The In-the-Crease Inferior Gluteal Artery Perforator Flap for Breast Reconstruction

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Background: Perforator free flaps harvested from the abdomen or buttock are excellent options for breast reconstruction. They enable the reconstructive surgeon to recreate a breast with skin and fat while leaving muscle at the donor site undisturbed. The gluteal artery perforator free flap using buttock tissue was first introduced by the authors' group in 1993. Of the 279 gluteal artery perforator flaps, the authors have performed for breast reconstruction, 220 have been based on the superior gluteal artery and 59 have been based on the inferior gluteal artery. The authors have found that for some women with excess tissue in the upper buttock and hip area, use of the gluteal artery perforator flap resulted in an improvement at the donor site, whereas for others the aesthetic unit of the buttock was clearly disrupted. Therefore, the authors have recently been placing the scar in the inferior buttock crease to improve donor-site aesthetics.

Methods: The authors have now performed 31 in-the-crease inferior gluteal artery perforator free flaps for breast reconstruction and found that the results are very favorable.

Results: The removal of tissue from the inferior buttock results in a tightened, lifted appearance. The resultant scar is well concealed within the infrabuttock crease, and exposure or injury of the sciatic nerve has not occurred. Extended beveling at this site is also possible, with less risk of causing an unsightly depression. The final aesthetic result of the scar lying within the inferior buttock crease is very favorable. All patients report satisfaction with the donor site. Complications included one total flap loss, two reoperations for venous congestion, one hematoma, two cases with delayed wound healing at the recipient site, and one with delayed wound healing at the buttock.

Conclusion: The in-the-crease inferior gluteal artery perforator flap from the buttock is now the authors' primary alternative to the deep inferior epigastric perforator flap from the abdomen for breast reconstruction. (*Plast. Reconstr. Surg.* 118: 333, 2006.)

Perforator free flaps harvested from the abdomen or buttock have been shown to be excellent options for breast reconstruction. They enable the reconstructive surgeon to recreate a breast with skin and fat while leaving the muscle at the donor site essentially undisturbed. For women who would benefit from an abdominoplasty, use of the abdomen as a donor site has an added advantage of removing the excess abdominal skin and fat. The buttock donor site has similar aesthetic advantages in selected patients with excess buttock tissue.

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The gluteal artery perforator free flap was first introduced by our group in 1993, which used the buttock as an alternative donor site to the abdomen for breast reconstruction.[1] Of the 279 gluteal artery perforator flaps we have performed for breast reconstruction, 220 have been based on the superior gluteal artery and 59 have been based on the inferior gluteal artery. These flaps can provide sufficient tissue for breast reconstruction and can improve the appearance of the buttock donor site in women with excess tissue higher up on the buttock. However, we found that for many patients the use of superior buttock tissue clearly disrupted the aesthetic unit of the buttock. An area of depression at the upper buttock often resulted and the scar was left in a prominent area of the buttock.[2] Less beveling of the flap under adjacent tissue reduced this de-

formity at the expense of obtaining a smaller overall breast flap with a less spherical shape.

Many women with excess buttock tissue will automatically point to the inferior buttock when asked where excess tissue might preferably be removed. Le-Quang and Paletta et al. used this site for their inferior gluteal myocutaneous free flaps for breast reconstruction, with excellent cosmetic results.[3,4] Initially, we had some concern about the use of the inferior portion of the buttock because of reports that myocutaneous flaps harvested from this inferior site had left the sciatic nerve unprotected, causing significant postoperative morbidity. However, our clinical experience has shown that soft tissue can be harvested from the inferior buttock without sciatic nerve exposure.

