

# Breast Reconstruction With Gluteal Artery Perforator (GAP) Flaps

## *A Critical Analysis of 142 Cases*

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**Abstract:** Fujino was the first to introduce gluteal tissue as a free flap for breast reconstruction. The use of the musculocutaneous flap from the buttock in breast reconstruction has been championed by Shaw. Despite the initial enthusiasm for this area as a donor site, few other large series exist on the subject. Two decades of experience with this region as a donor site led to recognition of advantages and drawbacks. Furthermore, use of both the superior and inferior gluteal musculocutaneous flap was associated with certain important donor site complications and the use of vein grafts to allow for microvascular anastomosis. The evolution of free tissue transfer has progressed to the level of the perforator flap. This reconstructive technique allows elevation of tissue from any region consisting only of fat and skin. This minimizes donor site morbidity by allowing preservation of the underlying muscle and coverage of important structures in the region such as nerves. The superior and inferior gluteal perforator flaps have been used at our institution for breast reconstruction since 1993. The superior gluteal artery perforator (S-GAP) flap is our preferred method of breast reconstruction when the abdomen is not available or preferable. We report the result of this flap over the past 9 years and point out important surgical refinements, advantages, disadvantages, and lessons learned during this time.

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**R**ecreational of the breast with autogenous tissue has become increasingly popular during the past several decades. In this setting, the abdomen is usually chosen as a

donor site.<sup>8,11–13</sup> However, in approximately 20% of patients who undergo mastectomy, the abdomen might not be a suitable<sup>3,9,10</sup> donor site. The back,<sup>14,15</sup> buttocks,<sup>1–5</sup> and thighs<sup>16–19</sup> serve as alternative sites for breast reconstruction in those cases.

In 1993, our group described the superior gluteal artery perforator (S-GAP) flap for breast reconstruction.<sup>9</sup> This flap has been used at our institution as a first-line alternative in patients in whom the abdomen is judged inadequate as a donor site. We present our 9-year experience with 142 GAP flaps. There were 6 patients who underwent reconstruction with the inferior gluteal artery perforator (I-GAP) flap. This flap provided adequate tissue to perform the reconstruction, but necessitated exposure of the sciatic nerve and was found to have significant disadvantages compared with the S-GAP flap.

Patient satisfaction with the reconstructed breast and donor site has been excellent. We harvested only fat and skin from the gluteal region, applying perforator techniques previously described.<sup>7–10</sup> Dissection of the vascular structures out of the muscle proved to be advantageous by providing a much longer pedicle and a much easier dissection of the parent vessels when compared with gluteal musculocutaneous flaps.<sup>2,3,9,10</sup> The greatest advantage of the S-GAP flap is the ability to perform microvascular anastomosis without the need for vein grafts,<sup>2–5</sup> which are frequently required with musculocutaneous flaps from the same region.<sup>2–5</sup>

The technique is not easy to learn; however, it does provide a reliable flap and an excellent esthetic reconstruction. The nature of the fat in the gluteal region allows for creation of a breast with good projection and volume. Shaping the flap is easier because of the longer pedicle. Using the internal mammary vessels also allows greater flexibility when shaping and inseting the flap at its new site.<sup>9,20–22</sup> When the abdomen is not available, we feel strongly that the S-GAP flap should be used as an alternative site before considering other options for breast reconstruction.

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## PATIENTS AND METHODS

All patients who underwent breast reconstruction with the GAP flaps between February 1993 and April 2002 were included in this study. A total of 142 patient charts were reviewed. There were 6 patients who underwent reconstruction with the I-GAP flap. This flap provided adequate tissue to perform the reconstruction, but necessitated exposure of the sciatic nerve and was found to have significant disadvantages compared with the S-GAP flap. It was abandoned early in our series. The remaining patients were reconstructed with the S-GAP flap.

The goal was to analyze the series for operative time, length of stay, flap weight, flap size, blood loss, transfusion requirements, return to the operating suite, fat and/or flap necrosis, and overall flap survival. There was no patient mortality in this series.

All statistical analysis was performed using StatView for Windows, version 4.7 (Abacus Concepts, Inc., Berkeley, CA). An analysis of variance (ANOVA) followed by a Fisher's projected least significant difference (PSLD) posthoc test was used to determine significance. *P* value less than 0.05 was considered to be significant.

