



ELSEVIER
SAUNDERS

Gluteal Artery Perforator Flaps

Christoph Heitmann, MD^{a,*}, Joshua L. Levine, MD^b,
Robert J. Allen, MD^c

- Superior gluteal artery perforator flap
 - Patient evaluation and selection*
 - Patient preparation*
 - Technique*
 - Complications*
- Inferior gluteal artery perforator flap
 - Patient evaluation and selection*
 - Technique*
 - Complications*
- Summary
- References

Perforator flaps have allowed the transfer of a patient's own skin and fat in a reliable manner with minimal donor site morbidity for more than a decade. They represent the latest in the evolution of soft tissue flaps and provide the reconstructive microsurgeon with more freedom to select a donor site that matches the skin color, thickness, texture, and subcutaneous fat quality of the recipient site. More attention can be paid to the aesthetic quality of the reconstruction. The current information about existing perforator flaps are compiled in a comprehensive work by Blondeel and colleagues [1]. This book is unique in its coverage and contains all pioneers who blazed the trails to bring us to this point in the development of the perforator flap technique. However, these techniques have brought new difficulties and problems that must be addressed. First and foremost, these techniques require microsurgical expertise. Variability of vascular anatomy contributes to the difficulties with the procedures. Judgment as to how many and what size and location of perforators to select affects factors such as length of operation and incidence of fat necrosis. It is amazing how little blood supply is necessary to

adequately perfuse skin and fat; but how little is enough? Can perforator flaps only be performed by super-specialists, and are they beyond the realm of the occasional microsurgeon? What is the learning curve for a perforator flap breast reconstruction? Perhaps 50 to 100 procedures.

The most common type of breast reconstruction involves the use of saline or silicone gel implants. This technique has the advantage of simplicity and a lack of a donor site. Aesthetic results can be quite good, although these patients express to the senior author that the result never feels natural and always feels like an implant under the chest muscle. Approximately 25% of women seen for breast reconstruction by the senior author have had previous attempted implant reconstruction. The ideal tissue for breast reconstruction is fat with or without skin, not implants or muscle.

This article focuses on buttock flaps for breast reconstruction and covers aspects such as patient evaluation, selection, preparation, surgical technique, and complications of superior gluteal artery perforator (SGAP) and inferior gluteal artery perforator (IGAP) flaps.

^a Department of Hand, Plastic and Reconstructive Surgery, Burn Center, BG Trauma Center, Hand and Plastic Surgery of the University of Heidelberg, L. Guttmanstr. 13, 67071 Ludwigshafen, Germany

^b The Center of Microsurgical Breast Reconstruction, 1776 Broadway, Suite 1200, New York, NY 10019, USA

^c Medical University of South Carolina, 125 Doughty Street, Suite 480, Charleston, SC 29401, USA

* Corresponding author.

E-mail address: heitmann@bgu-ludwigshafen.de (C. Heitmann).

Superior gluteal artery perforator flap

Breast reconstruction with the use of autologous tissue allows the creation of a new breast that looks and feels like normal breast. The abdomen is the most commonly used soft tissue donor site. However, in patients in whom the abdomen cannot provide enough tissue, the buttock with the SGAP and IGAP flap is an excellent alternative. The SGAP was first introduced by the authors' group in 1993 [2]. It is a good choice for breast reconstruction in women who have more skin and fat available in the buttock area than in the abdomen [3]. The donor site is minimal, and no sacrifice of muscle is required (Fig. 1).

Patient evaluation and selection

Patients in whom the abdomen cannot be used as a donor site or who have more tissue in the buttock area than in the abdomen are the best candidates. In the case of breast reconstruction, the authors prefer to have the patient complete any radiation therapy and a delay of 6 months before the free flap procedure. Although perforator flaps usually tolerate radiation well, a superior long-term result is typically obtained in reconstructions performed after, rather than before, chest wall radiation [4]. Absolute contraindications for an SGAP procedure in the authors' practice include history of previous liposuction at the donor site, active smoking (within 1 month before surgery), and poor general medical condition. Patients should be informed about possible contour deformities and the future location of the scar at the buttock.

