

Bilateral Outpatient Breast Reconstruction with Stacked DIEP and Vertical PAP Flaps

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Background: Stacking free flaps for breast reconstruction is far from novel, even in the case of a deep inferior epigastric perforator (DIEP) plus profunda artery perforator (PAP) configuration, where the latter is always described in the traditional transverse configuration. We present a series of consecutive patients undergoing bilateral breast reconstruction with stacked DIEP and vertical PAP flaps.

Methods: Patients with inadequate abdominal donor tissue were offered the possibility of a stacking breast reconstruction. The DIEP flap was harvested via microfacial incisions, whereas the vertical PAP flap was harvested in the lithotomy position, following the course of the gracilis muscle.

Results: In total, 28 consecutive patients with a mean BMI of 24.9 underwent bilateral breast reconstruction with stacked DIEP and vertical PAP flaps. The internal mammary artery and vein were used as recipient vessels in all 56 stacked flaps. Fifty-three PAP flaps were anastomosed to the distal portion of the (primary) DIEP flaps utilizing a sequential flap anastomosis technique, and one DIEP flap was anastomosed to the distal portion of the (primary) PAP flap. Hospitalization for the initial eight patients averaged 35 hours, whereas the following 20 patients were discharged within 23 hours. There were no postoperative takebacks or vascular complications.

Conclusions: Stacked DIEP/PAP flaps offer an excellent option for patients who require more volume than available from DIEP flaps alone. When compared with transverse PAP flaps, the vertical PAP offers excellent variability of volume and ease of shaping to allow for excellent results, while minimizing donor site tension in the seated position and preserving the gluteal fold. (*Plast Reconstr Surg Glob Open* 2021;9:e3878; doi: 10.1097/GOX.0000000000003878; Published online 18 October 2021.)

Microvascular breast reconstruction with stacked flaps represents a reliable option for patients with low body mass index (BMI), limited donor sites, or in those desiring avoidance of prosthetic implants. By creating a single reconstructed breast combining two flaps, such as the deep inferior epigastric perforator (DIEP) and the profunda artery perforator (PAP), adequate volumes and shapes can be readily achieved with outstanding cosmetic results.

The concept of stacking free flaps for breast reconstruction is far from novel, even in the case of a DIEP/PAP configuration, where the latter is typically described using a traditional transverse configuration. Although the crescent-shaped transverse configuration, arising from the upper thigh, is a good choice for use in the lower pole of the reconstructed breast, we prefer the vertical PAP option to optimize postoperative comfort, prevent labial and buttock distortion or scar widening, and provide additional malleability during flap inset. We present a series of consecutive patients undergoing bilateral breast reconstruction with stacked DIEP and vertical PAP flaps.

PATIENTS AND SURGICAL TECHNIQUE

From January 2017 to January 2021, the senior author performed 28 consecutive bilateral stacked DIEP/PAP flaps for breast reconstructions at multiple institutions.

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We performed a retrospective chart review. Demographic data as well as intraoperative and postoperative outcomes were analyzed and assessed following institutional review board approval. Categorical and continuous variables were expressed as frequency (%) and mean \pm SD, respectively.

During preoperative consultation, autologous reconstruction patients with average-to-low body mass index (BMI), desiring volumes greater than available in a DIEP flap alone, were offered stacked DIEP/PAP flaps for breast reconstruction. Throughout the course of the series, an early recovery autologous breast reconstruction protocol was implemented, facilitating expeditious discharge within 24 hours of surgery.¹ This protocol includes modified operative techniques with minimal anatomic disruption and no rib removal during preparation of the recipient vessels, microfascial incisions (DIEP) and fascial sparing (PAP) flap harvest. Additionally, our protocol includes a multimodal pain control regimen to minimize narcotic requirements and promote early mobilization and postoperative anticoagulation therapy. We do not routinely perform preoperative imaging studies, unless unreliable flap perforators are suspected due to history of major surgery or trauma.

A two-surgeon team is used to optimize efficiency and minimize operative time. Preparation of recipient vessels is performed at the lowest (inferior) possible intercostal space utilizing a rib-sparing technique. DIEP flap dissection is performed through a microfascial incision as previously mentioned. (See Video 1 [online], which displays DIEP flap dissection through a microfascial incision, which minimizes disruption of the abdominal wall. The dissection of the pedicle is taken to the confluence of the iliac.) Whenever possible, a large superior continuation of the deep inferior epigastric vessels or large medial/lateral row branches are preserved with all available length.

