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Review

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Autologous augmentation of contralateral native breast in conjunction with unilateral abdominal-based free flap breast reconstruction: case series and literature review

Sherry Y. Q. Tang, Theodore A. Kung, Adeyiza O. Momoh

Section of Plastic Surgery, Department of Surgery, University of Michigan, Ann Arbor, MI 48109-5340, USA.

Correspondence to: Dr. Adeyiza O. Momoh, Section of Plastic Surgery, Department of Surgery, University of Michigan, 1500 E. Medical Center Drive, 2130 Taubman Center, Ann Arbor, MI 48109-5340, USA. E-mail: amomoh@med.umich.edu

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Abstract

In autologous breast reconstruction, the deep inferior epigastric perforator (DIEP) flap is the most commonly used. For patients undergoing unilateral breast reconstruction who desire augmentation of the contralateral breast but wish to avoid using implants, augmentation of the contralateral breast using DIEP flaps is a reliable option. Preoperative evaluation requires assessing the patient's desired outcome and the amount of abdominal tissue available. CT angiography (CTA) helps facilitate the evaluation of abdominal perforator anatomy and the estimation of flap volumes for simultaneous reconstruction and contralateral augmentation. Flap design takes into consideration the perforators needed for a large flap for the primary reconstruction and the length of the pedicle needed to access contralateral recipient vessels for a smaller flap for augmentation. One set of recipient vessels [internal mammary artery (IMA)/internal mammary vein (IMV)] are used with antegrade anastomoses performed for primary reconstruction flaps and retrograde anastomoses for flaps used in augmentation. Augmentation flaps can be completely buried or include a skin paddle for monitoring. Subsequent secondary procedures are often needed to achieve the desired final breast shape and symmetry. Overall, patients who have undergone unilateral autologous breast reconstruction with simultaneous contralateral autologous augmentation report high levels of satisfaction postoperatively.

Keywords: Breast reconstruction, autologous augmentation, DIEP

INTRODUCTION

Over 150,000 women in the United States undergo breast reconstruction procedures each year[1]. Of these women, approximately 20% undergo reconstruction using autologous tissue[1]. The deep inferior epigastric perforator (DIEP) flap is the most commonly used flap for autologous breast reconstruction. Patients undergoing unilateral breast reconstruction who desire a larger post-reconstruction breast size may seek augmentation of the contralateral breast. Contralateral augmentations are traditionally achieved using implant-based techniques. However, in select patients who wish to avoid using implants for a variety of reasons including the possible need for replacement in the future and implant-specific complications, augmentation of the contralateral breast using autologous tissue is an effective and reliable option.

CLINICAL CONSIDERATIONS

The preoperative evaluation of patients considering breast reconstruction includes a detailed and thorough history[2]. The timing of breast reconstruction, immediate or delayed, and patient preference should be considered and discussed. Any adjuvant breast cancer therapies should be discussed, particularly the need for postoperative radiation. A critical part of the consultation involves understanding the patient's desired outcome following breast reconstruction, including the desired post-reconstruction breast size and preferences related to the use of implants or autologous tissue. Specifically, for patients undergoing unilateral mastectomy and unilateral reconstruction, future procedures for the contralateral breast designed to achieve symmetry should be reviewed. Typical options include fat grafting, mastopexy, breast reduction, and breast augmentation. For patients who desire autologous reconstruction and a larger post-reconstruction breast size but want to avoid breast implants, unilateral autologous reconstruction in conjunction with contralateral augmentation with abdominal-based free flaps should be considered. While procedures for the contralateral breast are typically performed at a secondary operation after the initial breast reconstruction operation, autologous augmentation of the contralateral breast is performed at the same time as the first stage operation. However, there are a few factors that may preclude a patient from immediate unilateral reconstruction with contralateral autologous augmentation. First, patients with significant comorbidities may not be ideal candidates, given the additional operating time involved in performing a contralateral autologous augmentation. Second, patients needing post-mastectomy radiation or requiring wise-pattern mastectomy may be better served by undergoing staged tissue expander placement at the time of mastectomy, followed by delayed autologous reconstruction and contralateral autologous augmentation.

Breast shape, size, asymmetry, degree of ptosis, nipple position, skin envelope quality, and the presence of scars should be assessed. The abdominal exam should document the amount of infra-umbilical abdominal adipose tissue, skin laxity, the presence of scars, and the presence of any compromise of the abdominal wall integrity (e.g., hernias). The amount of abdominal tissue present should be considered in the context of the patient's desired reconstructed breast size to determine whether the patient is a good candidate for autologous augmentation of the contralateral breast. For example, thin patients who lack sufficient abdominal tissue may not be candidates for autologous augmentation as both abdominal pedicles may be needed to utilize the entire lower abdominal tissue for a stacked or bipedicled flap reconstruction to match the volume of the native breast. In contrast, though donor site soft tissue limitations are less of an issue in patients with higher BMIs and ample soft tissue, the potential increase in postoperative flap and donor site complications should not be overlooked. The standard approach to autologous breast reconstruction indicates that the presence of scars on the abdomen may preclude the use of abdominal-based flaps[3]. However, in our experience, autologous augmentation is still feasible in most of these patients. For example, if a patient has a large open appendectomy scar on the right hemiabdomen, it is possible to use the left

abdominal flap for the reconstructive breast and a smaller right abdominal flap based on medial row perforators for the augmented breast. In patients considering delayed unilateral reconstruction and contralateral autologous augmentation, we typically do not use the mastectomy weight directly to determine the size of the flaps. While mastectomy weight can serve as a benchmark for the size of the breast prior to mastectomy, that information is sometimes not available with mastectomies performed at other institutions. We find that the sizes of the reconstructive and augmentation flaps can be determined based on CT scans and intraoperative assessments. These considerations are limited by the amount of donor abdominal tissue available.

Alternative autologous free flaps for breast reconstruction have a shorter pedicle [e.g., profunda artery perforator (PAP) or superior gluteal artery perforator (SGAP) flaps] and, for this reason, have not been used for autologous augmentation in our practice. However, vein grafts could be used to achieve sufficient pedicle length for the augmentation side to reach across the chest for anastomosis. In addition to free tissue transfer, autologous augmentation of the contralateral breast can also be achieved using loco-regional flaps, such as lateral intercostal artery perforator (ICAP) flaps, which are usually performed in a delayed fashion. In patients who require only a small volume for autologous augmentation of the contralateral breast, delayed fat grafting is also a good alternative, though with less reliability for volume retention and should be discussed with the patient. Whether patients choose to undergo autologous augmentation with fat grafting, loco-regional flap, or a free flap is based on personal preference and an adequate amount of fat at donor sites for fat grafting.

Potential complications are discussed with patients preoperatively. Specifically, for autologous augmentation of the contralateral breast, there can be increased risks associated with increased operative time, especially in patients with significant comorbidities. The risk of vascular compromise and flap failure is also higher, given the need to place the pedicle of the augmentation flap in a long subcutaneous tunnel. Additionally, patients are counseled that routine breast cancer screening is needed.