### Patient Selection

The reasons for selecting the gluteal flap versus the abdominal donor site are listed in Table 1. The most common reason was a patient with a thin, nulliparous abdomen (64%). These women tend to be tall and thin with an average body mass index (BMI) of 21 for this series (BMI normal range, 19–24.9).

The most common indication for surgery was postmastectomy reconstruction (Table 2). The mean age of patients undergoing S-GAP flap reconstruction in this series was 46 years (range, 32–60 years). Twenty-seven percent of the patients received radiation therapy before undergoing GAP flap reconstruction. Thirty percent of patients had failed or failing breast reconstructions with implants and were judged to have inadequate abdominal tissue for autologous breast reconstruction. Only 10% (14 of 142) of the patients gave a history of cigarette smoking at the time of surgery.

**TABLE 1.** The Gluteal Region as a Donor Site

Reason	Percentage
Thin abdomen	64
Abdominal incisions	14
Previous abdominoplasty	8
Patient preference	7
Nulliparous	6
Failed abdominal flap	1

**TABLE 2.** Indications for the Use of Gluteal Flaps

Indication	Percentage
Postmastectomy	62
Implant failure	25
Breast enlargement	7
Lumpectomy deformity	3
Poland's syndrome	2
Pectus excavatum	1

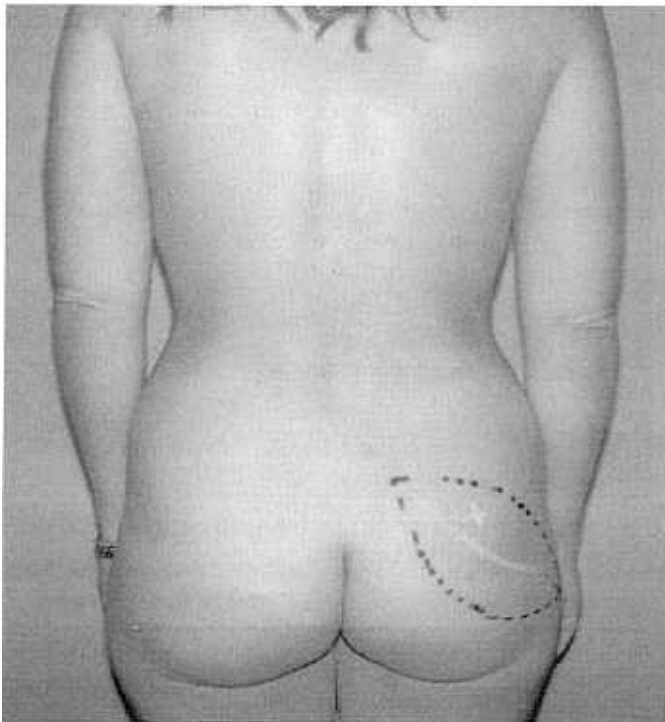
### Anatomy

Both the superior and inferior gluteal arteries are terminal branches of the internal iliac artery.<sup>23</sup> They pass out of the pelvis above and below the piriformis muscle, supplying the upper and lower halves of the muscle, respectively. As the superior gluteal artery passes the greater sciatic foramen, it divides into a superficial and a deep branch. The deep branch travels in between the gluteus medius muscle and the iliac bone. The superficial branch goes on to supply the gluteus muscle and the overlying skin territory. It is this superficial branch of the gluteal artery that nourishes the fat and skin in musculocutaneous flaps in this region. These perforating vessels can be separated from the underlying muscle and fascia and form the basis for the S-GAP flap, which allow maximal preservation of the donor site muscle and other underlying structures while creating a reliable skin-soft tissue flap. One usually finds 3 perforators arising from this vessel with a pedicle length between 3 to 8 cm.<sup>24</sup>

### Flap Design

Markings are placed on the patient in the operative position. The posterior superior iliac spine is palpated and marked, as is the greater trochanter. A line is drawn connecting these 2 points. The artery emerges from the edge of the sacrum approximately one third the distance from the posterior iliac spine along the previously marked line (Fig. 1). Perforators can be identified along this line on the buttock with a Doppler ultrasound probe.