The vertical PAP flap is harvested in lithotomy position (Fig. 1). A reliable perforator is typically located 15 centimeters from the pubis and readily identified at the antero-medial aspect of the adductor magnus muscle. Multiple perforator variations exist. The initial incision is made superficial to the gracilis muscle, with minimal anterior beveling. Once the fascia overlying the gracilis is identified, dissection continues above the fascia and through the anterior aspect of the intermuscular septum between the gracilis and adductor magnus. Perforators are typically identified on the anterior aspect of the adductor magnus

fascia and the fascia is longitudinally incised around the perforator. If two or more perforators are visualized, the fascial incision is extended to encompass them. Perforator dissection follows a muscle and fascia sparing technique. In cases where multiple perforators are visualized, the inter-perforator muscle is divided. The dissection is carried towards the origin of the perforators. Large adductor magnus branches are typically harvested with all available length allowing for possible flowthrough anastomosis between flaps and recipient vessels. Dissection is taken to the profunda vessels and harvested at this level. The remainder of the flap is elevated in the same suprafascial plane. The posterior skin attachments are typically preserved until the flap is ready to be harvested.

Once all four flaps are ready for harvest, the flap with the most favorable pedicle branch for secondary flap anastomosis is anastomosed to the internal mammary artery and vein. The second flap is anastomosed to the primary flap pedicle. Secondary venous anastomosis is not routine but performed if there is any congestion of the DIEP flap. Flow is confirmed with Doppler ultrasound and the flaps visualized via indocyanine green angiography (ICG) to evaluate perfusion. Donor site fascia is closed with absorbable sutures and subfascial injections with a blend of Marcaine and Exparel performed in all donor sites. Incisional wound vacs are routinely placed over the donor sites to reduce edema and promote wound healing. Postoperatively, flaps are monitored by held-hand Doppler and clinical examination and we preferentially use a skin paddle of the second of the two sequential flaps, as this will monitor the flowthrough of both flaps, assuming adequate intraoperative indocyanine green angiography (ICG). On occasions where there is no skin paddle, a small incision is made in the mastectomy skin flap, so that a Doppler probe can be inserted directly onto the dermis of the flap to be monitored. A purse-string closure of the monitoring site is done before discharge the following morning. We find this incredibly useful for monitoring a variety of flap configurations and it allows direct examination of the dermis in addition to Doppler examination of both venous and arterial flow.

RESULTS

A total of 28 consecutive patients underwent bilateral breast reconstruction with stacked DIEP and vertical PAP



Fig. 1. Vertical PAP flap dissection and positioning. The vertical PAP flap with the distinctive fishtail extension (A) offers excellent variability of volume and ease of shaping (B). The DIEP (marked with a yellow arrowhead) flap replaces the superior pole (C), whereas the PAP flap adds lower pole volume and projection.

flaps between January 2017 and January 2021. Mean age and body mass index (BMI) were 46.5 ± 8 years (range 29–60) and 24.9 ± 4 (range 19–33), respectively. No patients were actively smoking and 18 (64%) reported previous abdominal surgical procedures. All the patients except one (BRCA prophylaxis) underwent mastectomies due to malignancy; eight (29%) patients underwent immediate reconstruction, 20 (71%) underwent delayed reconstruction. Nine patients had a previous reconstruction with implants, requiring widespread dissection with capsulectomies. Microfascial incisions to harvest the DIEP flaps averaged 1.6 centimeters for single perforator (51% of the flaps) and 2.1 centimeters for multiple perforators (49%). The internal mammary artery and vein were used as recipient vessels in all cases; in one reconstructed breast, the PAP flap was anastomosed to the anterograde limb of the IMA, whereas the DIEP flap was anastomosed to the retrograde. We had one case where the IMA perforator was large enough in caliber for anastomosis with the PAP flap, and the IMA artery was anastomosed to the DIEP flap. Fifty-three PAP flaps were anastomosed to the distal portion of the (primary) DIEP flaps utilizing a sequential flap anastomosis technique, and one DIEP flap was anastomosed to the distal portion of the (primary) PAP flap. Sequential flap anastomosis only requires monitoring of the secondary flap, decreases operative length by avoiding multiple interspace resections, and reduces pain and morbidity associated with rib resection. No intraoperative complications were reported. Average operative time was 546 ± 58 minutes, with an estimated average blood loss of less than 200 cm^3 . Hospitalization for the initial eight patients averaged 35 hours postoperatively, whereas the following 20 patients were discharged within 23 hours of initiation of surgery, following implementation of our early recovery protocol at an outpatient surgical center. All patients were discharged with strong Doppler signals and prescribed anticoagulation therapy (rivaroxaban 10 mg daily for 9 days), which we find convenient for patients as it simplifies compliance, with similar safety and efficacy when compared with subcutaneous enoxaparin (Lovenox).^{2,3} There were no postoperative takebacks or instances of vascular complications. Average follow-up was 40 weeks (Figs. 2, 3). One patient (3.5%) developed a minor thigh donor site infection which resolved with oral antibiotics. One patient

(3.5%) underwent mastopexy due to asymmetry and 13 (46.4%) patients required fat grafting to correct minor contour defects and volume asymmetries.