Patient preparation

The patient is usually seen in the office on the day before surgery. The surgical plan is reviewed with the patient, and any remaining questions are answered. The operation is performed under general anesthesia with the patient in lateral decubitus position. Preoperatively placement of intravenous lines, an indwelling urinary catheter, and antithrombotic stockings are the routine. Markings are placed while the patient is placed in the lateral position and a Doppler probe is used to find perforating vessels from the superior gluteal artery. These are usually found approximately one third of the distance on a line from the posterior superior iliac crest to the greater trochanter. Additional perforators may be found slightly more lateral to this location. This road map of the largest perforators helps the surgeon to make decisions intraoperatively. The skin paddle is marked in an oblique pattern from inferior medial to superior lateral to include these perforators. The outline of the flap may be customized to almost any orientation as long as it contains the perforating vessels. The width of the skin paddle averages 10 cm. The length of the flap is usually 20 to 26 cm.

Patient positioning is important when using the SGAP flap. In a lateral decubitus position a two-team approach is possible. Normally the arm ipsilateral to the breast being reconstructed is prepared and draped into the field so that it can be maneuvered to provide adequate exposure. The patient is returned to a supine position after elevation of the flap, closure of the donor site, and before flap anastomosis. When immediate breast reconstruction is being performed, the mastectomy specimen is weighed to gauge the volume needed. The flap

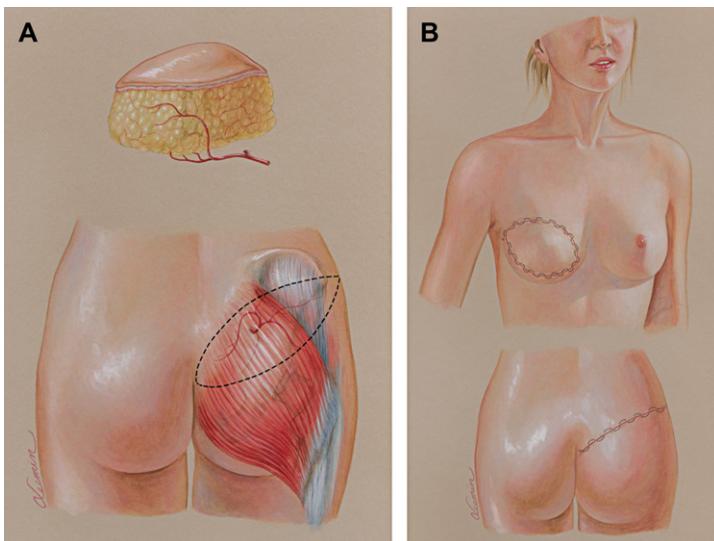


Fig. 1. (A) Skin island location of the SGAP flap. The superior gluteal artery may be found one third of the distance from the posterior superior iliac spine to the greater trochanter. (B) Flap inset and donor site.

dimensions are measured and flap weight (g) is estimated as follows: width (cm) \times one half of the length (cm) \times height or thickness (cm). For example, an SGAP flap that is 20 cm long, 10 cm wide, and 4 cm thick would have an appropriate weight of 400 gm. These weights and estimates are important to avoid overresection.

Technique

A two-team approach is used with simultaneous flap harvest and preparation of the recipient vessels under loupe magnification; the internal mammary artery and internal mammary vein are the recipient vessels of choice. The central position of the internal mammary artery and internal mammary vein in the chest wall makes medial placement of the flap easier on inseting. The vessels are dissected between second and third rib space. A distance of 2 to 3 cm in width is enough space to enable anastomosis. If the rib space is less than 3 cm in width, the removal of a portion of the lower rib is performed. Occasionally, a large perforating artery and vein from the internal mammary vessels may be found and these vessels used as the recipients in the chest. Care must be taken to preserve at least small lengths of the side branches of the internal mammary artery and internal mammary vein that may be used for improving any size mismatch, which may occur with the flap vessels. This is especially important with the internal mammary vein because the gluteal vein is often very large and may measure 4 to 5 mm in diameter.

The harvest of the flap starts with an incision carried down to the fascia of the gluteus maximus muscle. Beveling is used as needed in the superior and inferior direction to harvest enough tissue. The flap is elevated from the muscle in the subfascial plane and the perforators approached beginning from lateral to medial. It is preferred to use a single large perforator if it is present, but several perforators that lay in the same plane and the direction of the gluteus muscle fibers can be taken together as well. Subfascial elevation is also performed from medial to lateral to ensure that the largest perforator is found before flap is islanded. The muscle is then spread in the direction of the muscle fibers and the perforating vessels are dissected free. This is done by blunt dissection, staying close to the vessel at all times because it remains covered by a thin layer of loose connective tissue. The perforating vessels are kept moist with normal saline. Complete dissection of a perforator helps prevent vessel damage when raising the flap. Using bipolar coagulation diathermy and small hemoclips, one continues to ligate all side branches until the main stem of the gluteal vessels are reached.

