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Review

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Modern approaches to alternative flap-based breast reconstruction: stacked deep inferior epigastric perforator flaps

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Abstract

Autologous breast reconstruction has greatly evolved with the introduction of stacked deep inferior epigastric perforator (DIEP) flaps, providing a sophisticated option for patients with insufficient donor tissue or those requiring substantial breast mounds. This technique utilizes either conjoined/bipedicled or separate abdominal flaps to recreate the breast with natural-looking results and high satisfaction rates. Preoperative planning is critical, involving detailed vascular mapping to ensure successful outcomes. Despite the complexity of the procedure, the complication profile remains comparable to non-stacked methods, with a notable reduction in fat necrosis and no significant increase in overall risk. Similar to the DIEP flap, possible complications related to the stacked DIEP flap include donor-site morbidity such as abdominal bulge or hernia, and complications at the recipient site such as flap ischemia or fat necrosis. The stacked DIEP flap technique has improved the symmetry and volume matching of reconstructed breasts while maintaining abdominal integrity, marking a significant advancement in the field that aligns with the aesthetic aspirations of patients undergoing mastectomy.

Keywords: Autologous breast reconstruction, DIEP flap, stacked flap, conjoined flap, bipedicled flap

INTRODUCTION

The evolution of breast reconstruction techniques has significantly advanced over the years, offering women undergoing mastectomy for breast cancer or other conditions a range of options for restoring breast shape, symmetry and possibly sensation. Among these, autologous breast reconstruction, which uses the patient's own tissue to recreate the breast mound, has gained prominence for its ability to achieve natural-looking results with possible resensitization[1]. Studies have shown that autologous breast reconstruction, including microsurgical abdominal-based free flaps, tends to result in high levels of patient satisfaction and quality of life[2-4].

The history of autologous breast reconstruction is marked by continuous innovation and refinement. A pivotal development in this field was the introduction of the deep inferior epigastric perforator (DIEP) free flap, which involves the transfer of skin and fat from the lower abdomen to the chest without sacrificing the underlying abdominal muscles[1,5,6]. This technique has been lauded for its effectiveness in mimicking the natural breast while preserving abdominal strength[6].

Building on the success of DIEP free flaps, the stacked DIEP free flaps represent a further evolution in flap-based breast reconstruction. This advanced technique involves utilizing two hemiabdominal DIEP free flaps, either as conjoined/bipedicled flaps or two separate flaps, to create a more substantial breast mound, and they are particularly beneficial for patients requiring larger volume unilateral reconstructions or those with limited hemiabdominal donor tissue availability[7-10].

Several variations of the stacked DIEP flap exist, such as the conjoined or bipedicled DIEP flap, where one flap from the abdominal donor site is harvested with two separate blood supplies for unilateral breast reconstruction. Another approach involves stacking two separate flaps harvested from the same or distinct areas of the abdomen, each with its own blood supply. The extended hemiflap represents another variation, wherein a single DIEP flap is extended beyond the hemiabdomen to utilize a larger portion of the abdominal tissue supplied by one hemiabdominal perforator group. The use of conjoined/bipedicled flaps, two separate flaps, or the extended hemiflap highlights the flexibility and adaptability of these modern breast reconstruction techniques [Figure 1][7,9-11].

The stacked DIEP free flap approach has opened new doors in reconstructive surgery, offering solutions for complex cases where traditional methods might not suffice. By providing a tailored, autologous tissue reconstruction, the stacked DIEP flap technique underscores the modern ethos of patient-centered care in breast reconstruction, striving to meet the diverse needs and aesthetic goals of individuals undergoing this life-changing procedure.

CONSIDERATIONS FOR STACKED FLAP BREAST RECONSTRUCTION

Indications for surgery

The use of stacked flap techniques, particularly the stacked DIEP free flap, is indicated in autologous unilateral breast reconstruction when a single hemiabdominal flap is insufficient to achieve the desired breast volume or shape[10,12]. This scenario is common in patients who desire autologous reconstruction but have low body mass index (BMI) and, thus, limited abdominal donor tissue volume [Example 1][7,13]. The stacked DIEP flap is also useful in patients with larger native breast sizes where maximizing volume and symmetry is crucial, and in patients who prefer to avoid implants due to concerns about implant-related complications or personal preference[6,7,10,14]. Additional breast volume or breast skin obtained during a stacked DIEP flap facilitates future revision surgeries and allows for more predictable and straightforward outcomes, such as in future breast mastopexy or reduction procedures[10,13]. Additionally, it can preclude the