We have now performed 31 in-the-crease inferior gluteal artery perforator free flaps for breast reconstruction with favorable results. The removal of tissue from the inferior buttock results in a tightened, lifted appearance. The resultant scar is well concealed within the infrabuttock crease, and postoperative exposure or injury of the sciatic nerve has not occurred. A greater amount of beveling of adjacent fat may be performed with less risk of an unsightly donor site. The inferior gluteal artery perforator also had a longer pedicle than the superior gluteal artery perforator, making the flap positioning for anastomosis easier and insetting more flexible. It also allows for use of either the internal mammary or thoracodorsal vessels as recipient vessels. Because of the many advantages of the inferior gluteal donor site, our preference has evolved from the use of the superior gluteal artery perforator flap to the use of the in-the-crease inferior gluteal artery perforator flap as the flap of choice when using the buttock as the donor site.

PATIENTS AND METHODS

A series of 31 patients have undergone in-the-crease inferior gluteal artery perforator free flap breast reconstruction between March and December of 2004. The average patient age was 49.4 years (range, 33 to 61 years). The series of patients was reviewed for indications for the use of a gluteal flap over other donor sites, flap weight, operative time and hospital length of stay, and intraoperative and postoperative complications.

Patient Selection

The indications for the use of a gluteal flap instead of an abdominal flap are listed in Table 1.

Table 1. Indications for Use of a Gluteal Flap

Reason for Use	No. of Breast Reconstructions	No. of Patients
Inadequate abdominal tissue	20	14
Patient choice	6	5
Prior DIEP flap	2	2
Prior failed TRAM flap	2	2
Prior abdominal liposuction	1	1

DIEP, deep inferior epigastric perforator; TRAM, transverse rectus abdominis musculocutaneous.

All patients were evaluated for perforator flap breast reconstruction. The inferior gluteal artery perforator flap was clearly the better choice for patients with inadequate tissue in the abdomen. This was the case in 14 of the patients in this series, accounting for 20 of the breast reconstructions. Five patients in this series chose the in-the-crease inferior gluteal artery perforator flap when offered the option, even though they had ample abdominal tissue to create a reasonable breast. The reason for this preference was either an aversion to a long, transverse abdominal scar or, for patients who were able to donate a larger, thicker flap from the buttock as compared with the flap available from the abdomen, a desire to have a larger, more projecting breast reconstruction. Less pain from a buttock rather than an abdominal donor site was also a factor in decision making.

The timing of the breast reconstruction is given in Table 2. We define primary reconstructions as taking place immediately after and with the patient under the same anesthesia as the mastectomy. Secondary, or delayed, reconstructions are defined as taking place after the mastectomy has been performed and the wound has healed. Tertiary reconstructions are defined as occurring after another form of breast reconstruction has failed or been inadequate. Of the nine tertiary reconstructions, seven were for failed implant reconstructions and two were for failed transverse rectus abdominis musculocutaneous flaps with subsequent failed implant reconstructions. All patients had an additional operation for flap revision and nipple creation several months after the initial

Table 2. Timing of Breast Reconstruction

	Breast Reconstruction	
	No.	%
Primary	16	52
Secondary	6	19
Tertiary	9	29

procedure under local anesthesia with sedation on an outpatient basis.

Anatomy

The inferior gluteal artery is a terminal branch of the internal iliac artery and exits the pelvis through the greater sciatic foramen.[5] The artery accompanies the greater sciatic nerve, the internal pudendal vessels, and the posterior femoral cutaneous nerve. Below the fascia of the sacrum, the vessel is also surrounded by several distinct fat pads. In this subfascial recess, the inferior gluteal vein will receive tributaries from other pelvic veins. The inferior gluteal vasculature will continue toward the surface by perforating the sacral fascia. It will exit the pelvis caudal to the piriformis muscle. Once under the inferior portion of the gluteus maximus, perforating vessels are seen branching out through the substance of the muscle to feed the overlying skin/soft-tissue envelope.