PREOPERATIVE IMAGING AND PLANNING

The goal of preoperative imaging for patients undergoing unilateral reconstruction with contralateral augmentation is to (1) determine the bilateral abdominal perforator anatomy based on the deep inferior epigastric system; and (2) estimate the flap volume for the autologous reconstruction and the contralateral augmentation [Figure 1]. CT angiography (CTA) for preoperative planning in abdominal-based flaps for autologous breast reconstruction is a well-established way to identify perforators and delineate the vascular anatomy preoperatively. Alternative imaging modalities, such as Vectra, that reduce additional radiation could also be considered, but this is currently not used at our institution. At our institution, preoperative CTA of the abdomen and pelvis is performed for all patients scheduled for abdominal-based autologous breast reconstruction. CTA of the chest can also be used to evaluate the quality of the internal mammary vessels, though this is not routinely done at our institution. In patients for whom autologous augmentation is planned, a CT of the chest can be used to assess the volume of the native breast. Mapping of the perforators enables the surgeon to decide which side of the abdomen should provide the larger flap for mastectomy reconstruction and the smaller flap for contralateral augmentation[4]. From the CT images, perforators are identified and their locations are measured relative to the umbilicus[4]. Working closely with the radiologist, the locations of the perforators can be superimposed on a volume-rendered (VR) image of the patient's abdominal soft tissue[4]. Using VR images based on the chest CT, the volume of the native breast tissue is also estimated. Lastly, depending on the desired breast size, the estimated volume of the mastectomy reconstruction and the augmentation flap are calculated to optimize volume symmetry and the margins of the intended flaps are delineated on the VR image [Figure 2][4]. In contrast to patients

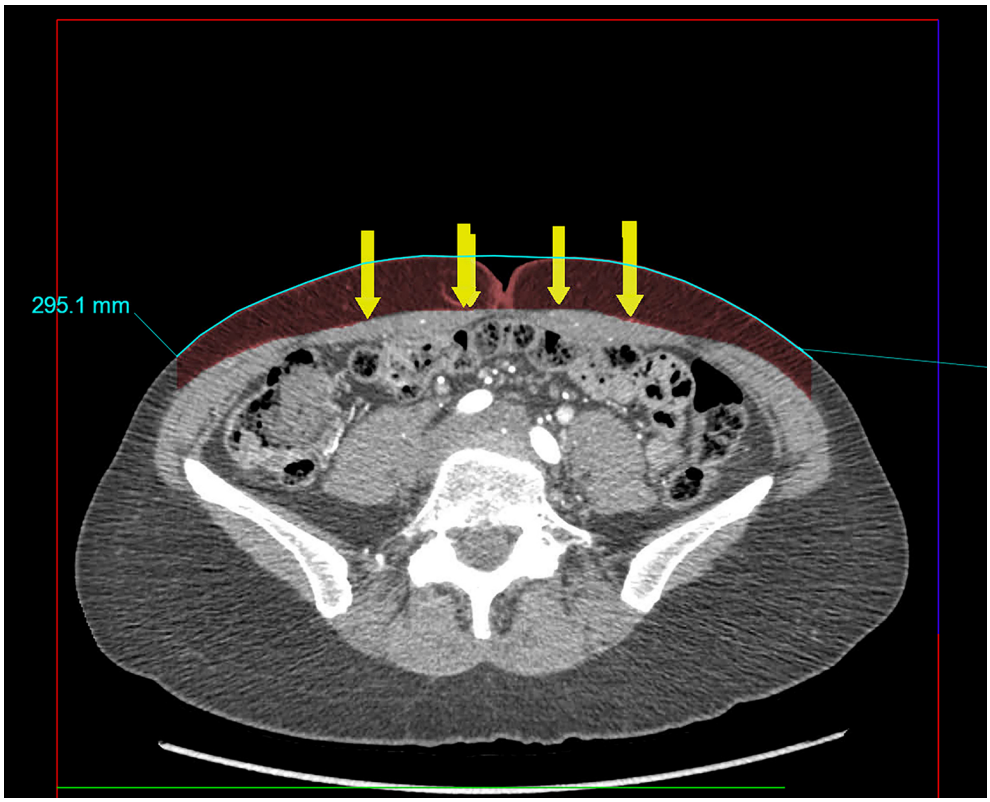

Figure 1. Axial section of abdominal CT with arrows indicating perforator locations and color rendering defining the surface area and depth of tissue to be harvested. This information from all sections of the CT is used to calculate the volume of tissue available for reconstruction/augmentation.

undergoing cosmetic breast augmentation, preoperative sizing is not performed for patients undergoing autologous augmentation. This is because the size of the augmented breast is either defined by the preop imaging or determined intraoperatively by the size of the reconstructed breast for symmetry, which can be limited by the amount of abdominal tissue available. Furthermore, no compensations to the volume of the reconstructive flap and the augmentation flap are typically made in case there is flap failure resulting in loss of volume, because the degree of asymmetry following flap loss cannot be accurately predicted preoperatively. Any volume differences are typically addressed at secondary revision surgeries.

RELEVANT VASCULAR ANATOMY

In patients undergoing unilateral breast reconstruction and contralateral autologous augmentation with DIEP flaps, the following are important considerations relating to vascular anatomy: (1) the number of perforators needed for the reconstructive and augmentation flap; and (2) the length of pedicle needed to cross midline for the augmentation flap. It is generally believed that medial row perforators can provide perfusion across the abdominal midline, whereas lateral row perforators do not reliably perfuse across the midline but can be sufficient for flaps encompassing the ipsilateral abdomen[5]. For patients wanting a larger reconstructed breast after mastectomy, the flap used typically needs to cross the midline to achieve the desired volume. This flap can often be based on ipsilateral medial row perforators[5]. Lateral row perforators are also an option when necessary to augment perfusion and should be considered when the medial row blood supply is in question. Intraoperative indocyanine green perfusion studies are helpful in selecting the appropriate number and location of perforators.