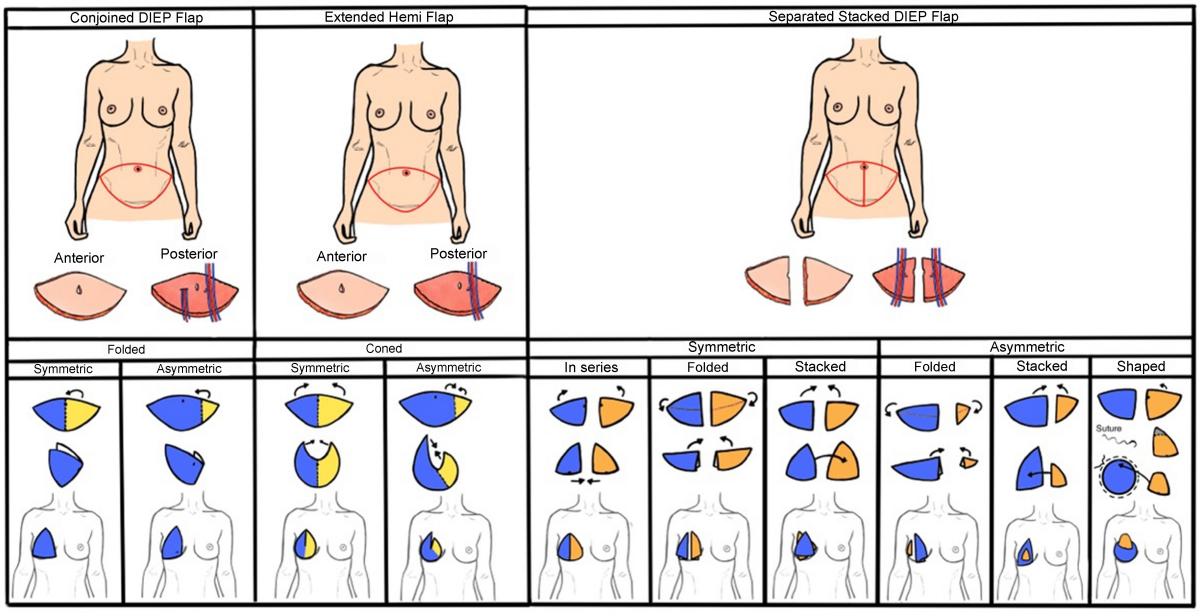
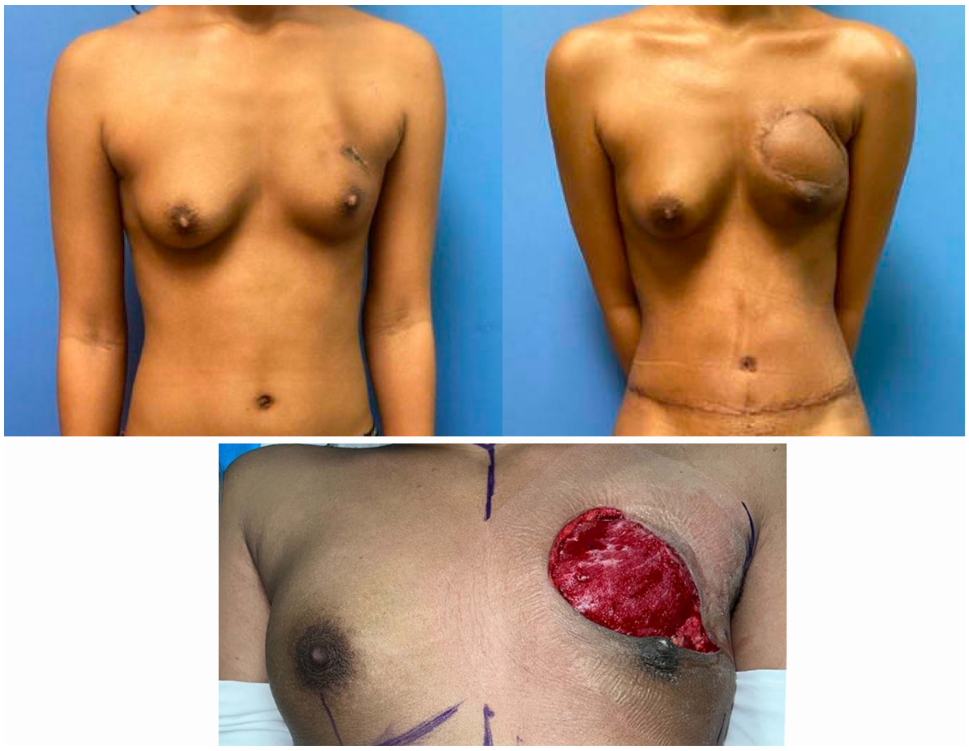


Figure 1. Illustrations of symmetric and asymmetric insetting options for conjoined DIEP stacked flap, extended hemiflap, and separated stacked DIEP flap. Of note is that the coning illustrated under the extended hemi flap can also be done with conjoined DIEP flaps. DIEP: Deep inferior epigastric perforator.



Example 1. This is a 17-year-old female with low BMI who underwent left breast reconstruction following dermatofibroma protuberans resection with a bipedicled/conjoined DIEP free flap to meet both skin deficit and breast volume requirements. Top Left: Preoperative photo. Note the left upper breast scar from the initial breast mass resection. Top Right: Postoperative photo. Bottom: Intraoperative photo showing the skin and volume deficit following a recent mastectomy with skin resection to obtain negative margins. BMI: body mass index; DIEP: deep inferior epigastric perforator.

need for secondary large-volume autologous fat grafting, which often faces high resorption rates and can require multiple procedures to achieve the desired volume[15].

Additionally, the stacked flap approach offers an advantage for cases with substantial breast tissue loss and skin deficit, especially following radiation or trauma. For radiated breasts, the approach ensures a more reliable outcome, reducing the risk of complications associated with compromised tissue quality[10]. It addresses the need for both skin coverage and volume, providing a robust foundation that can better accommodate the effects of radiation than alternatives like implants [Example 2]. Lastly, other autologous donor sites, such as the deep circumflex iliac artery (DCIA) flap, can also be considered in conjunction with the DIEP for these complex reconstructions[1,10].

The timing of breast reconstruction is another crucial consideration in the surgical planning process. Stacked DIEP flap breast reconstruction can be performed either immediately following mastectomy or in a delayed fashion. Immediate reconstruction is often preferred as it allows for better aesthetic outcomes and can be psychologically beneficial for the patient[2,3]. However, delayed reconstruction might be necessary in cases where adjuvant radiation is planned to reduce the risk of complications[1,5]. The decision on timing should be individualized based on the patient's overall treatment plan and medical condition.

Patient selection

The stacked DIEP flap breast reconstruction is a complex, yet highly rewarding procedure for both the patient and the surgeon. Like all autologous breast reconstructions, careful patient selection is critical in achieving successful outcomes with stacked flap breast reconstruction. Ideal candidates for this procedure are those in good general health with adequate donor sites for flap harvesting. Patients should be non-smokers or willing to cease smoking, as smoking can significantly impair wound healing and flap viability[1,5,6,16].