The course of the inferior gluteal artery perforating vessels is more oblique through the substance of the gluteus maximus muscle than the course of the superior gluteal artery perforators, which tend to travel more directly to the superficial tissue up through the muscle. Thus, the length of the inferior gluteal artery perforator and the resultant pedicle length for the overlying inferior gluteal artery perforator flap are greater than that found with a superior gluteal artery perforator flap. Because the skin island is placed inferior to the origin of the inferior gluteal vessels, a longer pedicle is also ensured.

The direction of the perforating vessels is superior, lateral, and inferior. Perforating vessels that nourish the medial and inferior portions of the buttock have relatively short intramuscular lengths, between 4 and 5 cm, depending on the thickness of the muscle. Perforators that nourish the lateral portions of the overlying skin paddle are seen traveling through the muscle substance in an oblique manner 4 to 6 cm before turning upward toward the skin surface. By traveling through the muscle for relatively long distances, these vessels are much longer than their medially based counterparts. The perforating vessels can be separated from the underlying gluteus maximus muscle and fascia and traced down to the parent vessel, forming the basis for the inferior gluteal artery perforator flap. Between two and four perforating vessels originating from the inferior gluteal artery will be located in the lower half of each gluteal muscle.[6]

In 91 percent of cases, the inferior gluteal artery then descends into the thigh accompanied by the posterior femoral cutaneous nerve (S1–S2) and follows a long course, eventually surfacing to supply the skin of the posterior thigh.[7] Another nerve branch (S1–S2) also supplies the skin of the inferior buttock. A neurosensory flap can be elevated if these nerves are preserved in the dissection of the flap.[8]

Flap Design

The flap is designed as a horizontal ellipse, with the axis centered above the gluteal crease. The gluteal crease is marked with the patient in the standing position and forms the inferior aspect of the skin paddle ellipse. Then, with the patient in the lateral position (similar to the position of the patient at the time of surgery), a handheld Doppler probe is used to find the strongest perforating vessels to the skin. The superior aspect of the skin island ellipse is then marked to capture these perforators. The direction of the skin paddle usually parallels the inferior gluteal crease. The dimensions of the flap are typically approximately 8 × 18 cm, depending on the amount of skin needed (less with a skin-sparing mastectomy) and the amount of excess buttock tissue available. Preoperative markings are shown in Figure 1.

Technique

A two-team approach is used. After intubation, the patient is placed in the lateral recumbent position and ipsilateral chest wall and buttock are prepared into the field. The ipsilateral arm and leg are prepared into the field as well to facilitate exposure at the surgical sites.

While a second microsurgeon prepares the recipient site and recipient vessels, incisions are

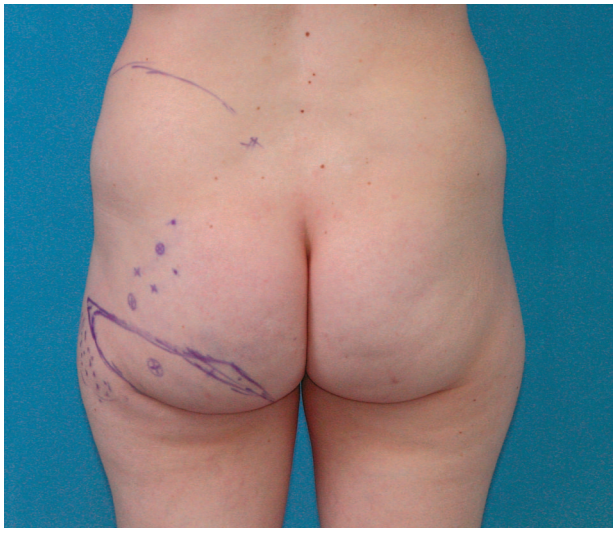

Fig. 1. Preoperative markings of skin paddle and perforator locations.