The orientation of the flap can vary from angled down along the line or perpendicular to the line. Oblique incisions are associated with contour deformity. A flap designed like in Figure 2 produces a more favorable scar. Skin flap design can be customized to almost any orientation as long as the outline contains a perforator. It should be noted that perforators positioned laterally from the flap's long axis will produce longer pedicles (Fig. 3). The average width of the flap has been 10 cm, but up to 12 cm can be closed in this area without undue tension. The length of the flap is usually between 24 to 26 cm (Table 3).

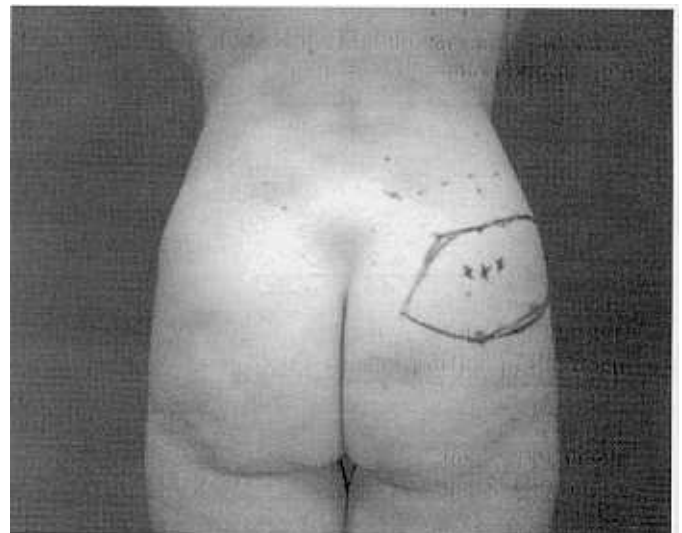


**FIGURE 1.** The emergence of the superior gluteal artery from the sacrum occurs at a point one third the way down a line drawn from the posterior superior iliac spine to the greater trochanter tuberosity. The oblique design, which has been abandoned as a result of postoperative contour deformity, is shown.

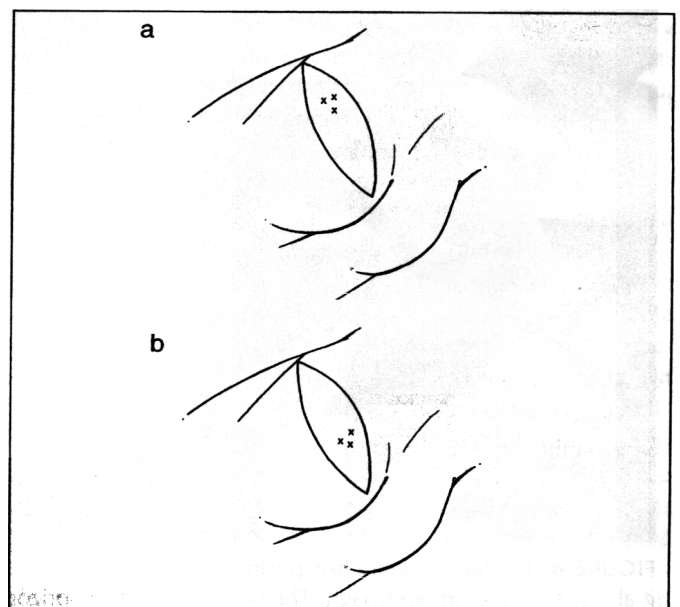
**Technique**

The S-GAP or I-GAP flap can be harvested with the patient either in the lateral decubitus or prone position. The lateral decubitus position is preferred because it allows a 2-team approach (Fig. 4). With immediate reconstruction, the mastectomy can be done followed by recipient vessel preparation while flap dissection is progressing. The S-GAP flap dissection is discussed subsequently.