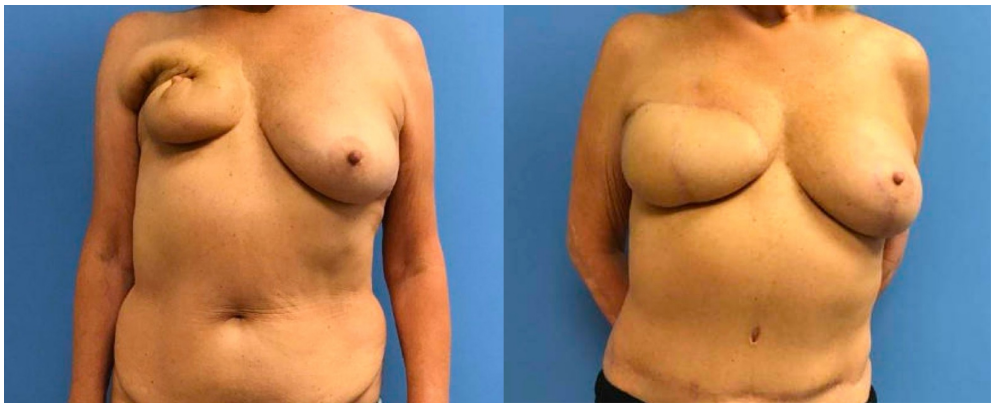
Patients with significant comorbidities (such as diabetes, vascular disease, or obesity), a history of radiation therapy, and those with previous abdominal surgeries may have an increased risk of complications[1,5,14]. For instance, patients with a lower midline vertical scar are not typically candidates for conjoined flaps and will require two separate hemiabdominal stacked flaps[17,18]. A thorough preoperative assessment including medical history and physical examination, and a thorough preoperative planning including imaging studies, such as CT angiography, are essential to evaluate the vascular anatomy and plan the surgery[1,5,19].

In addition, patient expectations and aesthetic goals should be discussed in detail. Autologous reconstruction using stacked flaps can provide a natural feel and appearance but requires a longer operative time, more advanced microvascular expertise and recovery period for the patient compared to other reconstruction methods[2,20,21]. Patients should be counseled about the extent of the surgery, potential risks, and the recovery process to make an informed decision.

The choice of stacked flap technique will depend on individual patient factors and the surgeon's expertise. Techniques such as the conjoined/bipedicled DIEP flap, two separate hemiabdominal perforator free flaps, and various combinations of these methods have been described in the literature, each with specific indications and technical considerations.

PREOPERATIVE PLANNING FOR STACKED FLAP BREAST RECONSTRUCTION

Preoperative planning is a critical component in the success of stacked flap breast reconstruction. This process involves a series of steps tailored to the patient's specific needs, ensuring the best possible outcomes.



Example 2. This is a 66-year-old female with a history of right intraductal breast carcinoma for which she underwent lumpectomy and adjuvant radiation treatment that was complicated by contracture. She subsequently underwent right skin-sparing mastectomy with breast reconstruction using separated stacked DIEP free flaps. Separated stacked DIEP reconstruction was necessary to meet her large volume requirement. Four months later, she underwent a revision of her right breast with autologous fat grafting and left balancing augmentation mastopexy. Left: Preoperative photo. Right: Postoperative photo. DIEP: Deep inferior epigastric perforator.

Detailed preoperative assessment

1. Comprehensive Patient Evaluation: A thorough medical evaluation, including past medical history, breast cancer treatment details, such as radiation history (dose, duration, time since completion of radiation therapy) and timeline and timing, as well as previous surgeries, is essential to identify any factors that might influence the surgery's success or the choice of reconstructive strategy[1,16,18].

2. Physical Examination and Donor Site Assessment: Assess the abdomen and other potential donor sites, such as the thighs or buttocks, for the availability and quality of tissue. This examination is crucial in patients who have undergone previous abdominal surgeries or have limited abdominal tissue. Evaluation for abdominal bulges and hernias is also important as it can affect the surgical approach[1,18].

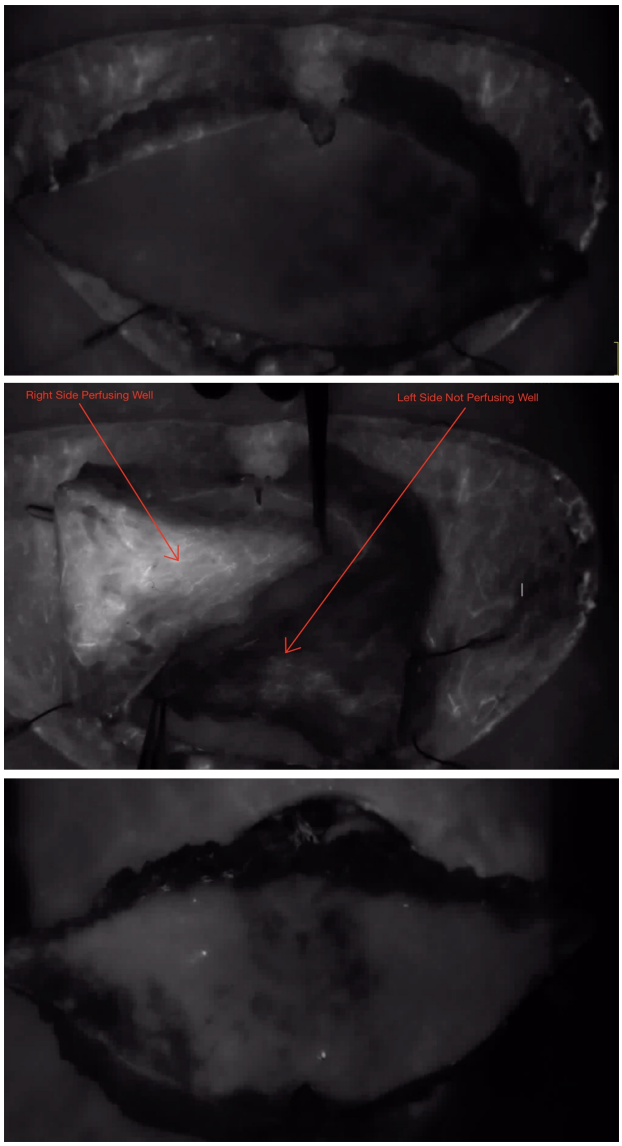
3. Breast and Chest Wall Analysis: Evaluate the breast size, shape, ptosis, and chest wall anatomy to determine the desired breast volume and shape following reconstruction. Since the stacked DIEP flap approach is utilized for unilateral cases, the contralateral native breast should also be evaluated to determine whether symmetrizing procedures will be necessary[13,18].