made along the previously drawn marks and electrocautery is used to divide the fat down to the gluteal fascia. The fat is beveled superiorly and inferiorly to include the maximum amount of fat and soft tissue in the flap as deemed necessary. Additional lateral beveling can also be used to obtain more fat from the lateral thigh or "saddlebag" area. Care is taken to leave sufficient fat medially over the ischium. The fat in this area is denser and slightly lighter in color than the more lateral fat that is incorporated into the flap. The fascia of the gluteus maximus is incised laterally and the dissection proceeds in the subfascial plane to allow easier visualization of the perforators. Perforators with an artery of at least 1 mm and venae comitantes are followed through the muscle between the muscle fascicles, which are spread apart to allow deeper dissection. On occasion, a second perforator is found during the dissection and is included if it easily joins the first perforator. The dissection proceeds under the muscle until a pedicle of sufficient length and with sufficient vessel caliber is obtained to allow microsurgical anastomosis with the dissected recipient vessels in the chest. This usually occurs when the perforating vessels join the inferior gluteal artery. The distal extension of the inferior gluteal artery and vein can be transected to aid in the mobilization of the pedicle. Care must be taken to avoid injury to the posterior femoral cutaneous nerve of the thigh, which travels with the inferior gluteal vessels. The sciatic nerve is usually not visualized. This results in a typical pedicle length of 8 to 11 cm and an arterial diameter of greater than 2 mm with a vein of 3 to 4 mm. Sometimes, adequate vessel size and length are obtained before entering the inferior gluteal artery and vein, simplifying flap harvest.

Once good recipient vessels are confirmed, the pedicle is divided and the flap harvested. The buttock wound is closed in three layers with a suction drain placed. The closed incision and resultant scar will fall within and slightly lateral to the buttock crease.

The patient is then returned to the supine position and the microvascular anastomosis and flap insetting are performed. An additional suction drain is placed at the recipient site.

Patients spend one night in the intensive care unit for flap monitoring every 15 minutes for the first hour, then every hour. They are then discharged to a regular hospital floor, where the flap is checked with a Doppler probe every 4 hours. Patients are out of bed and ambulatory on the first postoperative day. Many patients feel very well and report little or no pain on the second postoperative day. We keep all patients until the fourth postoperative day for flap monitoring. Patients typically return to work at 4 weeks after surgery. However, some patients feel well enough to go back to work sooner. We require that they do not engage in any vigorous activity or heavy lifting for 4 weeks after surgery.

RESULTS

The sizes and characteristics of the mastectomies, removed implants, and in-the-crease inferior gluteal artery perforator flaps are listed in Table 3. Final flap inset weights are slightly lower than harvest weights because of trimming of the flap during shaping and insetting at the time of the initial procedure. In most cases, the gluteal donor site allowed the creation of a flap as large as or larger than the mastectomy specimen or removed implant.

Six of the 31 reconstructions were performed on patients who had undergone radiation therapy (19 percent). The average time of the operation was 5.3 hours (range, 3.0 to 9.4 hours). The average intraoperative blood loss was 317 cc (range, 150 to 1000 cc). Five patients underwent a balancing procedure on the contralateral breast (16 percent), which consisted of either a mastopexy or augmentation (one with a saline implant and one with autologous lateral thoracic tissue) at the time of in-the-crease inferior gluteal artery perforator reconstruction. Hospital length of stay was an average of 4.2 days (range, 4 to 7 days).

In the series, there was one flap loss secondary to venous thrombosis that occurred on postoperative day 4. This patient had undergone staged, bilateral in-the-crease inferior gluteal artery perforator reconstructions because the abdomen was deemed insufficient to provide enough tissue for two breast reconstructions. A successful deep inferior epigastric perforator flap was subsequently performed for the unilateral reconstruction, with an initial weight of 589 g reduced to 473 g after inset. This compared with the final inset weights of 495 g and 530 g with the in-the-crease inferior

Table 3. Mastectomy, Flap, and Implant Weights

	Average	Range
Mastectomy weight, g	305	156–654
Removed implant weight, g	510	129–763
Flap harvest weight, g	425	148–833
Final flap weight after inset, g	407	137–806
Final flap weight		
% of harvest flap weight	96	91–100
% of mastectomy weight	124	59–190
% of removed implant weight	108	70–161

gluteal artery perforator flaps from each buttock with this particular patient.