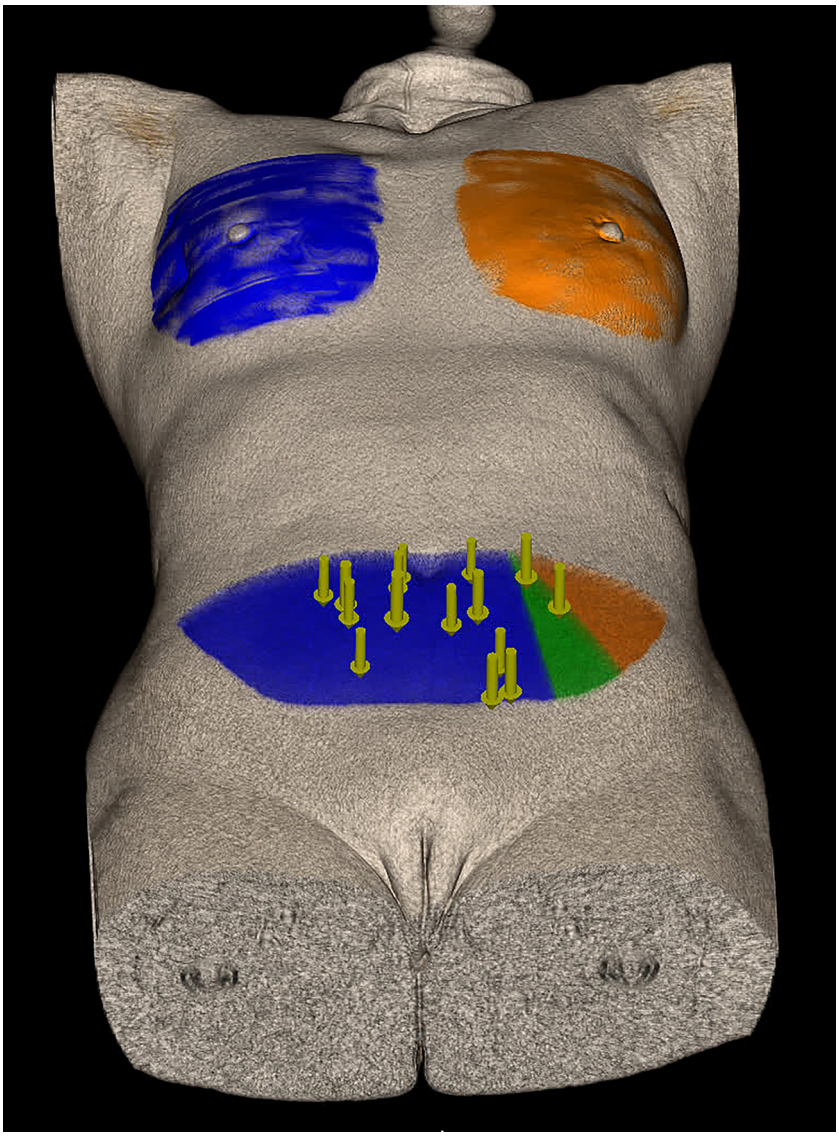

Figure 2. Volume Rendering of breasts and abdominal flaps (blue corresponds to the breast/flap for reconstruction and yellow the breast/flap for the augmentation) with superimposed perforators and the recommended location for flap division.

Conventionally, we prefer to use the contralateral abdominal flap for the reconstructive breast. It is also feasible to use the ipsilateral abdomen if the perforators on the ipsilateral side are easier to harvest and have an anatomic configuration that better minimizes injury to the rectus abdominus muscle. The flaps used for augmentation in these patients are typically smaller and can be supplied by lateral row perforators. Typically, only a single perforator may be needed given the smaller size of the flap and this will also optimize the length of the pedicle in order to be passed through a subcutaneous tissue over the sternum and allow for a tension-free anastomosis to the recipient vessels. Often, a high lateral perforator can be used to supply the augmentation DIEP and the resultant pedicle length can be around 15 cm. If lateral row perforators are not present, consideration can be given to harvest of a superficial inferior epigastric artery (SIEA) flap or superficial circumflex iliac artery perforator (SCIP) flap[6]; the utility of these flaps would be dependent on pedicle length given the need to cross over to the contralateral chest recipient vessels.

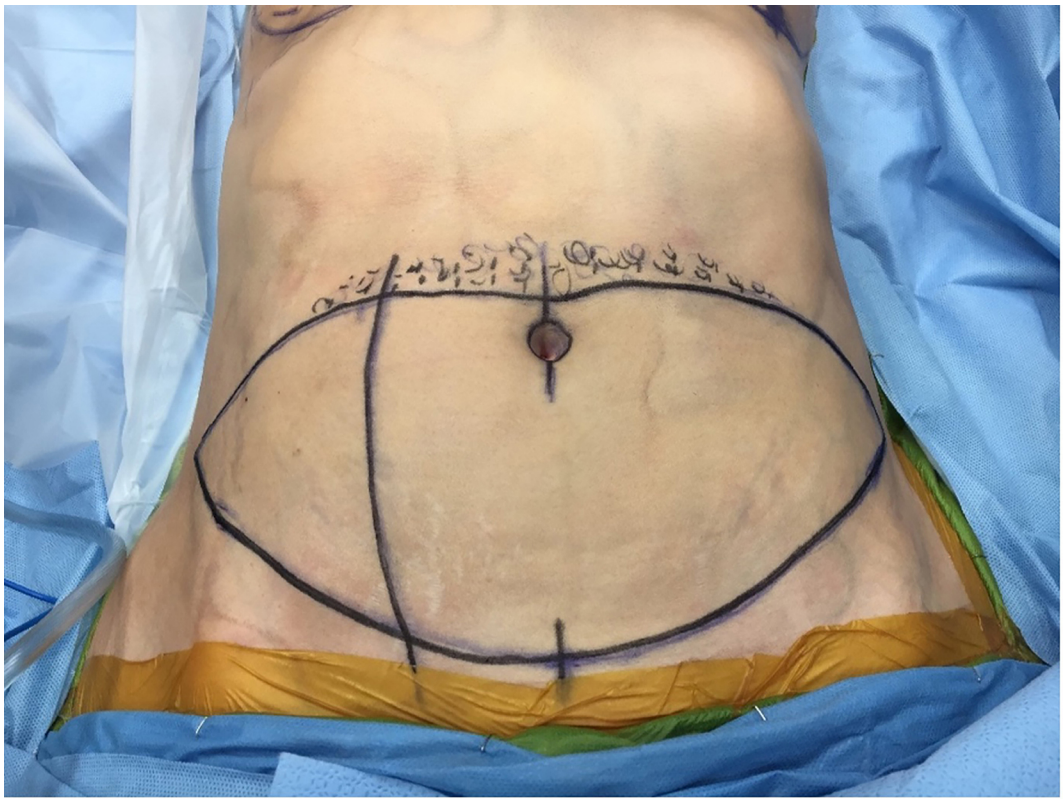

Figure 3. Flap marking includes a vertical line indicating the planned divide between the larger and the small flaps based on preoperative CT scans/volumetric analysis.

OPERATIVE TECHNIQUE

Positioning and preparation

The patient is positioned supine with arms abducted. The bed is typically turned 180 degrees to allow simultaneous access to the chest and abdomen for the surgical teams. The patient is prepped in the standard fashion from the neck down to the suprapubic region.

Flap design and elevation

Standard marking for DIEP flap surgery is marked out over the abdomen, ensuring the capture of the major perforators shown on the preoperative CTA. A vertical line is marked, indicating the planned divide between the two flaps and is based on the ideal position for dividing the flaps based on preoperative CT scans/volumetric analysis [Figure 3]. Incisions are made and standard DIEP flap elevation from lateral to medial is performed. The superficial inferior epigastric veins (SIEV) are preserved.