4. Imaging Studies for Vascular Mapping: Preoperative imaging, most commonly CT angiography or MR angiography, is essential for visualizing the vascular anatomy of the abdomen, including the deep inferior epigastric vessels and their perforators. Ultrasonography can also be utilized. This step helps identify the best perforators for flap harvest and plan the flap design[1,19].

5. Volume Assessment and Symmetry Planning: Assess the required volume for the reconstructed breast and plan for achieving symmetry with the contralateral breast, if applicable. This may involve considering contralateral procedures for symmetry[1,10,19].

Surgical planning

1. Flap Design and Harvest Strategy: The design of the flaps should consider the patient's anatomy, the patient's reconstruction needs (e.g., amount of skin deficit), the desired breast shape and size, surgeon preferences and experience, as well as pedicle availability and overall flap perfusion[10,18,22,23]. The strategy for flap harvest, including the sequence and technique, must be planned to ensure adequate blood supply and



Example 3. Intraoperative SPY Angiography Images from Patient A. Top: Image shows the anterior aspect of abdominal flap after the deep inferior epigastric perforators have been dissected on each side of the abdomen and the left-sided perforators were clamped. This was done to determine if a right extended hemiabdomen DIEP free flap can be utilized, but there is poor perfusion passed the midline. Middle: Image shows the posterior aspect of the right and left abdominal flaps flipped up, demonstrating poor fat perfusion after the left-sided perforators were clamped, preventing the use of the right extended hemiabdomen DIEP free flap. Bottom: Image demonstrates satisfactory flap perfusion after both the right and left deep inferior epigastric pedicles were anastomosed to the antegrade and retrograde internal mammary vessels at the recipient site before the inset. DIEP: Deep inferior epigastric perforator.

minimize donor-site morbidity[1,5,10]. Adjunct measures, such as intraoperative fluorescence angiography using the SPY (ICG-A) system [Example 3], can assist with the perforator selection and ensure appropriate perfusion of the flaps[10,24-26].

2. Anastomosis Strategy: Plan the microvascular anastomosis considering primary options like the internal mammary vessels and alternatives such as the thoracodorsal vessels[1,5]. For the bipedicled or two separate flaps, when the usual cranial and caudal internal mammary vessels are not available, one of the two anastomoses can be completed using a side branch of the flap pedicle or, most commonly, the cephalad

extension of the flap pedicle (one pedicle draining into the second pedicle)[27]. Preoperative imaging aids in identifying viable options for anastomoses, and intra-operative confirmation of vessel flow is mandatory [Figure 2][19,28]. The decision between using a single or double vascular pedicle depends on the flap's volume and the patient's vascular anatomy. Intraoperatively, ICG-A can help confirm vessel patency and flap perfusion[10,24-26].

3. Risk Assessment and Management: Identify potential risks and complications, such as flap failure, donor site morbidity, and aesthetic concerns. Develop strategies to minimize these risks[1,8,16,21,29].

4. Patient Counseling and Informed Consent: Discuss the procedure's details, benefits, risks, expected outcomes, and recovery process. Obtain informed consent after ensuring the patient's understanding of the procedure.

5. Team Coordination and Resource Allocation: Ensure the availability of a skilled microsurgical team and necessary resources, including operating room facilities and postoperative care arrangements[10].

6. Customization and Flexibility: Adapt the surgical plan to each patient's unique needs, maintaining flexibility to modify the approach intraoperatively as needed.

In-depth preoperative planning for stacked flap breast reconstruction is essential to address the complex needs of patients seeking autologous breast reconstruction. By carefully evaluating each aspect of the patient's case and planning the surgical approach, surgeons can optimize the chances of successful outcomes and patient satisfaction.

RELEVANT VASCULAR ANATOMY[19,28,30,31]

The vascular anatomy of the DIEP flap is integral in the successful execution of stacked flap breast reconstruction. The DIEP flap primarily relies on the deep inferior epigastric artery (DIEA) and its perforators, which typically emerge through the rectus abdominis muscle and supply the overlying skin and subcutaneous tissue. This artery is a direct continuation of the external iliac artery, branching off just above the inguinal ligament[28,30].

At the donor site of conjoined/bipedicled DIEP flaps, perforator(s) from both the left and right DIEA are utilized, supplying different perforasomes within one flap. In contrast, with the separated stacked flap, each flap has its own individual pedicle and associated perforator(s). At the recipient site, the cranial and caudal internal mammary arteries, a branch of the subclavian artery, and veins are most commonly used[28,30,31].

An understanding of the vascular territory of the DIEA is essential for harvesting DIEP flaps. This includes recognizing the variations in the number, location, and size of the perforators. The choice of perforators significantly influences the design and viability of the flap. Sometimes, dissection of multiple perforators on both sides of the abdomen may be needed. The vascular anatomy must be assessed preoperatively, often using imaging techniques like CT angiography, to map the course and caliber of these perforators and plan the flap harvest accordingly[19].

Moreover, a thorough understanding of the vascular anatomy reduces the risk of flap ischemia and ensures optimal flap perfusion. It also allows for strategic planning in cases where variations in the vascular anatomy are present, which is not uncommon. Intraoperative ICG-A can provide real-time perfusion assessment and