Flap dissection is usually begun laterally where the flap is over the tensor fascia lata so dissection can proceed rapidly. The gluteal muscle fascia is identified and elevated. This makes visualization of the perforators much easier. Beveling away from the flap for 1 to 2 cm superiorly and inferiorly will provide more tissue for filling out the breast envelope later. When the fascicles of the gluteus muscle are encountered, dissection proceeds more carefully, incising the perimysium as it inserts into the fascia overlying the muscle. Perforators with a clearly definable artery measuring 1 mm and accompanied by 2 venae comitantes are followed through the fascia (Fig. 5). Occasionally, a second large perforator can be found as the dissection on the fascia proceeds medially. It can also be included if it easily joins the first perforator.



**FIGURE 2.** The horizontal design leads to a more favorable scar and avoids revisions for postoperative contour deformity.



**FIGURE 3.** The further one can begin dissecting the perforators to the flap from the point where the superior gluteal artery emerges from the sacrum, the longer the pedicle. This will simplify dissection and microvascular anastomosis. A conscious effort should be made to take advantage of this anatomy.

The dissection proceeds toward the sacral fascia. Once the fascia is encountered, it must be opened to reveal the fatty subfascial recess, which contains multiple communicating venous and arterial branches. Here dissection becomes more delicate in an effort to ligate multiple branches carefully. The dissection is continued until the superior gluteal artery and vein are reached. The pedicle length at this time is usually

TABLE 3. S-GAP Flap and Perforator Vessel Characteristics

S-GAP Flaps	Average	Range
Size		
Width	9.5 cm	7–12 cm
Length	24.5 cm	16–29 cm
Weight	451 g	190–894 g
S-GAP Vessels		
Pedicle length	9.1 cm	7–12
No. of perforators		1–2
Gluteal artery diameter	3.38	2–4.5
Gluteal vein diameter	3.9	2.5–4.5
Mammary artery diameter	3.26	2.5–4
Mammary vein diameter	3.27	2.5–4.5

S-GAP = superior gluteal artery perforator.



FIGURE 4. The lateral decubitus position is preferred because it allows for a 2-team approach. The figure shows the horizontal design of the S-GAP flap with perforators marked out to ensure a longer pedicle. The location of the sciatic nerve and the underlying gluteus maximus muscle is shown as well.

between 8 and 12 cm (Fig. 6). The superior gluteal vein at this level is invariably large enough in diameter to perform microvascular anastomosis without difficulty (range, 2.5–4.5 mm). Because of this fact, the determining factor in ending this dissection will be the diameter of the gluteal artery (Table 3). Once the gluteal artery is dissected to a diameter of 2 mm or greater (range, 2–4.5 mm), the flap is harvested.

The assistant carefully supports the flap while dissection proceeds. The insertion of the pedicle into the flap is

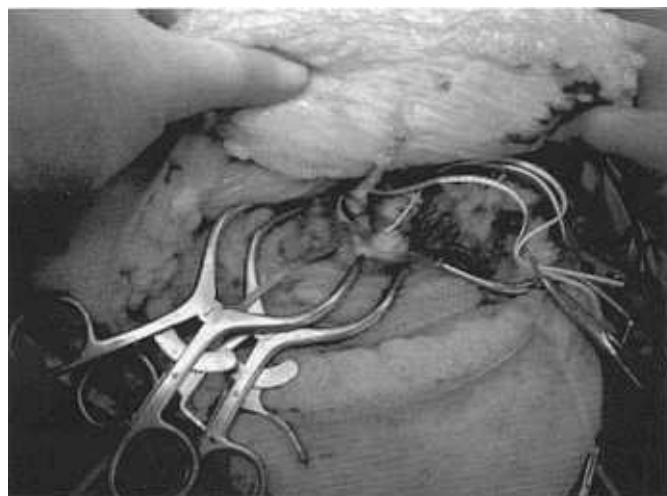


FIGURE 5. A perforator can be followed to the parent vessel, which dives under the sacral fascia.



FIGURE 6. A pedicle length of 7 to 12 cm was seen in this series. The average length was 9.1 cm.

delicate and care in handling is a must so as not to avulse this vessel. Once the flap is passed off the field, the wound is further undermined at the level of the gluteus muscle and closed in multiple layers. A large suction drain is left in the defect to prevent postoperative seroma. This is supplemented with a surgical girdle, which is worn for 2 weeks.