Typically, flaps of different weights are used and division is performed based on the previously defined location of the left or right hemiabdomen, determined by the volume needed for each breast [Figures 4 and 5]. Perfusion zones of the flaps can be assessed through physical exam or laser angiography. Once perforator selection is established, intramuscular dissection through the rectus abdominus muscle and down to the deep inferior epigastric vessels deep to the muscles is performed. The pedicle for the augmentation flap may need to be dissected all the way down to the external iliac vessels to maximize the length for the anastomosis.

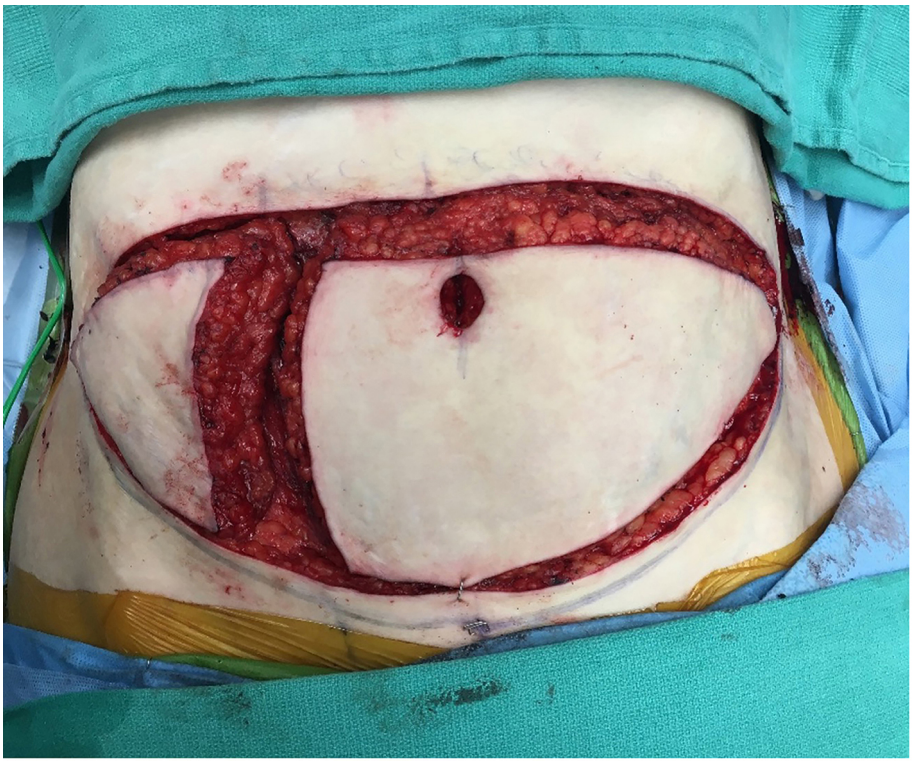

Figure 4. Flaps of different weights are used for reconstruction and augmentation.

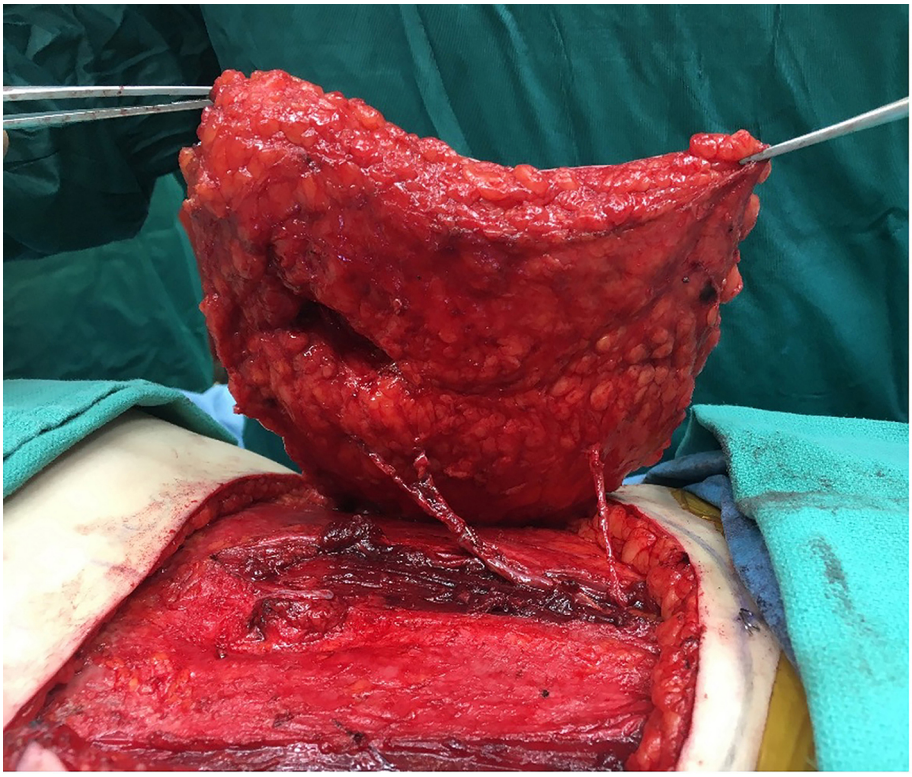

Figure 5. The larger flap used for reconstruction is based on the ipsilateral medial row perforators.