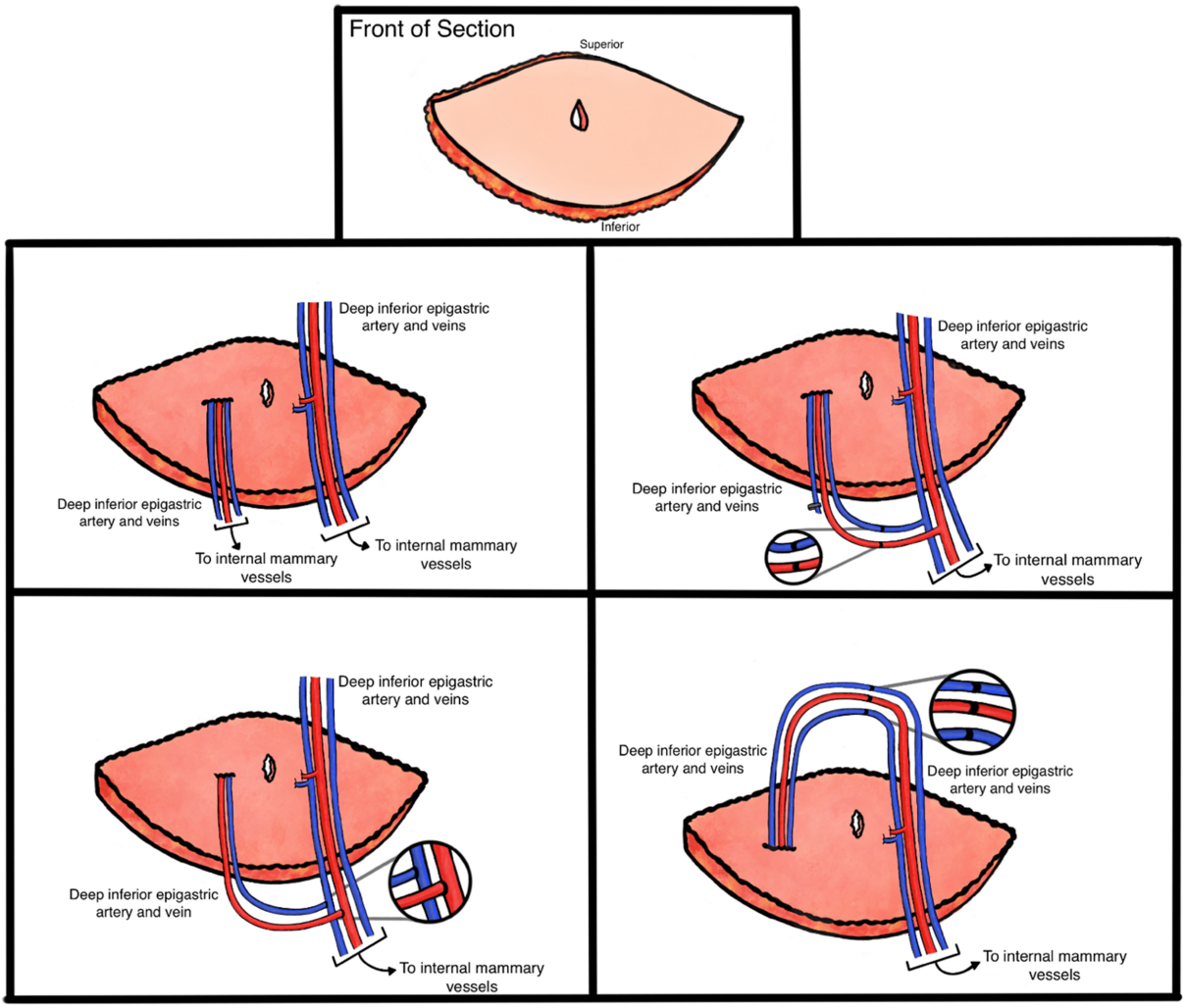


Figure 2. Illustrations of options for the stacked flap.Top left: Two independent pedicles. Top right: One pedicle attached to a branch of the other pedicle with end-to-end anastomoses. Bottom right: One pedicle attached to the cephalad extension of the other pedicle with end-to-end anastomoses. Bottom left: One pedicle attached directly to the other pedicle with end-to-side anastomoses.

help ensure the viability of the flap and the success of the microsurgical anastomoses[24-26]. Surgeons must be adept at navigating these variations to maximize flap viability and achieve a successful outcome.

OPERATIVE TECHNIQUE: STACKED DIEP FLAP BREAST RECONSTRUCTION

The operative technique for stacked DIEP flaps in breast reconstruction is a multi-step procedure that demands an in-depth understanding of the patient's anatomy, proficient microsurgical skills, and a keen sense of aesthetic judgment. This overview provides a guide to the critical steps of the process.

1. Preoperative Markings and Patient Positioning

• Preoperative Markings: Carefully mark the patient's abdomen to delineate the DIEP flaps. Doppler ultrasound can be employed to identify and mark the course of the DIEA and its key perforators based on imaging. Additionally, mark potential alternate perforators as backup[1,18].

• Patient Positioning: Place the patient in a supine position on the operating table. It is typically more convenient to tuck in the arms, unless access to the axilla and lateral chest area is needed by the oncologic

surgeon with immediate autologous reconstruction[1].

2. Flap Harvesting

• Flap Selection: The choice of the flaps should take into account the patient's anatomy, the patient's reconstruction needs (e.g., amount of skin deficit), the desired breast shape and size, surgeon preferences and experience, as well as pedicle availability and overall flap perfusion. Based on the authors' experience, the preference is to use the conjoined flap whenever possible, since no additional incisions have to be made and the perfusion across the midline is maintained between the two sides. However, the configuration of the pedicles might not always allow the surgeon to proceed with this approach and separate stacked flaps should be considered. In addition, separate stacked flaps need to be considered in cases where the patient's reconstructive needs and goals will not be met with the folding/coning of the conjoined flaps.

• Incision Planning: The upper abdominal transverse incision is completed first to ensure the main perforators are included. Then, the lower abdominal transverse incision is completed after ensuring that the patient's abdominal donor site will be able to close at the lower incision mark. This is typically the opposite sequence to that utilized in an abdominoplasty[1,30].

• For a conjoined/bipedicled flap, the dissection is done from lateral to medial on both sides because there is no infraumbilical vertical midline incision. For separate stacked flaps, an infraumbilical vertical midline incision is made and the dissection is done from lateral to medial and from medial to lateral on both sides [Figure 1][12,32,33].

• For an extended hemiflap, the dissection is first completed from lateral to medial on both sides in order to identify the side with the best perforators to base the flap on, and then the contralateral perforators are sacrificed to allow for a medial to lateral dissection in order to keep most of the lower abdominal tissue intact. Additionally, the hemiflap can be based off the SIEA pedicle, as well as be extended laterally to include the DCIA[11,18].

• Once the perforators are identified, the rectus sheath is incised, and the dissection of the perforators and the deep inferior epigastric vessels is completed in a standard fashion. It is important not to divide the superior continuation of the deep inferior epigastric vessels at this point, as additional length might be needed in case an intra-flap anastomosis is necessary (for bipedicled flaps)[33]. Prior to harvesting of the flap, SPY (ICG-A) angiography can be used to confirm adequate flap perfusion and design. Areas with reduced perfusion can be excised to reduce the risk of wound healing complications and fat necrosis[24-26].