At this point, the patient is repositioned supine and the previously dissected recipient vessels are exposed. The microvascular anastomosis is done in the usual fashion, often using the coupler device for the venous anastomosis. We prefer the internal mammary vessels as the recipient vessels of choice for our reconstructions.<sup>9,20–22</sup> The vessel match at this level is very good, and the increase in pedicle length

allows plenty of room to perform a comfortable anastomosis, as well as increased flexibility in shaping the breast flap. Use of the thoracodorsal system would position the flap too lateral.

## RESULTS

Overall flap survival was 98%. Three flaps were lost during the 9-year period this clinical series comprises. One flap was avulsed during surgery, irreversibly damaging the vascular pedicle. This led to the use of the opposite gluteal region during the same procedure for a second S-GAP flap that did survive. One flap was lost to thrombosis at the arterial anastomosis. The other flap failed due to thrombosis at the venous anastomosis. There were a total of 8 vascular complications. Five of 8 flaps went on to survive. Two of those flaps experienced partial necrosis. Vascular complications were not associated with history of smoking ( $P = 0.57$ ) or radiation therapy ( $P = 0.9$ ) or the number of perforators associated with the pedicle ( $P = 0.27$ ). No vein grafts were required for this series of patients. Despite the fact that venous dissection is the most challenging portion of this procedure, only 1 flap in the series was lost to venous thrombosis.

A single perforator vessel nourished the flap in over 90% of cases. The S-GAP flap has a robust blood supply and no watershed regions that are predisposed to ischemia, unlike the more common abdominal flaps. Six patients experienced partial tissue necrosis, which required debridement. Two patients had received radiation therapy ( $P = 0.66$ ) and 2 patients were smokers ( $P = 0.11$ ); both factors were found not to be significantly associated with wound necrosis. The addition of more than one perforator was found not to be a significant protective factor in preventing partial flap necrosis ( $P = 0.14$ ). Similarly, having the flap nourished by more than one perforator did not reduce the overall complication rate ( $P = 0.86$ ). The other 2 patients with partial flap necrosis had no risk factors. Eventually, all healed their wounds with conservative management.

Other reasons to return to the operating room included isolated breast hematoma evacuation ( $n = 2$ ) and donor site hematoma evacuation ( $n = 1$ ). The average blood loss was 300 mL. Thirty-six percent of patients received autologous blood transfusion during their hospitalization with only one patient receiving banked blood during our entire series. Six patients (4%) required surgery to the donor site for unacceptable contour deformities. Although more complications with the donor site were seen in patients with the oblique design, this was not a statistically significant finding ( $P = 0.4$ ). The overall take-back rate for the series was 8% with an overall complication rate of 18% (Table 4). Satisfaction with the reconstructed breast and donor site has been excellent.

TABLE 4. Total Complications

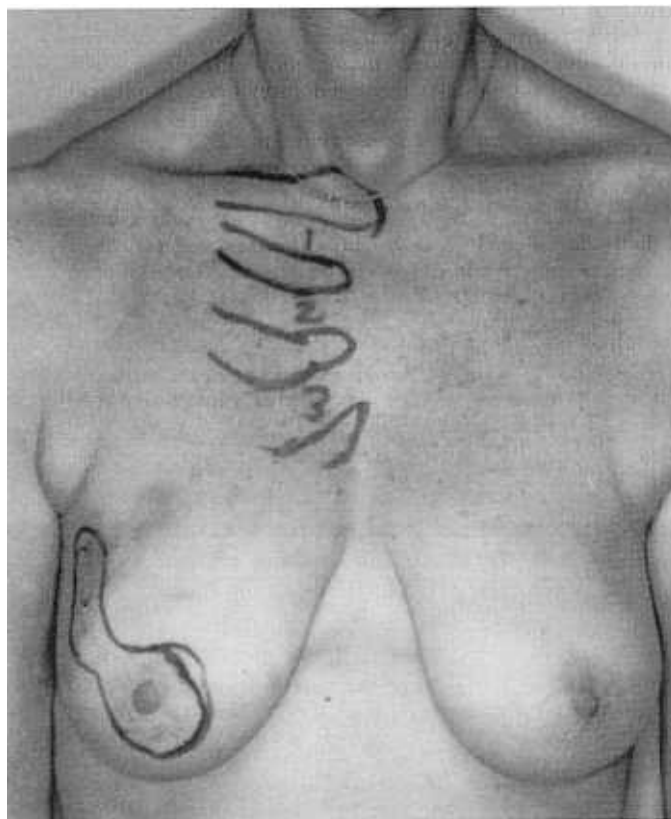
Vascular complication	8 (6%)
Donor contour deformity	6 (4%)
Partial flap necrosis	6 (4%)
Donor site seroma	3 (2%)
Breast hematoma	2 (2%)
Donor site hematoma	1 (1%)