The length of the pedicle can be tailored to meet the needs of different recipient sites or the demands of the shape of the flap. The artery usually is the limiting factor in this dissection. The artery and vein diameter for anastomosis is 2.0 to 2.5 mm and 3.0 to 4.5 mm, respectively. Excellent exposure is required throughout the procedure but becomes critically important when ligating tributaries to the superior gluteal vein. Without adequate exposure, the risk of injury to the vein is magnificent. To avoid this damage, the authors recommend placing the retractor so that it holds the piriformis and gluteus minimus muscle widely apart. Ligation of the venous tributaries is performed only when the gluteal vein is clearly visualized as it exits the pelvis. The pedicle length is usually 7 to 12 cm. Although the approximate 8-cm length of the SGAP pedicle is a great improvement over the 2- to 3-cm SGA myocutaneous flap pedicle length [5], the SGAP 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 SGA. If a medial perforator is chosen close to the sciatic foramen, the resultant pedicle may be no more than 6 cm long. The donor defect should be closed with great care. After undermining the skin flaps, the gluteal muscle is reapproximated with single absorbable sutures and a single suction drain is placed over the muscle. The superficial fascial system is identified and closed with sutures before final skin closure. At the end of the procedure the patient should be placed in a supporting girdle, which the authors recommend to be worn for 2 weeks.

The patient is now returned to a supine position to facilitate the microsurgical part of the procedure. The operating microscope is brought into position. Great care is taken to lay the donor pedicle in alignment with the recipient vessels without any twists or kinks. Although the overall incidence of vascular complication is low, experience has shown that many cases of venous compromise can be traced to a kinked pedicle. For the venous anastomosis, the authors use an anastomotic coupling device. The coupling device makes the anastomosis easier and faster, and has the additional benefit of stenting the vein open after the vessels are joined.

The arterial anastomosis is typically performed manually with interrupted sutures. After the anastomosis is complete, the flap is checked for bleeding and capillary refill. The inseting and closure are performed over a suction drain, and great care is used to monitor the integrity of the pedicle during the inseting of the flap. Excess skin is deepithelialized superiorly and inferiorly, and the flap inset with a visible skin paddle is left in place. The

external Doppler probe is used to identify the locations on the flap with good arterial and venous signals, and these locations are marked for postoperative monitoring in the ICU and on the floor with a hand-held Doppler. For monitoring it is also possible to use an implantable Doppler probe. This is especially helpful in cases whereby a smaller skin paddle is left or no dominant point can be found on the exposed skin portion of an otherwise healthy flap. Care must be taken with the placement of these probes. A Doppler sleeve placed too loosely around the vessel may result in loss of signal despite the presence of good blood flow, and a tight sleeve or wire connection may kink or otherwise compromise the vessel's patency. Postoperatively, the patient is observed in the surgical ICU overnight and

transferred to the floor on the morning of the first postoperative day. Because the postoperative pain is similar to that with other perforator flaps and is significantly less than with a transverse rectus abdominis myocutaneous flap reconstruction [6], oral pain medications are given also beginning on postoperative day 1. The patient ambulates on postoperative day 2 and is discharged home on postoperative day 4. A second-stage revision and nipple creation are performed under local anesthesia with intravenous sedation in the operating room between 8 and 12 weeks after the initial surgery to further refine and finish the appearance of the breast. Any revisions at the donor site, such as dog ear removal or liposuction, are also performed at this time (Fig. 2).