• The SIEV should be preserved if present as it can become beneficial for additional venous outflow[1,7,30].

3. Stacking Procedure

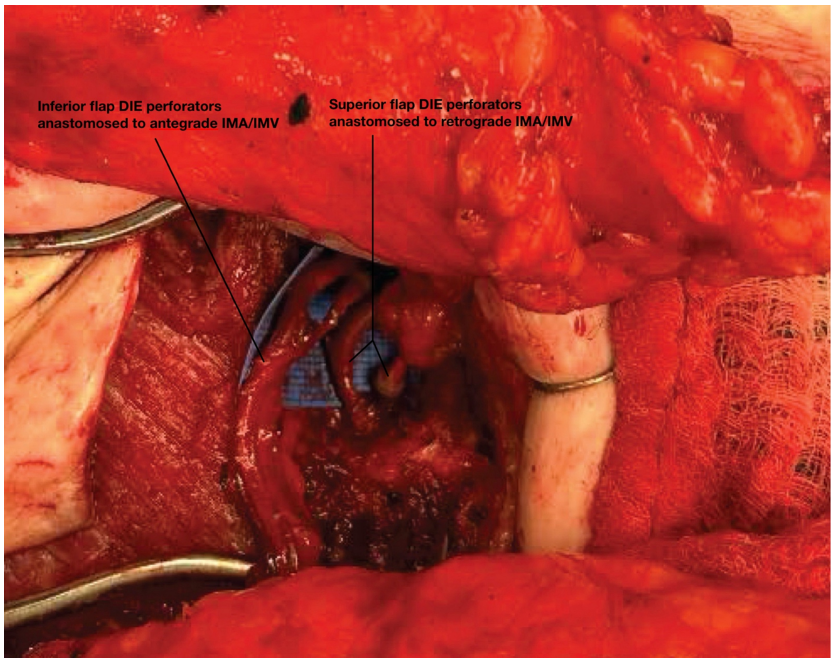
• Flap Design: Depending on the patient's anatomy and volume requirements, either harvest two separate DIEP flaps from each hemiabdomen or shape a single large flap to achieve the desired volume [Figure 1].

• Bipedicled Flap Approach: In a bipedicled approach, each pedicle should have an independent blood supply and reach the recipient site without tension. Sometimes, an intra-flap anastomosis is completed with one of the pedicles; thus, only one pedicle is left for the anastomosis to the recipient site [Figure 2]. The flaps can be folded in a symmetric or asymmetric manner to meet the tissue needs at the recipient site. Folding will also be dependent on the locations of the perforators[7,32,34].

• Stacked (Separate) Flap Approach: Each flap should have its own independent blood supply, capable of adequately perfusing the flap and reaching the recipient site vessels without tension. The flaps can be divided in a symmetric or asymmetric manner to meet the tissue needs at the recipient site. Dividing the flaps will also be dependent on the locations of the perforators[7,12,34].

4. Recipient Site Preparation

• Prepare the recipient vessels, often the internal mammary artery and vein(s), in the chest wall. Rib



Example 4. Separated stacked DIEP flaps for a patient with a large unilateral volume requirement. Independent pedicle anastomoses to the internal mammary vessels in an antegrade and retrograde fashion. DIE: Deep inferior epigastric; IMA: internal mammary artery; IMV: internal mammary vein; DIEP: deep inferior epigastric perforator.

cartilage resection is typically necessary to allow optimal length and access to these vessels because antegrade and retrograde anastomoses might be necessary[1,10,16,30,33,35,36].

5. Microvascular Anastomoses

• For separate stacked flaps, each flap's vessels are typically anastomosed separately to the internal mammary vessels in an antegrade and retrograde fashion [Example 4][12,27,29,32,33,35-37].

• For bipedicled flaps, there are two main options:

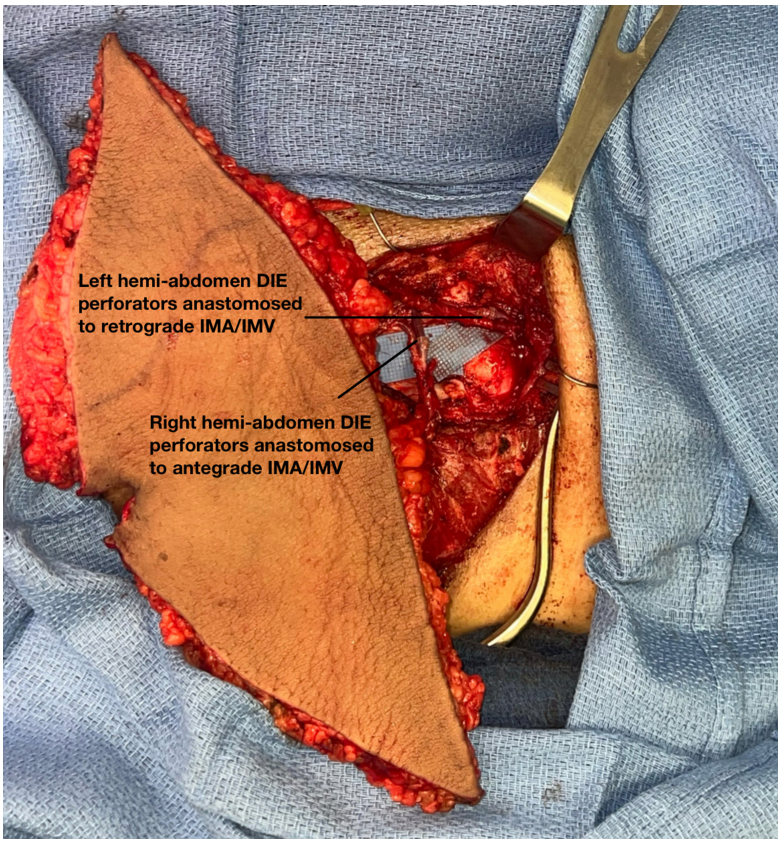
•• The first option is to anastomose each flap's vessels separately to the internal mammary vessels in an antegrade and retrograde fashion [Example 5][7,27,33,38].