DISCUSSION

Our practice has transitioned from inpatient to exclusively outpatient free flap breast reconstruction. Surgical costs are broadly divided into three categories: surgeon fee, facility fee and equipment fees. One of the most substantial overall expenses in DIEP and other free flap-based breast reconstructions is the payment to the hospital (facility fee). Although there has been considerable migration to outpatient surgery in other surgical subspecialties, reconstructive microsurgery may be lagging. For example, anterior cervical discectomy and fusions have traditionally been performed inpatient. However, with advancements in surgical technique, advent of minimally invasive surgery, appropriate patient selection, surgeon experience and improvement in pain control, anterior cervical discectomy and fusions and numerous other surgeries are now routinely performed on an outpatient basis with equivalent results and decreased expenditure.⁴⁻⁶ Overall, we have identified facility fee as one of the most substantial expenditures and therefore targeted this to increase productivity and decrease cost.

Previous publications have shown that DIEP flaps can be performed successfully on an outpatient basis.^{1,7} The purpose of this study was to show that complex and multiple flaps can also be done without an extended hospitalization. To accomplish this, we employ a team-based model. Our surgical team includes two surgeons and two assistants [physician assistants (PAs)]. One surgeon begins harvest of the PAPs in lithotomy position, identifies and isolates the pedicles, but leaves the posterior skin attached. Simultaneously, the second surgeon prepares the chest to receive the flaps and prepares the internal mammary vessels. The first available surgeon harvests the first DIEP flap and transfers it to the chest for anastomosis with the assistance of a PA. The second surgeon harvests the second DIEP flap and passes it to the chest for anastomosis. During the second DIEP anastomosis, the thighs are closed by PAs. Once the thighs are closed, the patient is flexed and the abdomen is closed by a surgeon and/or PA while another surgeon is performing microsurgical

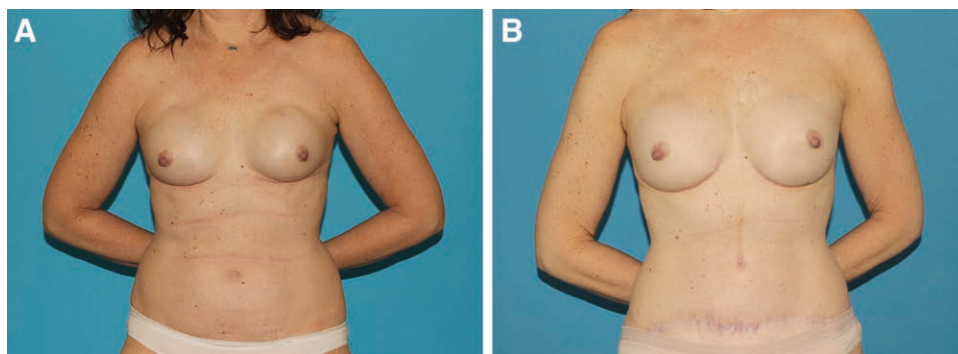


Fig. 2. A 51-year-old patient with a history of implant-based reconstruction (A) underwent subsequent autologous reconstruction with DIEP and vertical PAP stacked flaps (B).



Fig. 3. Preoperative photographs (A, B) of a 32-year-old patient with a BMI of 20 and limited abdominal donor availability. Postoperative photographs (C, D): a vertical approach preserves the gluteal fold and diminishes the risk of long-term scar spreading.

anastomosis. All four members of the surgical team are working, in concert, throughout the case.

Our team extends beyond those performing surgery. We routinely work with the same surgical technicians, circulating nurses, and anesthesiologists who are familiar with our surgeries and practice model. Our recovery room nurses are familiar with flap monitoring and call us directly with any questions or concerns. Additionally, we have transitioned to utilizing a physician-owned outpatient surgical center, allowing us to control quality of staff and cost of procedures. This model has been encouraged by third-party payers.

Furthermore, our practice has evolved based on patients and referral patterns. The bulk of our early practice was based on referrals from breast surgeons. Currently, we have many patients who come to us seeking autologous reconstruction after being turned down for procedures of this type elsewhere. It is for this reason that we have many patients with limited donor sites requiring breast reconstruction with stacked flaps. We carefully screen patients, only implementing this model for those who are ASA class

I or II and tailor our approach in those with above-average coagulopathy risk. We mitigate risk further using a postoperative anticoagulation protocol on all patients.