Two additional patients were returned to the operating room after the completion of the initial reconstruction for successful treatment of venous insufficiency. These were both thought to be secondary to twisting or kinking of the flap vein away from the site of anastomosis and were probably inset-related. One patient developed a hematoma that resolved without intervention. Two patients had problems with wound healing and wound breakdown at the recipient site. Both patients had undergone previous radiation therapy to the chest wall, and wounds eventually healed in both. One patient suffered wound breakdown at the donor site that healed with conservative wound care. These complications resolved without flap loss and are similar to problems that occur with other types of breast reconstruction. One patient reported initial minor adjustments to their sitting position when sitting on a hard surface. This problem resolved within 6 weeks after the operation. No other patients had any complaints about discomfort on sitting when asked at 3 months after the operation. All patients were seen for nipple reconstruction at 3 months postoperatively. The longest follow-up period was 9 months in one patient.

We typically use the internal mammary vessels as recipient vessels. Favorable internal mammary perforators superficial to the pectoralis muscle and thoracodorsal vessels were also used, as displayed in Table 4. In one patient, the internal mammary artery and a favorable perforating vein were used.

DISCUSSION

Microvascular transfer of gluteal tissue was accomplished for the first time using a superior gluteal musculocutaneous flap by Fujino in 1975. Le-Quang subsequently described transfer of inferior gluteal musculocutaneous flaps in 1978.[3] Gluteal musculocutaneous flaps were later described by both Shaw and Paletta et al.[4,9] Shaw used the superior gluteal myocutaneous free flap, but acknowledged its difficulty secondary to the short pedicle length. Paletta et al. preferred the inferior gluteal flap because it provided a longer pedicle and more tissue bulk, and the incision was hidden in a more cosmetic location:

Table 4. Recipient Vessels Used

	Anastomoses	
	No.	%
Internal mammary	51	82
Internal mammary perforator	5	8
Thoracodorsal	6	10

the inferior gluteal crease. However, use of this flap with harvest of gluteus muscle often left the sciatic nerve unprotected, with no soft-tissue cover between the skin and the nerve, with many patients suffering significant postoperative symptoms. In addition, despite the proposed longer pedicle, a high number of patients continued to require vein grafts and endured the increased risk of vascular complications. In our experience with the in-the-crease inferior gluteal artery perforator flap, the sciatic nerve was seen in only two dissections. In these cases, the gluteus maximus fibers, once the pedicle was harvested, fell closed over the nerve and provided a thick muscle mass between the skin and the nerve. Neither of these patients nor any other patient in this series suffered postoperative complaints related to the sciatic nerve. The difference in the perforator flap as compared with the previous technique is that no muscle is taken. Therefore, the gluteus muscle continues to cover and protect the sciatic nerve, and exposure is not a problem.

Although the approximately 8-cm length of the superior gluteal artery perforator pedicle is a great improvement over the 2- to 3-cm superior gluteal artery myocutaneous flap pedicle length, the superior gluteal artery perforator pedicle is not always optimal. The superior gluteal artery exits the sciatic foramen and immediately sends perforators up through the gluteus muscle. Thus, the pedicle length is typically equal to the length of the perforator plus a short cuff of superior gluteal artery. If a medial perforator is chosen close to the sciatic foramen, the resultant pedicle may be no more than 6 cm long. In contrast, as previously discussed, the inferior gluteal artery takes an inferior course underneath the gluteus maximus muscle, sending out more obliquely oriented perforators all along its length. Therefore, when the skin island is designed inferiorly, the surgeon is ensured of obtaining an overall longer pedicle that is typically 8 to 11 cm long.