•• The second option is to complete an intraflap anastomosis with typically three variations depicted in Figure 2[27,38]. The first variation involves one pedicle attached to the cephalad extension of the other pedicle with end-to-end anastomoses. The second variation involves one pedicle attached to a branch of the other pedicle with end-to-end anastomoses[34]. The third variation involves one pedicle attached directly to the other pedicle with end-to-side anastomoses[34]. The main DIEA pedicle is next anastomosed to the internal mammary vessels in an antegrade fashion[34].

6. Shaping and In-setting the Flap

• Carefully shape the flap to mimic the natural contour of a breast. This involves de-epithelializing certain parts of the flap and precise fat trimming [Example 6]. The various insetting options are shown in Figure 1[34].

• Consider performing a symmetry procedure on the contralateral breast, either in the same operation or as a separate procedure [Example 7][34].



Example 5. Patient A's bipedicled DIEP free flap. Independent pedicle anastomoses to the internal mammary vessels in an antegrade and retrograde fashion. DIE: Deep inferior epigastric; IMA: internal mammary artery; IMV: internal mammary vein; DIEP: deep inferior epigastric perforator.

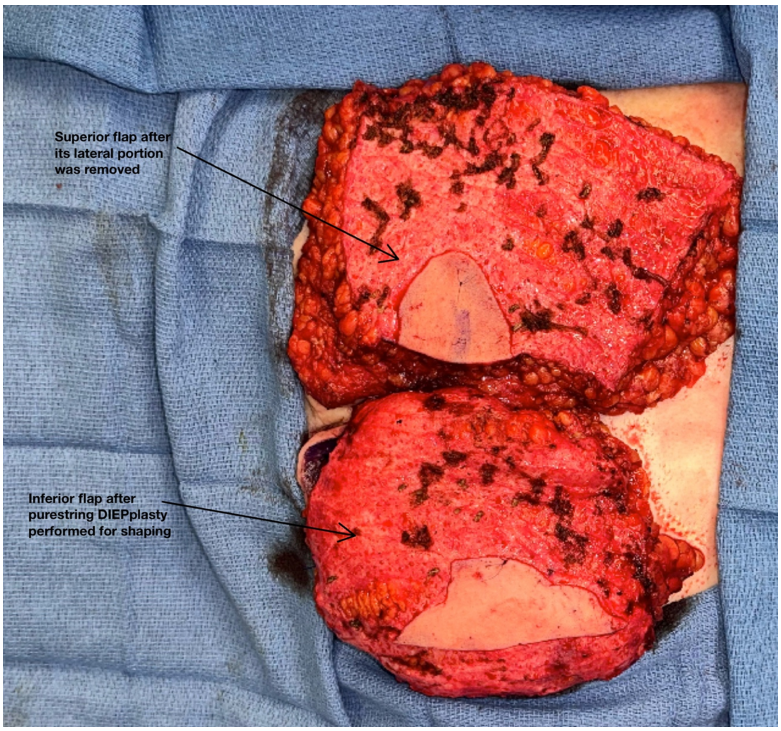
7. Postoperative Monitoring

• Monitoring of the flap is essential in the immediate postoperative period to detect vascular compromise early. Techniques include clinical observation, use of a handheld Doppler, tissue oxygen saturation monitoring and, in some cases, implantable Doppler probes and venous couplers. Implantable Doppler probes and venous couplers are useful if one of the flaps must be fully buried and external skin monitoring is not possible[39].

POSTOPERATIVE CONSIDERATIONS

1. Monitoring Flap Viability: Postoperative monitoring is crucial for any free flap reconstruction to ensure flap viability. Frequent monitoring of flap perfusion is highly recommended for the first 48 h to detect vascular compromise early and allow prompt intervention if needed to salvage the flap. Monitoring can be done through clinical assessment, the use of a handheld Doppler, tissue oxygen saturation monitoring and, in some cases, implantable Doppler probes and venous couplers[39].

2. Pain Management: Effective pain management is critical in the immediate postoperative period. A multimodal approach is recommended, typically as part of an Enhanced Recovery After Surgery (ERAS) pathway, including the use of several different classes of drugs such as acetaminophen, non-steroidal anti-inflammatory drugs (NSAIDs), pregabalin, and opioids[40,41]. Such an approach allows not only satisfactory pain control, but can also facilitate early mobilization.



Example 6. Example of stacked flap de-epithelialization and asymmetric shaped inset. DIEP: Deep inferior epigastric perforator.

3. Minimizing Thromboembolic Risk: Patients undergoing autologous breast reconstruction are at an increased risk for thromboembolic events, which can be attributed to the long operative time and the tightening of the abdominal wall to improve the aesthetic appearance of the donor site. Prophylactic anticoagulation with low molecular weight heparin, compression devices, and early ambulation are recommended to reduce this risk[1,42].

4. Scar Management: Proper wound care is essential to promote healing and reduce the risk of infection. Scar management strategies, including silicone gel sheets and pressure garments, may be used to optimize aesthetic outcomes.

5. Monitoring for Donor-Site Morbidity: Postoperatively, during the immediate and long-term follow-up period, the donor site should be monitored for complications including abdominal weakness, bulge, or hernia[43,44]. Regular follow-up is necessary to assess abdominal wall integrity and function.

6. Long-Term Surveillance: Long-term follow-up is necessary to monitor for complications such as fat necrosis, flap volume changes, and asymmetry.

7. Patient Education and Support: Educating patients about the expected recovery process, potential complications, and lifestyle modifications is crucial. Providing psychological support and resources for body image adjustment is also an important aspect of postoperative care.

8. Adjunct Procedures: Secondary procedures, such as autologous fat grafting with donor site contouring or nipple-areolar complex reconstruction, may be required to optimize the aesthetic result[45]. These should be planned based on the individual patient's needs and desires.