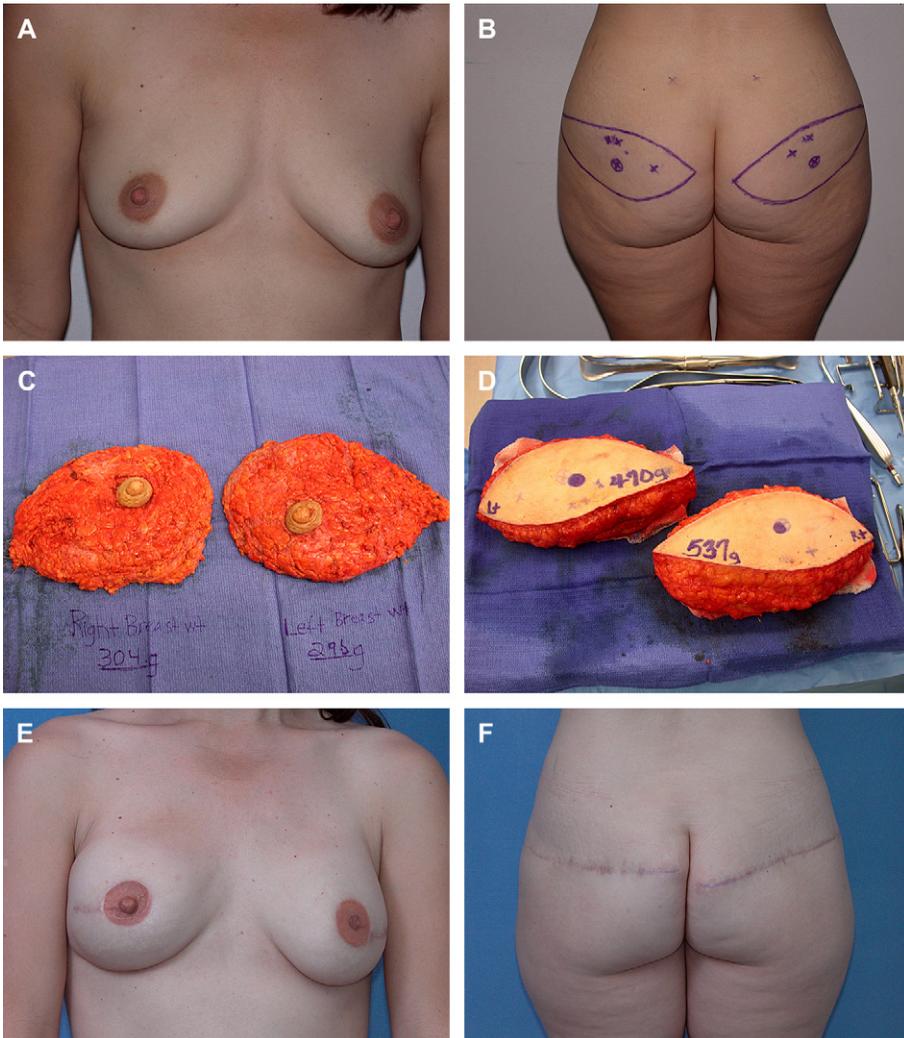


Fig. 2. A 35-year-old BRCA gene mutation carrier. (A, B) Preoperative views and markings. (C, D) Intraoperative view of bilateral prophylactic mastectomy specimen and SGAP. (E, F) Postoperative views.

Complications

In a review of 170 GAP flaps done by the senior author for breast reconstruction, the incidence of complications was low. The overall take-back rate was approximately 8% with 6% rate of vascular complication. The total flap failure rate was approximately 2%.

Donor site seroma occurred in 2% of patients, and approximately 4% of patients required revision of the donor site.

Inferior gluteal artery perforator flap

The technique of the SGAP flap was applied to the inferior gluteal vasculature in 1995. However, early in the experience with the IGAP flap, some patients developed temporary symptoms consistent with sciatic nerve irritation. The flap was believed to be inferior to the SGAP flap for many years. Changes in technique, with consideration of the location of the sciatic nerve, renewed the interest in this procedure.

Patient evaluation and selection

As for the SGAP, the IGAP flap is the better choice for patients who have inadequate tissue in the abdomen. For some patients who have excess tissue in the "saddlebag" area, an IGAP flap may be chosen over an SGAP flap to make use of this extra tissue and provide desirable body contouring. Many women who have excess buttock tissue will automatically point to the inferior buttock when asked where excess tissue might preferably be removed. 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 decubitus position, a hand-held Doppler probe is used to find the strongest perforator 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 approximately 8 × 18 cm, depending on the amount of skin needed and the amount of excess buttock tissue available.