This added length allows for more leeway in orientating and insetting the flap, and can make the anastomosis easier. It also allows for greater reach to the thoracodorsal vessels, if necessary, with better medialization of the flap on the chest wall should these vessels be used.

Two problems occurred with venous congestion of the flap. Both were successfully addressed, and the flaps subsequently did well, and were thought to be caused by a kinking or twisting of the vein rather than a problem at the anastomotic site. Our group uses the vein coupler almost exclusively for the venous anastomosis, and we feel that the coupler acts as a stent

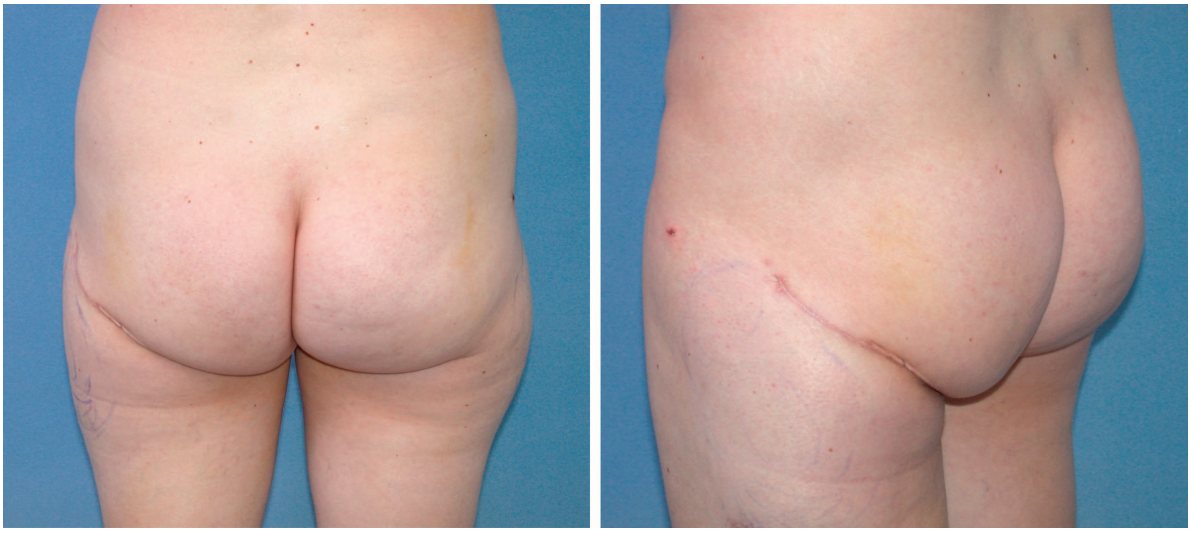

Fig. 2. Postoperative views of the patient in Figure 1 at 9 months postoperatively.

