of the crest in only 2.7%; in all other cases it courses anterior to the ASIS through or below the inguinal ligament (Fig 3).[3,8,29] Any damage to the lateral femoral cutaneous nerve is therefore probably more often caused by any indirect trauma, such as from retractors, large medial hematomas, or scar tissue near the nerve.[2] Theoretically, the lateral cutaneous branch of the iliohypogastric nerve could also be injured if the incision is extended far posterior, as can be necessary for taking large grafts (Fig 3).

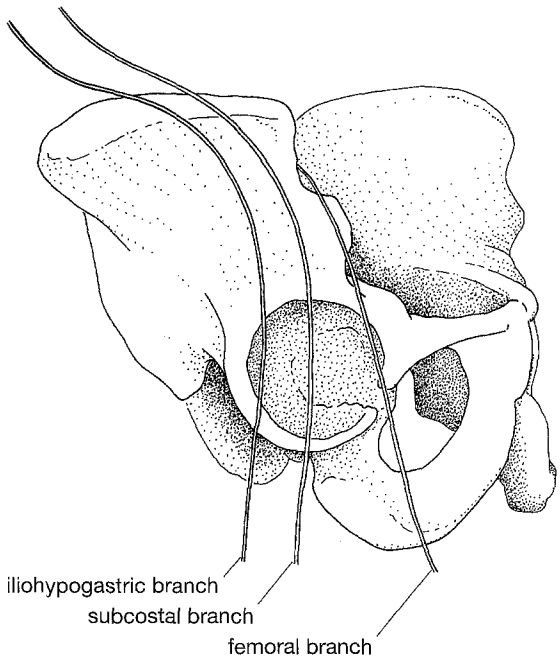

FIGURE 3. Anterolateral view of the pelvis in relation to the nerves that pass the crest near the donor site.

Damage to the lateral femoral cutaneous nerve might be avoided in some cases by gentle tissue handling while exposing the medial plate with the retractor, and by starting the incision 1 cm behind the ASIS in anticipation of its abberrant course. To avoid damaging the lateral cutaneous branches of the subcostal and iliohypogastric nerve, the incision should not be extended too far posteriorly.

Chronic pain at the donor site is probably unavoid-

able in a small number of patients. Chronic pain often has a psychosomatic component and therefore may not be entirely under control of the surgeon.

Contour defects occur only in a small number of patients after split-thickness bone harvesting. A secondary fracture of the iliac crest, as occurred in one patient, has been described only a few times.[14,15]

Despite the patients' general acceptance of their surgical scar, we found the scars relatively wide. Widening of the scar could perhaps be caused by traction on the healing wound at this location. Also contributing could be the fact that the incision line follows the contour of the iliac crest, instead of the skin lines of Langer.

The most important conclusion that can be drawn from the statistical analysis is that a higher Quetelet index correlates with a less favorable postoperative course. This might be explained by a poorer condition for healing of the surgical wound in obese patients, and by the fact that in these patients it is more difficult to minimize tissue trauma during surgery. Perhaps overweight (Q-index > 30) should be considered as a relative contraindication for iliac crest harvesting.

Given its relatively low morbidity rate and its subjective acceptability, bone harvesting from the inner table of the anterior iliac crest appears to be a very good option when reconstructing bone defects. However, further improvements of allogeneic bone or bone substitutes, in combination with bone morphogenetic proteins, might alter this situation in the future.

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