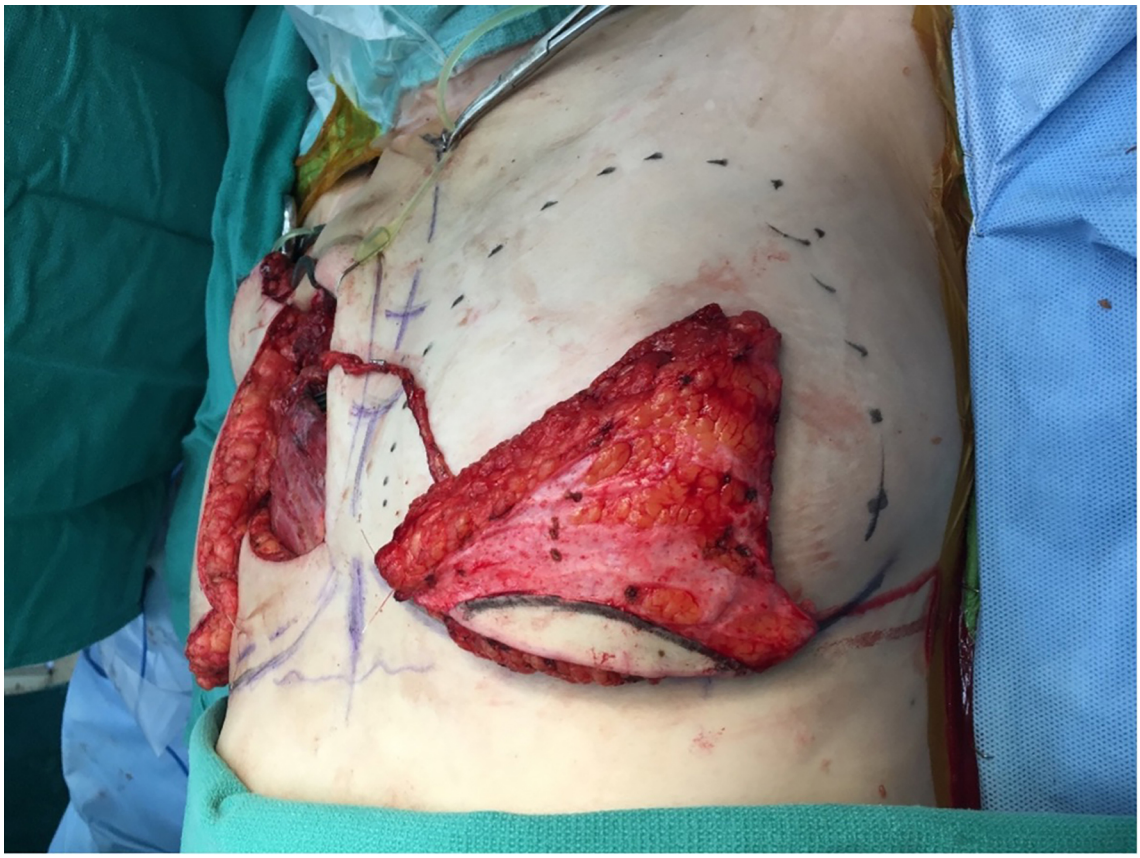

Figure 6. The pedicle of the smaller flap is advanced into the contralateral chest wall through subcutaneous tissue over the sternum.

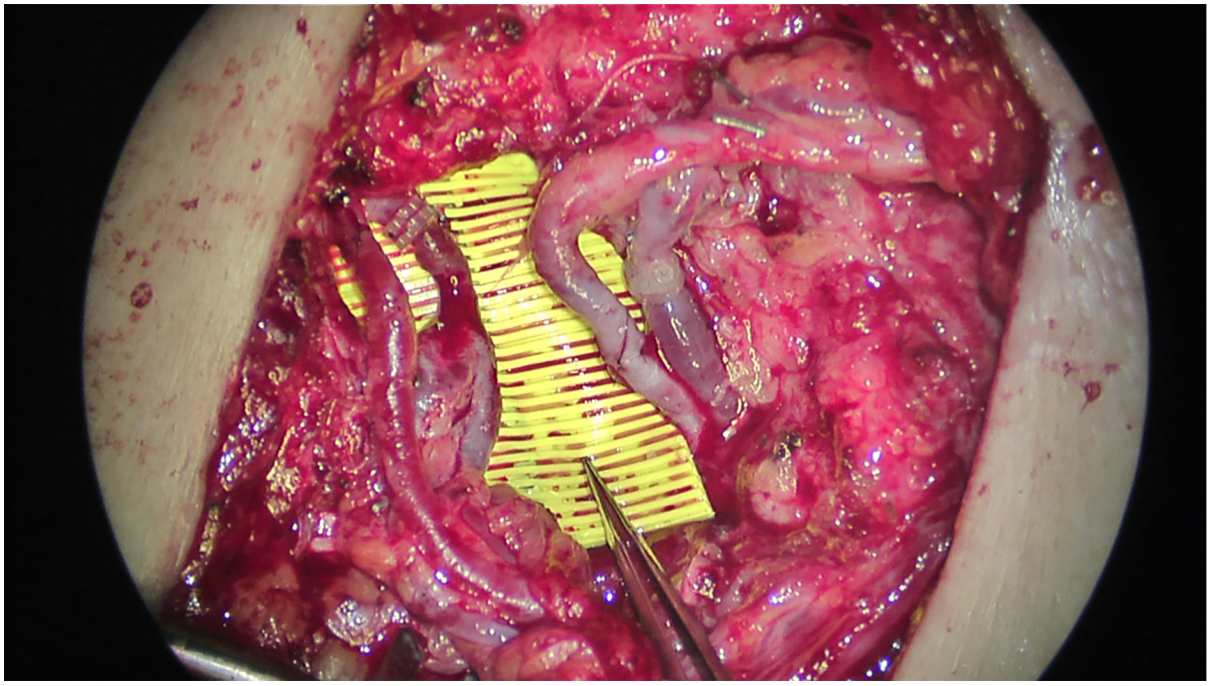

Figure 7. The larger flap vessels are anastomosed to the anterograde internal mammary vessels (vessels on the left). The smaller flap vessels are anastomosed to the retrograde internal mammary vessels (vessels on the right).

Recipient site preparation

The use of the antegrade and retrograde internal mammary vessels on the side of the mastectomy allows for the perfusion of two flaps used for both breasts. Exposure of the internal mammary vessels is performed in a routine fashion, with excision of the third or fourth rib cartilage. To maximize the recipient vessel exposure for two sets of anastomoses, soft tissue resection of the intercostal muscles typically extends from the rib superior to the excised cartilage to the rib below. For the planned augmentation, a subglandular pocket is created for the flap through an inframammary fold (IMF) incision. The IMF incision needs to be long enough to accommodate the volume of the flap. Once the subgladular pocket is created, a tunnel measuring approximately 5 cm wide is then created over the sternum connecting the subgladular pocket to the contralateral mastectomy defect. This limited subcutaneous tunnel is wide enough to allow for the passage of the pedicles, while limiting the risk of symmastia[7,8].

Microvascular anastomosis

We typically perform the anastomosis of the larger flap first. The flap is harvested by dividing the deep inferior epigastric artery and vein. The flap is then weighed and flushed with heparinized saline from the arterial end. Under magnification from an operative microscope, the internal mammary artery (IMA) and vein (IMV) are divided. The anterograde side of the recipient vessels is divided proximally, leaving the rest of the retrograde recipient vessels as long as possible for the contralateral flap. The larger flap (used for the mastectomy reconstruction) is first anastomosed in an end-to-end fashion to the antegrade vessels; arteries are hand-sewn and veins are coupled.