Technique

A two-team approach is used with the patient in the lateral decubitus position and the ipsilateral chest wall and buttock prepped and draped. The ipsilateral arm and leg are prepped 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 made along the previously drawn marks, and bovie

electrocautery is used to divide the flap down to the muscle. The fat is bevelled 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. When harvesting the IGAP flap, care must be taken to preserve the lighter colored medial fat pad, which overlies the ischium. Preservation of the fat pad will prevent possible donor site discomfort when sitting. 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. The course of the IGA perforating vessel is more oblique through the substance of the gluteus maximus muscle than the course of the SGAPs, which tend to travel more directly to the superficial tissue up through the muscle. Thus, the length of the IGAP and the resultant pedicle length for the overlying IGAP flap are greater than that found with an SGAP. Because the skin island is placed inferior to the origin of the inferior gluteal vessels, a longer pedicle is also assured. 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 underlying skin paddle are seen traveling through the muscle substance in an oblique manner 4 to 6 cm before turning upwards 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 IGAP flap.

The distal extension of the inferior gluteal artery and vein can be transected to aid in the mobilization of the pedicle. Between two and four perforating vessels originating from the inferior gluteal artery will be located in the lower half of each gluteal muscle. Care must be taken to avoid injury to the posterior femoral cutaneous nerve of the thigh, which travels with the inferior gluteal vessels [7]. The sciatic nerve is usually not visualized. This results in a typical pedicle length of 8 to 11 cm, the arterial diameter greater than 2 mm, and the venous diameter 3 to 4 mm. This length allows for more leeway in orientating and inseting the flap and can make anastomosis easier. It also allows for reach to the thoracodorsal vessels if necessary. Once good recipient vessels are confirmed, the

pedicle is divided and the flap harvested. The buttock wound is closed in three layers over a suction drain with a resulting scar slightly lateral to the buttock crease. The patient is then returned to the supine position, and the microvascular anastomosis and the flap inset are performed in the same way as the SGAP breast reconstruction (Figs. 3 and 4).

Complications

In a series of 31 in the crease IGAP reconstructions, there was one flap loss due to venous thrombosis. Two more patients were returned to the operating room for successful treatment of venous insufficiency. These were both thought to be secondary to twisting or kinking of the flap vein and were probably inset-related. Two patients had wound breakdowns at the recipient site. Both patients

had undergone previous radiation therapy to the chest wall, and both eventually healed their wounds. No patients had complaints about discomfort on sitting position. The IGAP flap, like the SGAP flap, 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 the better choice for patients who have the tissue available.

The authors experience using the gluteal artery perforator flaps for patients who are not deep inferior epigastric perforator/superficial inferior epigastric artery candidates has been favorable. Until recently the vast majority of the buttock flaps have been harvested from the upper buttock and therefore based on the SGAPs. Over the past 12 years, the authors have occasionally designed the skin