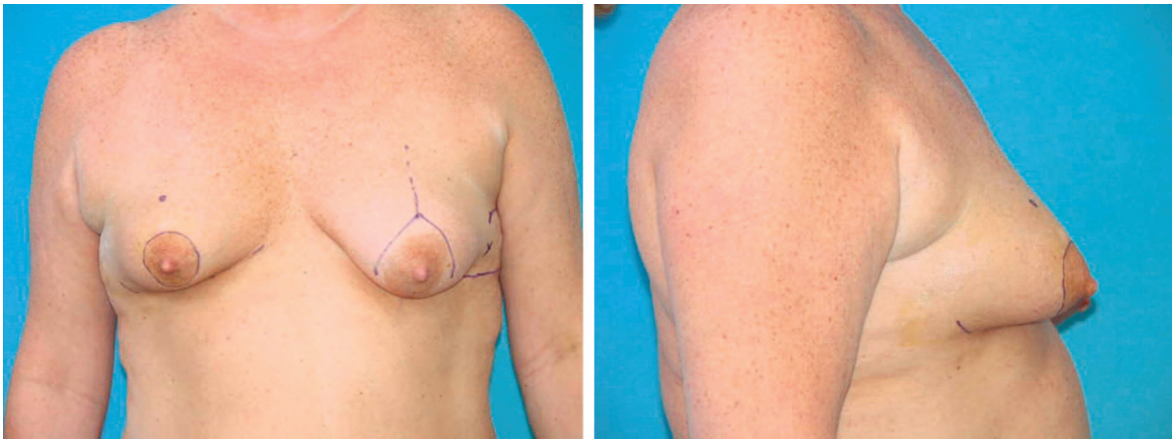

Fig. 3. Preoperative views of a patient with right breast cancer.

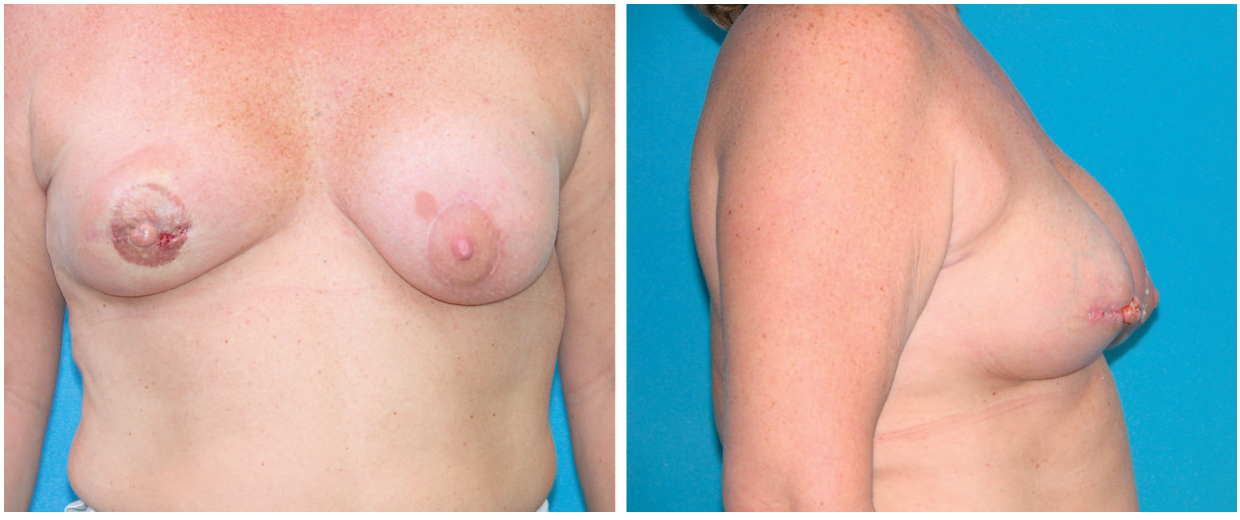

Fig. 4. Postoperative views obtained at 6 months postoperatively. The contralateral breast underwent autologous augmentation for symmetry with a pedicled intercostal perforator flap at the time of inferior gluteal artery perforator second-stage revision and nipple creation.

for the vein and keeps the lumen open, with the result that very few problems occur at the site of the venous anastomosis itself.

Our experience using the gluteal artery perforator flaps for patients who are not deep inferior epigastric perforator/superficial inferior epigastric artery flap candidates has been favorable.[2] Until recently, the vast majority of our buttock flaps have been harvested from the upper buttock and therefore based on the superior gluteal artery perforators. Over the past 12 years, we have occasionally designed the skin island slightly lower, according to the patient's anatomy or preference, and serendipitously used the inferior gluteal artery perforators. These upper buttock gluteal artery perforator flaps have occasionally resulted in a depression at the donor site that required revision. We have used liposuction around the scar and autologous fat injection to fill in the scar, depending on the patient's anatomy.