The smaller flap for augmentation is then harvested and prepped in the same manner as the larger flap. Of note, the flap should be oriented on the chest in such a way that the pedicle, often a single perforator, is located as medial as possible to maximize reach for anastomosis to the contralateral chest recipient site. Afterwards, the flap is de-skinned, and occasionally, a thin skin paddle is preserved at the IMF for flap monitoring. A lighted retractor is helpful when advancing the flap and pedicle into the subglandular pocket. The flap vessels are placed into a one-inch penrose drain and carefully guided into the subcutaneous tunnel over the sternum [Figure 6][4]. Under direct visualization, the flap vessels are positioned into the subcutaneous tunnel, ensuring that they are not kinked or twisted to reduce the risk of vascular compromise[7]. The augmentation flap is carefully advanced into the subglandular pocket. The flap vessels are then anastomosed to the retrograde internal mammary vessels [Figure 7]. In our experience, the retrograde internal mammary vessels have reliable and sufficient blood flow to perfuse the augmentation flap, since the flap is typically small and the internal mammary artery is a high-flow system[8]. In addition, using the retrograde internal mammary vessels avoids the need for additional dissection through the costal cartilages on the augmentation side and allows for a relatively short incision along the inframammary fold. If the retrograde internal mammary vessels are noted to be injured or found to be insufficient for perfusion of the augmented flap, consideration can be given to using alternative recipient vessels, such as the long thoracic vessels or the thoracoacromial vessels; our priority is ultimately a successful breast reconstruction, and as such if the augmentation is not possible based on the vasculature, that portion of the procedure does not have to be done (patients are counseled about this possibility preoperatively). The authors prefer to use an implantable venous Doppler (Synovis GEM FlowCoupler), particularly when a flap is completely buried without any skin paddle.

Flap inset and closure

The flaps are secured onto the chest wall using dissolvable sutures and drains are placed in both breasts. Inset of the buried flap for the augmentation side can be performed with [Figure 8] or without a skin paddle inset at the IMF. When present, the skin paddle can easily be excised during a secondary revision procedure.

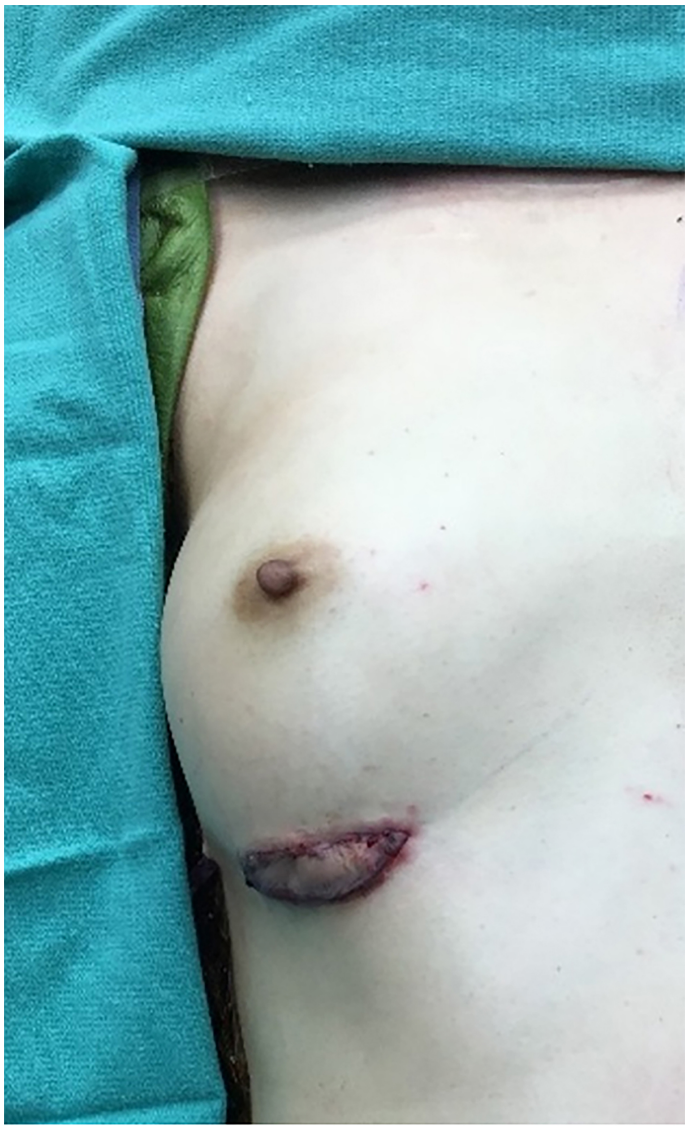

Figure 8. Inset of the smaller flap can include a small skin paddle along the inframammary fold for flap monitoring.

Case examples

Patient 1 [Figure 9]: 58 year old female with history of left breast cancer s/p left mastectomy and postmastectomy radiation. She underwent delayed left breast reconstruction and autologous contralateral augmentation with DIEP flaps. The right abdominal flap (484 grams) was used to reconstruct the left breast. The left abdominal flap (173.5 grams) was used to augment the right breast.

Patient 2 [Figure 10]: 53-year-old female with a history of right breast cancer s/p right mastectomy. She underwent delayed right breast reconstruction and left autologous augmentation with DIEP flaps. The left abdominal flap (126 g) was used for autologous augmentation of the left breast. The right abdominal flap (263 g) was used to reconstruct the right breast.

Patient 3 [Figure 11]: 53-year-old female with a history of right breast cancer status post right mastectomy and radiation. She underwent delayed right breast reconstruction and contralateral breast autologous