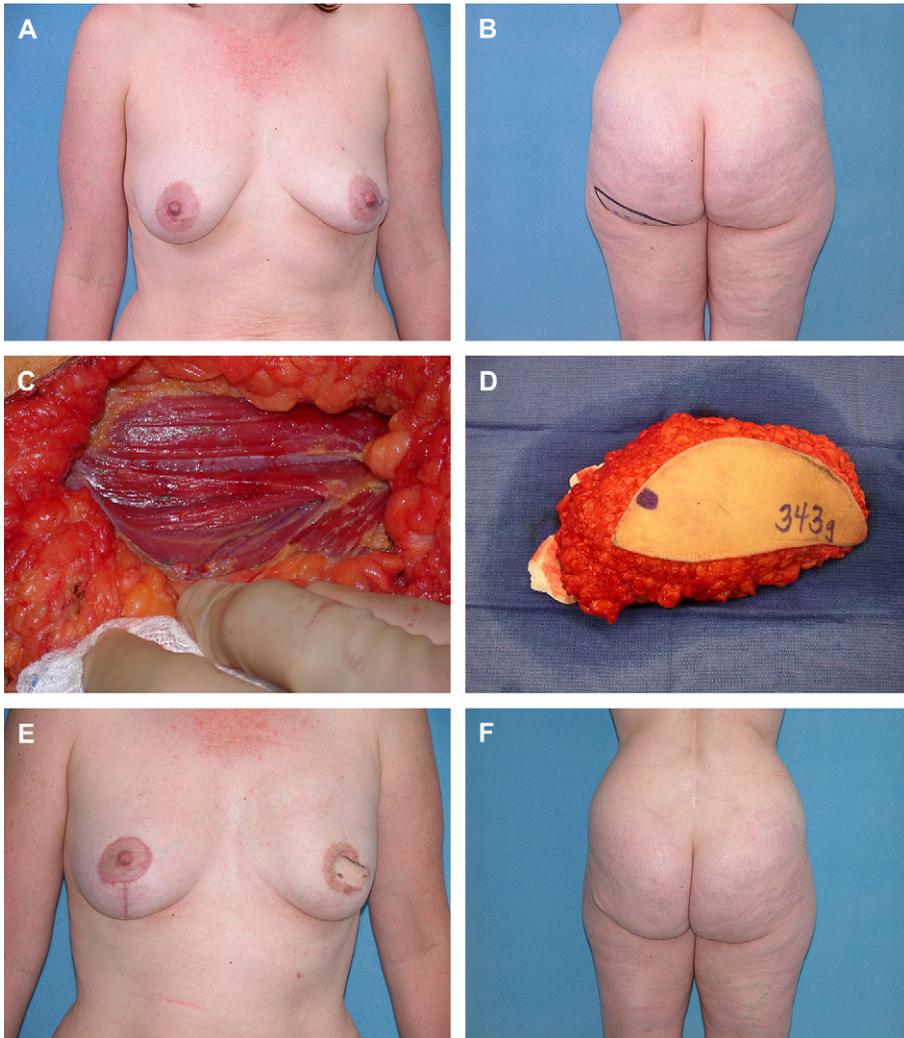


Fig. 3. A 42-year-old who has breast cancer with left areola sparing mastectomy. (A, B) Preoperative views and markings. (C, D) Intraoperative view of IGAP vessels and flap. (E, F) Postoperative views.