Example 7. This is a 40-year-old female with a history of invasive ductal carcinoma of the right breast who underwent right skin-sparing mastectomy with immediate breast reconstruction with a tissue expander. Four months later, she completed adjuvant right breast radiation therapy. Eight months after the completion of adjuvant radiation therapy, she underwent separated stacked DIEP flap reconstruction. Six months later, she underwent revision of the right breast reconstruction with removal of the flap skin paddles and mastopexy, as well as balancing mastopexy on the contralateral left side and bilateral fat grafting. Top Row: Preoperative photos. Middle Row: Postoperative photos following the stacked DIEP flap reconstruction of the right breast. Bottom Row: Postoperative photos following revision of the stacked DIEP flap reconstruction of the right breast and balancing left mastopexy. DIEP: Deep inferior epigastric perforator.

POSTOPERATIVE OUTCOMES AND COMPLICATIONS IN STACKED FLAP BREAST RECONSTRUCTION

Clinical outcomes

The stacked DIEP free flap has emerged as a promising option for patients seeking breast reconstruction with high satisfaction rates in both aesthetic and functional outcomes. The technique is particularly advantageous for those requiring larger volume reconstructions or when donor tissue is limited, as it allows for ample tissue to achieve desired breast volume and symmetry[20,46,47]. Additionally, with more tissue for reconstruction, stacked free flaps allow for better volume matching and symmetry with the contralateral native breast, subsequently requiring less reshaping[10,21].

From a functional standpoint, DIEP flap reconstruction is favored over alternatives like the pedicled transverse rectus abdominis muscle (TRAM) flap, with studies noting lower morbidity rates and shorter hospital stays[48,49]. Notably, patients experience fewer complications such as fat necrosis and abdominal wall hernias, underscoring the strength of DIEP flaps in preserving abdominal integrity and reducing donor-site morbidity[4,48]. DIEP Flap bulge and hernia rates have been reported from 3.6% to 6.6%, whereas hernia rates in TRAM flaps have been reported as high as 18%[50-52]. Furthermore, the bipedicled DIEP flap offers a viable option for large-volume autologous breast reconstruction with ample tissue, shorter recovery, and limited donor site morbidity, emphasizing its utility in specific reconstructive scenarios[27].

Long-term outcomes and patient satisfaction in stacked flap breast reconstructions, particularly with the use of double DIEP flaps, have demonstrated a high degree of satisfaction among patients[10,53]. Surveys, including BREAST-Q assessments, illustrate that patients exhibit similar satisfaction levels across DIEP, profunda artery perforator (PAP), and lumbar artery perforator (LAP) flap reconstructions, highlighting the effectiveness of these approaches in meeting patient expectations for aesthetic outcomes and minimal donor-site morbidity[20,47,49]. Moreover, the durability of the results and the low incidence of long-term complications like fat necrosis or flap failure likely contribute to this satisfaction[8,20,27,46].

Complications

Stacked and conjoined flap breast reconstructions, while more complex than traditional single-flap procedures, have not been associated with an increased overall risk of complications[7-10,13,29,36]. This suggests that despite their complexity, these advanced surgical techniques are capable of achieving desired outcomes without necessarily adding to the patient's risk profile. Studies comparing these methods to non-stacked flaps procedures report reduced rates of fat necrosis and comparable rates of other complications, such as infections and donor site morbidity, pointing to proficient risk management[8,10,12,21,46]. Furthermore, the outcomes reflect the capability of these methods to meet clinical goals without significantly adding to the complication burden[7,8,10,13,29,36].

Delving deeper into specific complications, the rate of fat necrosis in stacked or conjoined flaps is markedly lower than in non-stacked flaps (8.3% stacked flap *vs.* 25.4% non-stacked flap), with a significant reduction in risk substantiated by further analysis [odds ratio (OR) 0.278, $P = 0.045$][21]. Moreover, these findings are further solidified in a meta-analysis by Salibian *et al.*, showing a general decrease in flap-related complications, particularly emphasizing the lowered incidence of fat necrosis in stacked flap procedures compared to their non-stacked/conjoined counterparts[8,21]. These findings underline the technical efficacy of stacked flaps in preserving tissue viability and reducing complications.

In terms of operative intricacies, stacked/conjoined flaps present technical challenges and necessitate longer surgeries, especially in bipedicled procedures[7,8,12,21]. However, these extended operative times have not translated into an increase in either donor-site morbidity or systemic complications, demonstrating the resilience of the surgical outcomes to the demands of procedure duration[7,8,12,21]. Furthermore, long-term follow-up on bipedicled DIEP flap reconstructions suggests that the increase in donor-site morbidity is insignificant, even when compared to unilateral and bilateral unipedicled methods, ensuring their safety and acceptability, particularly for patients with specific anatomical needs like midline infraumbilical incisional scars[12,17,54]. The risk profile does shift slightly, however, with a marginal increase in deep vein thrombosis rates contrasting with lower infection rates, highlighting the complexity of risk assessment in stacked flap reconstructions[46].

CONCLUSION

In conclusion, the advancement of stacked flap breast reconstruction, particularly the stacked DIEP free flaps, represents a remarkable milestone in the field of autologous breast reconstruction. This technique embodies the culmination of years of surgical innovation, patient-centered care, and a dedication to improving the quality of life for those undergoing mastectomy. The ability to provide natural-looking, substantial breast mounds using the patient's own tissue has not only enhanced the aesthetic outcomes but also bolstered the psychological well-being of patients, contributing to a more holistic approach to breast cancer recovery.

As we look toward the future, it is imperative to continue refining these techniques, further reducing the risks and complications associated with such complex procedures. The ongoing research and development in microsurgical methods, preoperative planning, and postoperative care are essential to augment the success rates of stacked flap breast reconstructions. In addition, the emphasis on patient education, informed consent, and personalized care plans will remain central to achieving the best possible outcomes.

The journey of breast reconstruction has evolved from simple beginnings to sophisticated, patient-tailored procedures like the stacked DIEP flap. This evolution not only highlights the advancements in medical science and surgical skills, but also underscores the importance of understanding patient needs and expectations. As we move forward, the commitment to improving these reconstructive options will undoubtedly continue, offering hope and renewed confidence to countless individuals embarking on their journey of recovery and rejuvenation after breast cancer.

DECLARATIONS

Authors' contributions

Conceptualization, visualization, writing, review and editing, and project administration of the draft: Garoosi K
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Ethical approval and consent to participate

Consent was obtained from all patients included in this publication.

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