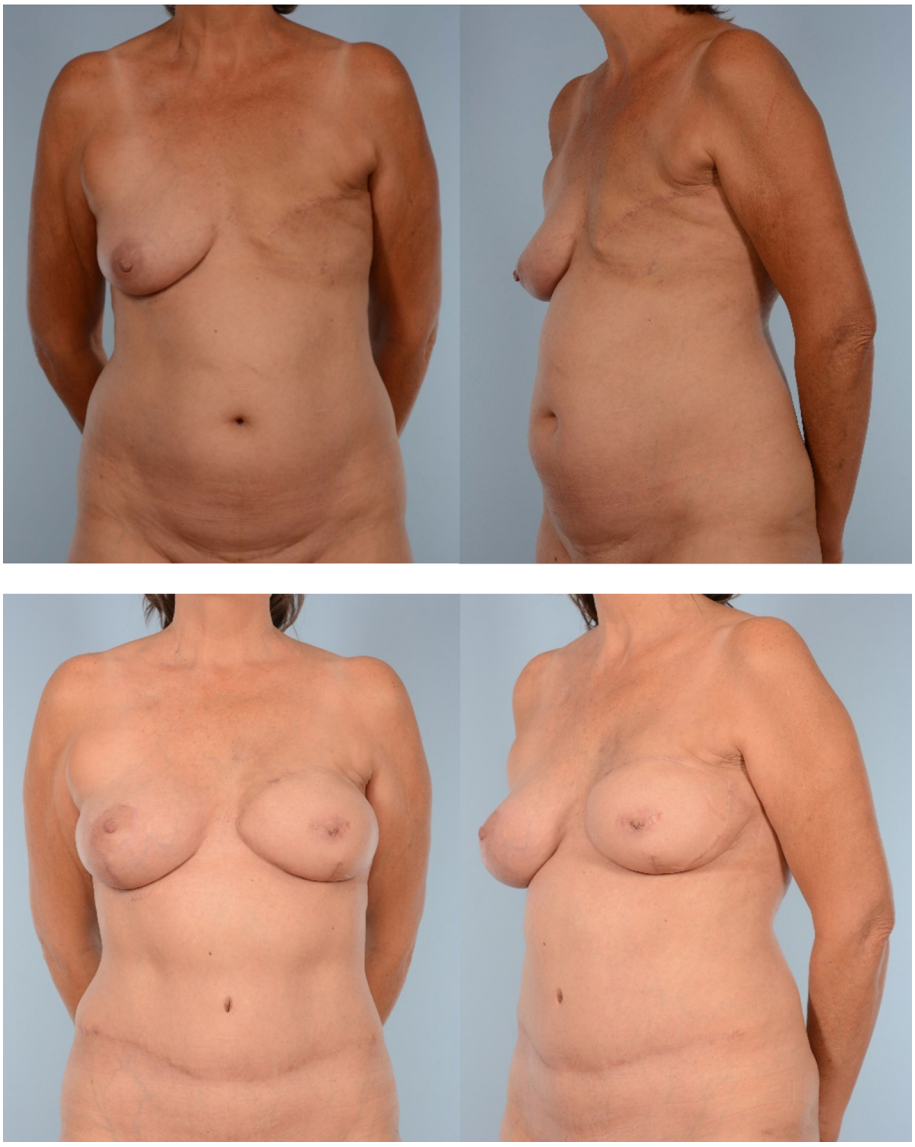

Figure 9. Preoperative (top) and postoperative (bottom) photographs of a 58 year old female who underwent delayed left breast reconstruction and autologous contralateral augmentation with DIEP flaps. The right abdominal flap (484 grams) was used to reconstruct the left breast. The left abdominal flap (173.5 grams) was used to augment the right breast.

augmentation with DIEP flaps. The left abdominal flap (1,020 g) was used to reconstruct the right breast. The right abdominal flap (383 g) was used for autologous augmentation of the left breast.

POSTOPERATIVE CONSIDERATIONS

Postoperatively, patients typically require an inpatient stay of three days on average. In addition to clinical exam, flap monitoring is typically performed using pencil Doppler, implantable venous Doppler, or non-invasive tissue oximetry, depending on the surgeon's preference. If a buried flap without a skin paddle is used for augmentation, implantable venous Dopplers are the preferred method for monitoring. One implantable venous Doppler is used for the reconstructive flap and the other is used for the augmentation flap. The wires for both Dopplers will exit on the side of the mastectomy reconstruction. Flap checks should be performed by applying gentle pressure to the flaps to confirm augmentation of the venous signal. It is

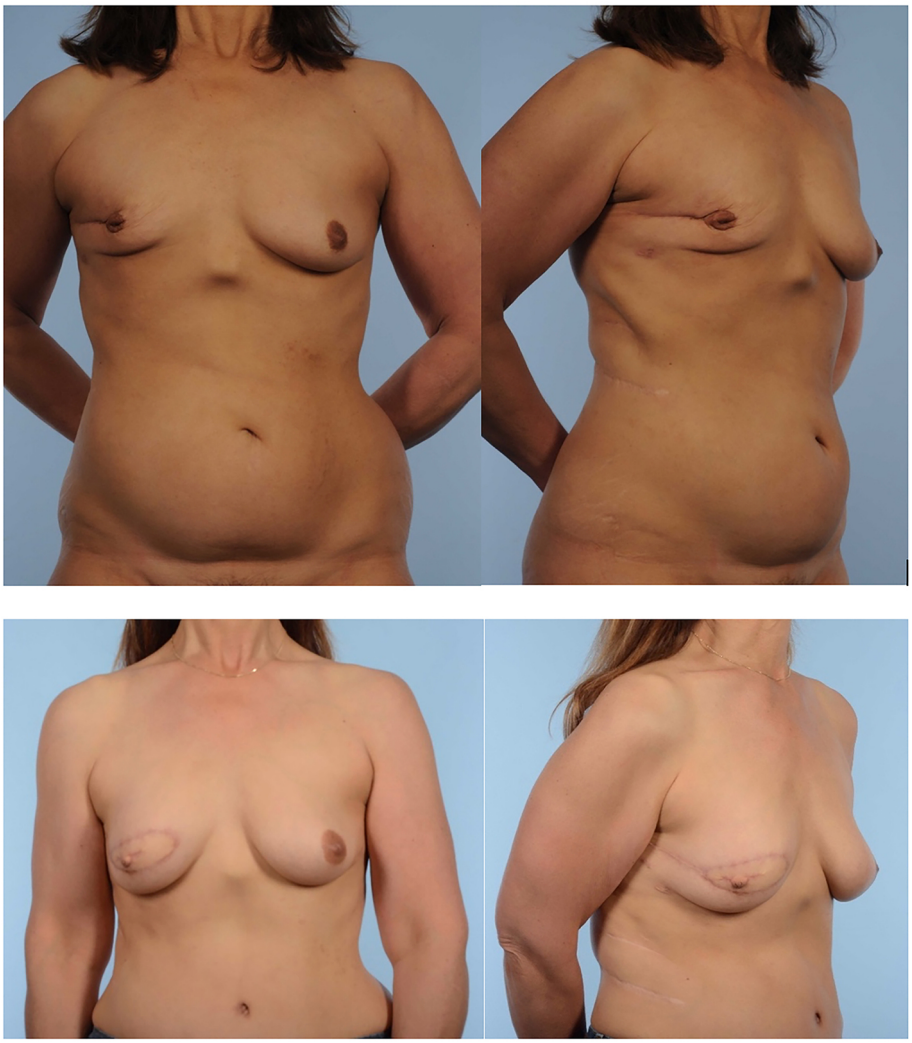

Figure 10. Preoperative (top) and postoperative (bottom) photographs of a 53-year-old female who underwent delayed right breast reconstruction and left autologous augmentation with DIEP flaps. The left abdominal flap (126 g) was used for autologous augmentation of the left breast. The right abdominal flap (263 g) was used to reconstruct the right breast.

important to be aware that the sound of the venous flow in the retrograde vessel is different from that of the anterograde vessel. If a small skin paddle is included on the augmentation flap, the use of non-invasive tissue oximetry may not be ideal because it may be difficult to secure the probe onto the skin paddle and can obscure the skin paddle, making it difficult to check capillary refill and flap color. Furthermore, the small skin paddle can be prone to appearing congested despite adequate venous drainage to the flap as a whole. The subcutaneous tunnel for the pedicle of the augmentation flap can be a potential site compression leading to an increased risk of vascular complications, so care is taken to ensure that there is no external pressure placed over the sternum. Venous thromboembolism (VTE) prophylaxis is used while patients are admitted and is continued for a total of two weeks postoperatively[9]. Activity restrictions are maintained for 6 weeks after surgery.