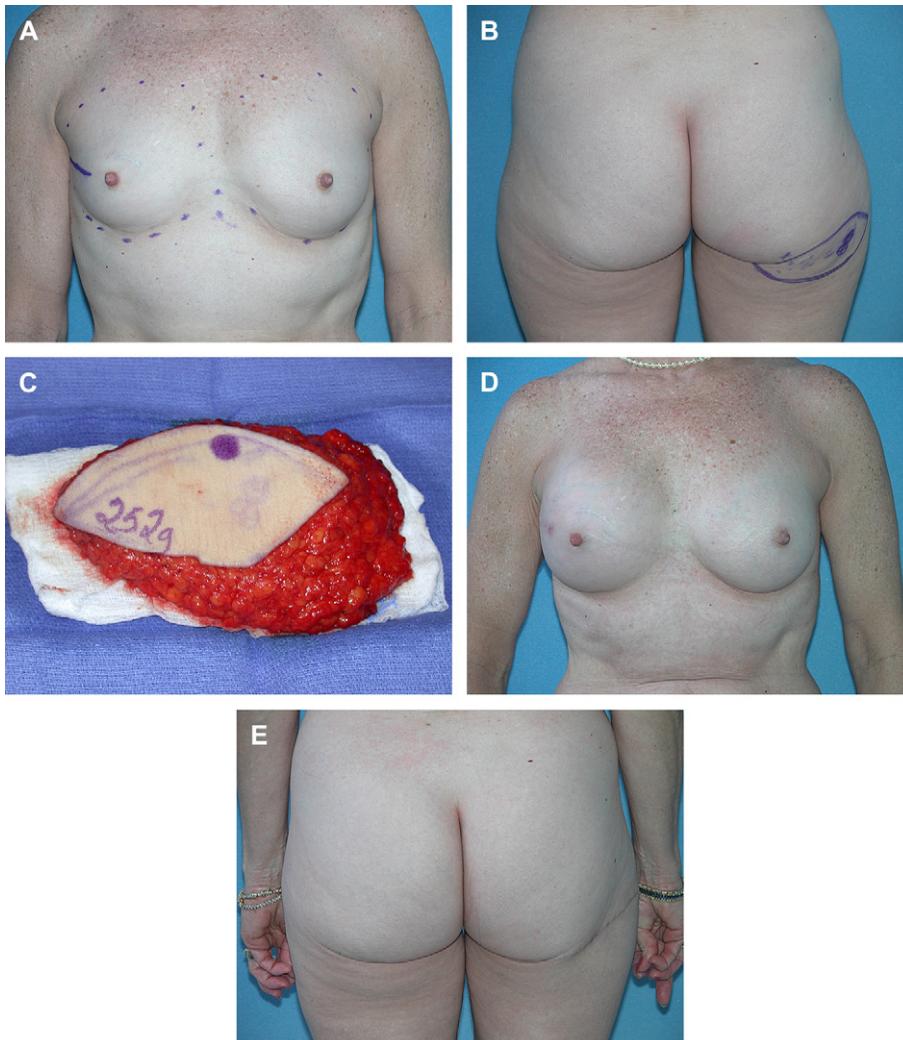


Fig. 4. A 52-year-old who has breast cancer with right mastectomy. (A, B) Preoperative views and markings of patient. (C) IGAP flap. (D, E) Postoperative views.

island slightly lower, according to the patient's anatomy or preference, and therefore used the IGAPs. The SGAP flaps have sometimes resulted in a depression at the donor site, which required revision [2]. The authors have used liposuction around the scar and autologous fat injection to fill the scar, depending on the patient's deficiency. The authors' experience with the in-the-crease IGAP donor site is that the donor site defect is more aesthetically favorable and less noticeable in the majority of patients. The aesthetic unit of the buttock is preserved, and the scar falls in the inferior gluteal crease [8,9]. The removal of tissue from the inferior buttock results in a tightened lifted appearance. Significant soft tissue depression at the donor site occurs less often and appears less noticeable than with the typical SGAP donor site. This results both

in an improved postoperative appearance and also allows a greater amount of bevelling and fat harvest with the flap in thin patients.

Summary

Overall SGAP and IGAP flaps allow reliable aesthetic reconstructions of the breast without the sacrifice of the muscle at the donor site. The buttock is an excellent choice as a donor site and can provide ample tissue in most patients. A significant amount of tissue may be harvested and, in the authors' experience, the average final inset weights of gluteal artery perforator flaps were slightly greater than weights of the mastectomy specimen removed. Patient satisfaction has been very high. Tissue may be transferred to replace tissue in a radiated field,

and long-term complications are almost nonexistent. In combination with the deep inferior epigastric perforator flap and superficial inferior epigastric artery flap, the plastic surgeon has a modern treatment plan available for the vast majority of patients who consult for breast reconstruction and is able to restore soft naturally shaped breasts with long-lasting results. The variety of donor sites allows most patients to be candidates for these procedures. Perforator flaps provide a superb option for autologous breast reconstruction.

References

- [1] Blondeel PN, Morris SF, Hallock GG, et al, editors. Perforator flaps: anatomy, technique, & clinical application vol. I, II. St. Louis (MO): Quality Medical Publishing; 2006. p. 37–52.
- [2] Allen RJ, Tucker C. Superior gluteal artery perforator free flap for breast reconstruction. *Plast Reconstr Surg* 1995;95:1207–12.
- [3] Guerra A, Metzinger S, Bidros R, et al. Breast reconstruction with gluteal artery perforator (GAP) flaps: a critical analysis of 142 cases. *Ann Plast Surg* 2004;52:118–25.
- [4] Rogers N, Allen R. Radiation effects on breast reconstruction with the deep inferior epigastric perforator flap. *Plast Reconstr Surg* 2002;109:1919–24.
- [5] Shaw WW. Breast reconstruction by superior gluteal microvascular free flaps without silicone implants. *Plast Reconstr Surg* 1983;72:490–501.
- [6] Kroll S, Sharma S, Koutz C, et al. Postoperative morphine requirements of free TRAM and DIEP flaps. *Plast Reconstr Surg* 2001;107:338–41.
- [7] Windhofer C, Brenner E, Moriggl B, et al. Relationship between the descending branch of the inferior gluteal artery and the posterior femoral cutaneous nerve applicable to flap surgery. *Surg Radiol Anat* 2002;24:253–7.
- [8] Babineaux K, Granzow JG, Bardin E, et al. Microvascular breast reconstruction using buttock tissue: the preferred scar location and shape. *Plast Reconstr Surg* 2005;116:174–6.
- [9] Boustred MA, Nahai F. Inferior gluteal free flap breast reconstruction. *Clin Plast Surg* 1998;25:275–82.