## DISCUSSION

Patients presenting for autogenous breast reconstruction are attracted to these techniques for a number of reasons. They prefer the permanence of results, the ability to match the opposite breast in both feel and look, and the avoidance of alloplastic materials. Many patients will have a history of radiation to the chest wall, making implant reconstruction more difficult and likely to result in failure.<sup>25</sup> Thirty-two percent of our patients were found to have failed or failing breast implant reconstruction, frequently associated with a history of radiation therapy to the chest wall. Few options exist in these cases when the abdomen is not a suitable donor site. Gluteal tissue transplantation allows for an esthetic reconstruction with autologous tissue, which closely parallels the normal breast mound in these complicated cases. The buttock has a high fat-to-skin ratio. This produces a youthful breast with good projection and little if any ptosis.

The goal of the reconstructive surgeon is to provide the most esthetic result with the least amount of donor site morbidity. Autologous tissue reconstruction allows the creation of a soft, symmetric, and esthetically pleasing breast mound<sup>11-13</sup> (Figs. 7 and 8). The donor site receives a significant insult and can be predisposed to considerable postoperative morbidity. This is particularly true when using the abdomen as a donor site. Patients undergoing reconstruction with musculocutaneous flaps from this area can be crippled by postoperative hernias or weakness in the abdominal muscles.<sup>26-28</sup> The highest risk occurs in patients who donate both rectus abdominus muscles for their reconstruction.<sup>28</sup> Techniques that preserve the underlying muscle units allow for better functional results and less risk of herniation. The recovery from a perforator flap is associated with less discomfort, a speedy return to work, and an earlier hospital discharge.<sup>29</sup>

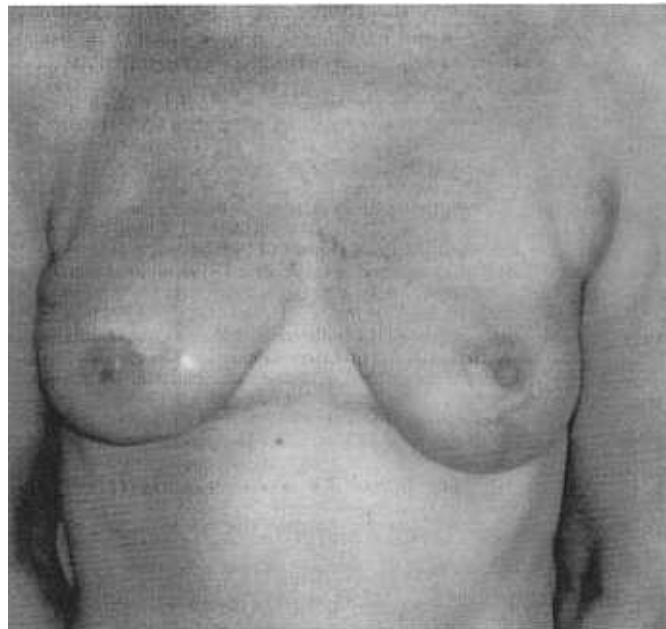
In the gluteal region, the donor site complications differ from those of the abdomen. However, the principles of perforator-based surgery remain unchanged, and preservation of the gluteus maximus muscle allows the patient to recover with less discomfort. The muscle is split, preserving its innervation. This muscle serves an integral function in ambulation, patients are ambulatory on postoperative day 1 and can be discharged home by postoperative day 4.<sup>29</sup> A much



**FIGURE 7.** The preoperative view of the typical thin, nulliparous candidate for breast reconstruction with the S-GAP flap. The thin breast-skin-soft tissue envelope can predispose certain patients to unsightly medial chest wall deformities if this is not considered preoperatively.