Our experience has been that the donor-site defect of the in-the-crease inferior gluteal artery perforator flap is aesthetically favorable and inconspicuous in the great majority of patients. The aesthetic unit of the buttock is preserved and the scar falls in the inferior gluteal crease. Significant soft-tissue depression at the donor site occurs less often and appears less noticeable than with the typical superior gluteal artery perforator donor site. This results in an improved postoperative appearance and also allows a greater amount of beveling and fat harvest with the flap in thin patients (Fig. 2). The one wound dehiscence that occurred may have been the result of tension on the wound. To prevent this, we now undermine both inferiorly and superiorly to bring the wound edges together under minimal tension.

The delayed wound healing at the recipient site occurred in two patients who had been irradiated. The damaged skin at the recipient site probably contributed to the delayed wound healing. The inferior gluteal artery perforator flap has a high fat-to-skin ratio as compared with the abdominal flaps. The typical skin island width is 7 to 10 cm. It is a thick flap and is sometimes difficult to inset in the irradiated chest after skin excision. If irradiated skin will be removed and there will be a large skin requirement, the abdomen may be a better choice for patients who have the tissue to donate.

CONCLUSIONS

Overall, in-the-crease inferior gluteal artery perforator flaps allow reliable, aesthetic reconstruction of the breast (Figs. 3 and 4) without the sacrifice of muscle at a donor site. Patient satisfaction has been very high and is comparable to that in the deep inferior epigastric perforator and superficial inferior epigastric artery reconstructions. We feel that the buttock is a reliable soft-tissue source for breast reconstruction. According to the patient's history and physical shape, a gluteal flap can be used successfully instead of an abdominal flap. A sufficient amount of soft tissue for an aesthetic breast reconstruction can be obtained reliably in most patients. The evolution of surgical technique from the superior gluteal artery perforator to the in-the-crease inferior gluteal artery perforator flap now allows an aesthetically superior result to be obtained for both the reconstructed breast and the donor site in the vast majority of patients.

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DISCLOSURE

None of the authors has any financial interest in any medical device or product mentioned in this article.

REFERENCES

1. Allen, R. J., and Tucker, C., Jr. Superior gluteal artery perforator free flap for breast reconstruction. *Plast. Reconstr. Surg.* 95: 1207, 1995.
2. Guerra, A. B., Metzinger, S. E., Bidros, R. S., Gill, P. S., Dupin, C. L., and Allen, R. J. Breast reconstruction with gluteal artery perforator (GAP) flaps: A critical analysis of 142 cases. *Ann. Plast. Surg.* 52: 118, 2004.
3. Le-Quang, C. Secondary microsurgical reconstruction of the breast and free inferior gluteal flap. *Ann. Chir. Plast. Esthet.* 37: 723, 1992.
4. Paletta, C. E., Bostwick, J., III, and Nahai, F. The inferior gluteal free flap in breast reconstruction. *Plast. Reconstr. Surg.* 84: 875, 1989.
5. Strauch, B., and Yu, H. L. Gluteal region. In B. Strauch and H. L. Yu. *Atlas of Microvascular Surgery: Anatomy and Operative Approaches.* New York: Thieme Medical, 1993. Pp. 102–119.
6. Koshima, I., Moriguchi, T., Soeda, S., Kawata, S., Ohta, S., and Ikeda, A. The gluteal perforator-based flap for repair of sacral pressure sores. *Plast. Reconstr. Surg.* 91: 678, 1993.
7. Windhofer, C., Brenner, E., Moriggl, B., and Papp, C. Relationship between the descending branch of the inferior gluteal artery and the posterior femoral cutaneous nerve applicable to flap surgery. *Surg. Radiol. Anat.* 24: 253, 2002.
8. Boustred, M. A., and Nahai, F. Inferior gluteal free flap breast reconstruction. *Clin. Plast. Surg.* 25: 275, 1998.
9. Shaw, W. W. Breast reconstruction by superior gluteal microvascular free flaps without silicone implants. *Plast. Reconstr. Surg.* 72: 490, 1983.