Most patients undergoing unilateral reconstruction with abdominally based free flap and contralateral autologous augmentation will require revisional secondary surgeries to achieve their desired final breast shape and size. These revisional surgeries commonly include scar revisions, fat grafting, liposuction, and

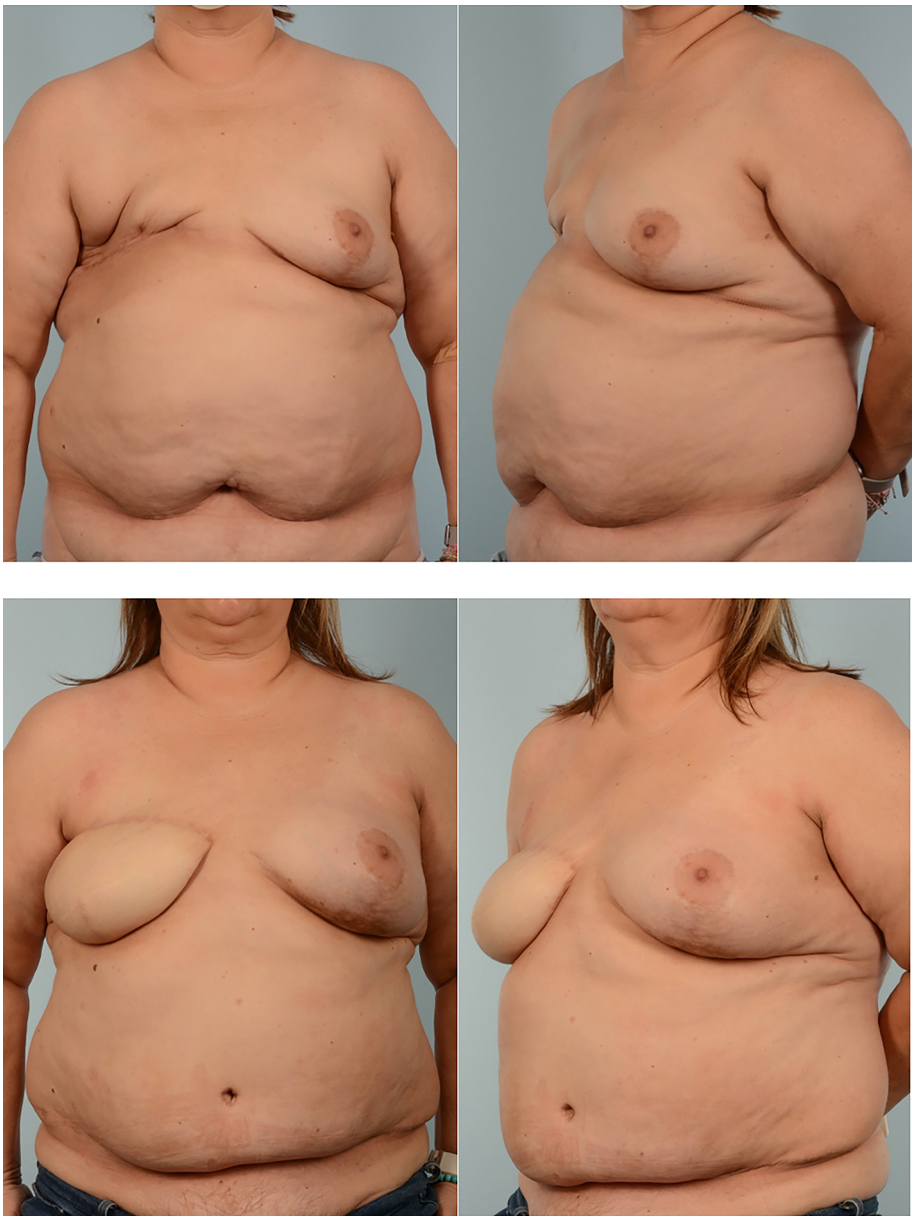

Figure 11. Preoperative (top) and postoperative (bottom) photographs of a 53-year-old female who underwent delayed right breast reconstruction and contralateral breast autologous augmentation with DIEP flaps. The left abdominal flap (1,020 g) was used to reconstruct the right breast. The right abdominal flap (383 g) was used for autologous augmentation of the left breast.

mastopexy. Some patients also elect to pursue nipple reconstruction and tattooing.

CLINICAL OUTCOMES

Patients who have undergone unilateral autologous breast reconstruction with simultaneous contralateral autologous augmentation report high levels of satisfaction with their breast, physical well-being, and sexual well-being postoperatively based on BREAST-Q[4,10]. Though reports in the literature on this technique are limited, complications seem to be similar to what would be expected for routine unilateral or bilateral breast reconstructions with DIEP flaps[4,10]. Based on our experience with 14 patients who have undergone unilateral breast reconstruction with contralateral augmentation with DIEP flaps, all flaps were successfully

transferred except for one patient who had delayed necrosis of the augmentation flap requiring debridement at two months postoperatively. In addition, we found one case of abdominal donor site infection that was treated with oral antibiotics, one case of a hematoma on the augmentation side requiring surgical washout, one case of a hematoma on the reconstructive side that did not require operative intervention, and one patient with delayed wound healing of bilateral breasts and abdominal donor site. Reports in the literature on DIEP flaps have indicated an increased risk of abdominal bulge and hernia with the use of lateral row perforators[11]. Complications relating to post-mastectomy radiation can be detrimental from a reconstructive standpoint, causing loss of volume, distortion of the reconstructed breast shape, and tightening of the skin envelope. Thus, for patients with any possibility of needing post-mastectomy radiation, we recommend tissue expander placement at the time of mastectomy and pursue reconstruction in a delayed fashion at least six months following completion of radiation.

SUMMARY WITH SOME KEY POINTS

In select patients undergoing unilateral mastectomy and autologous breast reconstruction who desire augmentation of the contralateral breast, unilateral breast reconstruction with contralateral augmentation can be safely and reliably achieved with DIEP flaps. This technique is ideal for patients who desire to avoid implants and who have adequate lower abdominal tissue.

Preoperative planning with CTA is helpful for mapping out the course of the perforators, calculating the anticipated volume of the reconstructed and the augmented breast, and designing the anticipated divide between the larger flap for reconstruction and the smaller flap for augmentation. Perforator selection is based on the volume needed for each flap, length of pedicle required, location of perforators, and ease of perforator dissection to minimize abdominal morbidity. Augmentation flaps can be completely buried in the subangular plane or include a small skin paddle for monitoring which can be excised at a secondary procedure. Overall, unilateral breast reconstruction with contralateral autologous augmentation is associated with high levels of patient satisfaction.

DECLARATIONS

Authors' contributions

Contributed to the writing of the manuscript: Tang SYQ
Contributed to the clinical cases and the writing of the manuscript: Kung TA, Momoh AO

Availability of data and materials

Not applicable.

Financial support and sponsorship

None.

Conflicts of interest

All authors declared that there are no conflicts of interest.

Ethical approval and consent to participate

Approval by the review board is not applicable. Written informed consent for participation was obtained from all subjects.

Consent for publication

Written informed consent was obtained from patients for publication.

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