longer pedicle is obtained with the muscle split, and this makes the terminal dissection of the flap much easier. Performing the microsurgical anastomosis with a pedicle of adequate length avoids the need for vein grafts and is the major advantage over the gluteal musculocutaneous flap.<sup>2-6,9,10</sup> Nahai et al.<sup>5,6</sup> reported a 17% incidence of vein grafts or vein loops in their series. This necessitated additional morbidity and operative time. The inseting and shaping of the breast is also improved because the longer pedicle gives the surgeon freedom to manipulate the flap into a more esthetic shape.

Use of the internal mammary vessels at the level of the third intercostal space results in a good vessel match to the gluteal pedicle and is an important aspect of this reconstruction. At this level, vessels have been found to be highly reliable as recipient vasculature.<sup>22</sup> The cartilage is not discarded, but banked for subsequent nipple reconstruction.<sup>31</sup> Occasionally, when a patient presents with a thin breast-skin-soft tissue envelope, we have seen small contour deformities in the medial breast area when the third rib is removed (Fig. 7). This is a rare complication that can be seen from

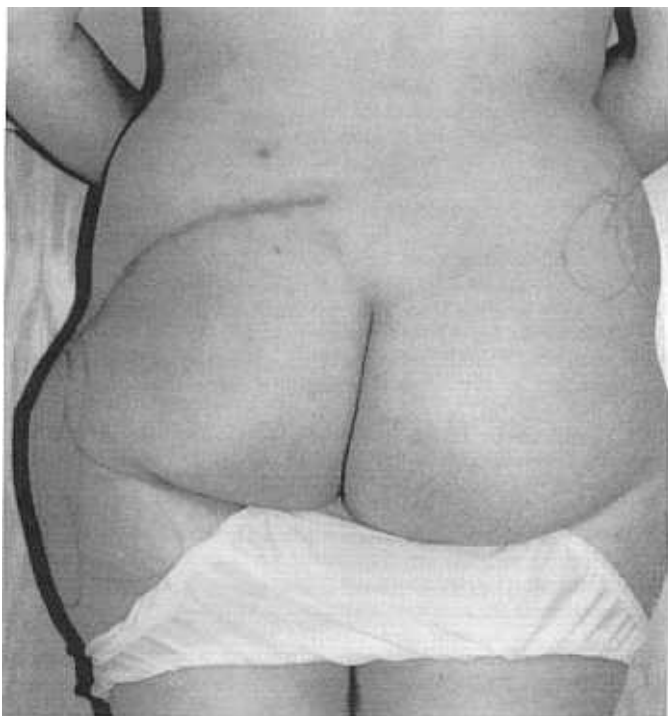


**FIGURE 8.** The postoperative view of the same patient. She required anastomosis in the fourth intercostal space and conservative cartilage resection to avoid contour irregularities on the chest wall.

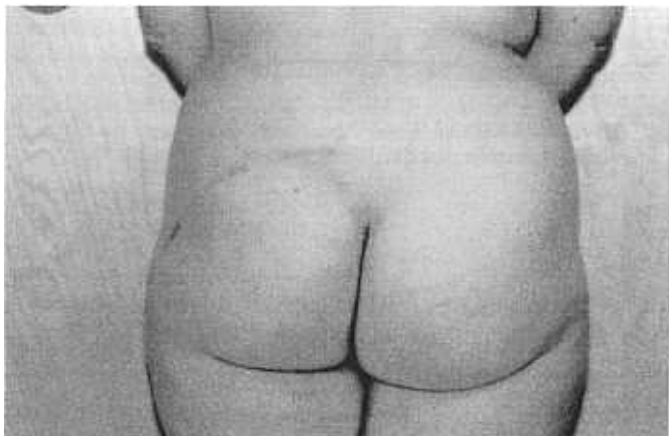
extracting the entire chondral portion of the rib, which can be avoided by removing only the amount of rib needed to expose the vessels or by going through the fourth rib area. It is advantageous, especially in thin-breasted patients, to revascularize the flap through the fourth rib space to fill out the breast envelope more fully in the superior medial portion of the breast and to avoid these contour problems, which can be difficult to correct. The anatomy of the vessels at this level might not be as reliable.