The novel aspect of this study is combining stacked DIEP with vertical PAP flaps in an outpatient setting. No prior studies have demonstrated this combination of techniques. Although DIEP flaps are often the ideal reconstructive choice due to their favorable blood supply and ability to resemble preoperative form, adequate abdominal tissue is not always present and breast size is limited by donor site tissue availability. In cases where abdominal tissue is not available, alternative free flap options, such as the PAP, may be used.⁸⁻¹⁰ When DIEP flaps do not provide sufficient volume to achieve desired aesthetic outcomes, stacking flaps is a good option.¹¹⁻¹⁴

When the goal is increased volume and projection of reconstructed breasts, we believe that stacked flaps offer superior outcomes compared with adjunct use of implants¹⁵⁻²² or fat grafting.²³⁻²⁹ The PAP flap, properly introduced in 2012 by Allen et al,³⁰ is an excellent solo choice for small and medium reconstructions, but its

versatility truly shines when combined with other flaps, especially the DIEP.^{31–33} Although stacking flaps provides a superior and natural appearance, this approach often receives criticism related to operative length and associated complications. We would argue that surgeon experience and careful patient selection can mitigate these concerns. Unlike prosthetics, flaps can lose volume secondarily due to fat necrosis or muscle atrophy. We diminish these risks with routine use of indocyanine green angiography for flap evaluation, and avoidance of muscle flaps.³⁴

The design utilized for PAP flaps further optimizes its reconstructive potential. Accessibility and varied perforator location provide versatility when creating the PAP flap. The PAP flap's advantageous anatomy extends transversely in the upper thigh and longitudinally in the distal thigh, allowing the surgeon to fashion flaps in transverse, diagonal, or vertical orientations.^{35–38} Rivera-Serrano et al first described the use of a vertical PAP for bilateral breast reconstruction, highlighting the use of more favorable distal perforators, which are larger and centrally located, in contrast to proximal perforators used in transverse PAP flaps.³⁹

Primary limitations of transversely oriented skin paddles include: restricted flap width, excessive tension on donor site closure, and flattening along the gluteal fold. In our hands, when performing the transverse-oriented PAP flap, we had extensive incidences of scar widening, as well as several patients who developed labia distortion and sexual function complaints. Furthermore, while trying to mitigate these issues anchoring the fascia to the pubis, we had several cases of pubalgia that were debilitating, requiring several injections of local anesthetics to alleviate. It is for this reason that we felt it was necessary to switch from a horizontal approach to a vertical design. Vertical flap offers several advantages. First, when harvested in the vertical direction, available volume is increased and subsequent projection is optimized. Additionally, tension along groin incisions, which are prone to short term dehiscence and long-term widening, can be diminished by utilizing a vertical approach. The vertical pattern donor site is also less subject to compressive forces from sitting, allowing for optimized healing and diminished postoperative discomfort.

Before this series of patients, we routinely performed the PAP flap in a subfascial or standard approach. Approximately 7 years ago, we transitioned to a suprafascial dissection of the PAP flap. This change in dissection plane, while making it more difficult to identify the perforators, results in a noticeable improvement in seroma and complication rates at the thigh donor site. We believe this is due to the fact that the constant muscle contraction underneath the raised flaps for closure is one of the main causes of seroma formation. The vertical design also prevents distortion of the posterior portion of the labia and gluteal fold. For these reasons, we routinely use a vertically oriented flap with a proximal fishtail extension, yielding a larger volume flap and optimizing reconstructive outcomes.

Additionally, our early recovery protocol, similar to other early recovery after surgery procedures, allows us to perform microsurgical breast reconstructions in an

outpatient setting. This significantly decreases the length of stay without a rise in complication rates or hospital readmissions,^{1,40,41} while offsetting the costs associated with perforator-based breast reconstructions.^{42,43}

Importantly, we feel necessary to mention that this outpatient approach is not ideal for an inexperienced microsurgeon, in fact, we believe that this approach is only feasible after years of training and experience. We do not view outpatient microsurgical breast reconstruction as an initial step. Moreover, we believe the most important message that most of the readership will take away from this experience is that microvascular procedures can be performed with a more limited length of stay if done with a modified technique focused on less invasive approaches. With this being said, surgeons may begin to migrate from large fascial incisions with a prolonged length of stay to increasingly smaller lengths of incisions, resulting in decreased morbidity allowing for earlier discharge.

CONCLUSIONS

Stacked DIEP/PAP flaps offer an excellent option for patients who require more volume than available from DIEP flaps alone. When compared with transverse PAP flaps, the vertical PAP offers excellent variability of volume and ease of shaping to allow for excellent results. The vertical PAP minimizes donor site tension in the seated position and preserves the gluteal fold, which enhances buttock aesthetics and diminishes risk of long-term scar spreading or labial distortion.

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