Other problems seen with flaps from the gluteal area (superior<sup>2,3</sup> and inferior<sup>4-6</sup> gluteal musculocutaneous flaps) such as sciatica are largely avoided. We discontinued the use of the I-GAP for fear of creating chronic pain syndromes in this region. The sciatic nerve was routinely exposed and although there was muscle to cover the nerve, some patients experienced dysesthesias as long as 12 weeks postoperatively with the I-GAP flap. However, all of these patients resolved their pain syndromes soon after the 12th week. Furthermore, when compared with the S-GAP flap, there was no advantage with this dissection.

The superior artery dissection allows the surgeon to avoid exposing the sciatic nerve. The limited muscle dissection allows for more reliable coverage of the underlying structures so that chronic pain syndrome can be avoided. The contour in this area is also improved by leaving the entire muscle unit in the donor site. None of our patients have reported any long-term discomfort. Only 6 patients have



**FIGURE 9.** This patient had a severe postoperative contour deformity of the gluteal donor site. Six patients in this series, all with the oblique flap design, experienced this type of contour deformity, requiring surgical intervention.



**FIGURE 10.** Revision surgery, using suction lipectomy and fat grafting, led to an acceptable result. We think this type of deformity can be avoided by using sound surgical technique, drains, and avoiding the use of the oblique design.

requested revision of the donor site (Figs. 9 and 10). These sites were augmented with autologous fat transplants from the thighs and opposite buttock and selective liposuction with good results. All of the patients that required donor site

revision had obliquely oriented designs, and although oblique incisions were not significantly associated with contour deformities, it has fallen out of favor at our institution (Figs. 1 and 9). In fact, we now routinely use only the horizontal design. The superior scar is also more easily camouflaged under a bathing suit and for most patients, it becomes a largely imperceptible scar in this location. The incidence of seroma has decreased significantly after the routine use of large suction drains and compression garments. These drains are usually left in place for 10 days and garments are recommended for 6 weeks.

Perfusion to the flap is excellent with only 6 incidences of partial flap necrosis. Over 90% of the flaps were carried on a single perforator. During the dissection, one may encounter several adequate perforators, but these usually do not meet to form a common trunk, and it is not advantageous to pursue their dissection and cause further damage to the gluteus muscle and prolong the operation. Statistically, the addition of more than one perforating vessel to the pedicle was not shown to decrease the overall complication rate ( $P = 0.86$ ), vascular thrombosis rate ( $P = 0.27$ ), or partial flap necrosis rate ( $P = 0.14$ ). There are no watershed regions for this flap, which makes it unlike flaps from the abdominal area. The gluteal fat tends to be more rigid than abdominal fat and creates a firmer, more projected breast reconstruction. Beveling away from the flap will provide more tissue to fill the breast envelope and create a more esthetic reconstruction. The skin territory can measure up to  $10 \times 25$  cm and adequately replaces any previously resected mastectomy skin. Even in patients with a history of radiation therapy, we have not experienced a lack of skin replacement. This flap can be made sensate by anastomosis of the nervi clunium superioris, which provides sensation at the gluteal region to the fourth intercostal nerve.<sup>30</sup>

In conclusion, the gluteal region offers a reliable alternative to the abdomen that can be used to create an esthetic breast. This region can provide an average of 451 g of fat and skin, even in thin patients. It is a ubiquitous donor site<sup>2-6,9</sup> which, with the use of perforator-based techniques to harvest the flap, is only minimally altered. Although the technique is not an easy one to learn, it does provide a dependable flap that performs well in smokers and patients receiving radiation therapy. Since 1993, we have averaged 15 gluteal artery perforator flap breast reconstructions per year. We favor the horizontal design, which leads to better esthetics at the donor site and minimizes revision procedures. We think the S-GAP will survive nicely when based on a single perforator, and that the additional time spent searching and dissecting other perforating vessels can only increase the operative time without significantly reducing morbidity. With experience, the surgical team can become proficient in using this flap. Gluteal-free flaps should be in the armamentarium of all reconstructive breast surgeons.

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