Stacked Deep Inferior Epigastric Perforator Flap Breast Reconstruction: A Review of 110 Flaps in 55 Cases over 3 Years

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**Background:** Breast reconstruction continues to evolve. The deep inferior epigastric perforator (DIEP) flap is a well-described means of providing natural tissue reconstruction with an attendant goal of minimizing damage in the abdominal donor site.

**Methods:** For patients with the need for autogenous reconstruction of a single breast and insufficient abdominal fatty volume for routine DIEP flap reconstruction, the authors present an option that allows for incorporation of the entire abdominal fatty composite with sequential linkage and stacked inset of two individual abdominal flaps. The ability to take advantage of the entirety of the abdominal donor volume allows those with a relatively thin body habitus to enjoy candidacy for DIEP flap reconstruction. This sophisticated microsurgical procedure overcomes some of the limitations of other techniques with similar goals such as the bipedicled transverse rectus abdominis musculocutaneous flap by avoiding muscle sacrifice and allowing precise, independent flap inset. The authors describe their experience with this technique in 55 patients with 110 flaps over 3 years.

**Results:** The authors’ experience reviews the use of the stacked DIEP flap in a large number of patients with high success rates and superb aesthetic outcomes over a relatively short period of time. Of the 55 patients who underwent reconstruction, all enjoyed successful outcomes. Patient satisfaction was high in the studied population.

**Conclusion:** Stacked DIEP free flap breast reconstruction is a reproducible, safe, and innovative yet technically demanding solution for patients seeking autogenous breast reconstruction with otherwise inadequate abdominal fatty volume. *(Plast. Reconstr. Surg. 127: 1093, 2011.)*

Breast reconstruction continues to evolve on both the artistic and scientific fronts. Women seeking improved outcomes and permanent solutions press the plastic surgeon forward toward achieving the best possible result. Autogenous breast reconstruction has proven to provide the most natural and lasting result over time.¹ The transverse rectus abdominis musculocutaneous (TRAM) flap² was a revolutionary step forward, but the deep inferior epigastric perforator (DIEP) flap gives the plastic surgeon the tools to provide the benefits of natural tissue reconstruction without sacrificing the abdominal musculature.³ The many benefits of natural tissue reconstruction have been well described, but a quandary is encountered when the patient presents with an inadequate amount of abdominal fat with which to rebuild the breast. In some cases, reconstructing the breast to a smaller size and reducing the opposite breast is an option. For others, the amount of abdominal tissue is so inadequate that the ultimate result with a standard abdominal tissue transfer will be disappointing and aesthetically poor. For those who would rather keep their breast size or in whom the amount of

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abdominal fat is insufficient to give projection and
shape to match the opposite breast, a number of
second-tier options are usually considered. Glu-
teal artery perforator flap reconstruction,4 which
can usually provide ample tissue in even the most
athletic of patients, is one potential solution, but
for the patient with a need for unilateral breast
reconstruction, the issue of donor-site asymmetry
with the opposing buttock must be considered.
Other options are to augment the DIEP breast
with an implant or to perform latissimus flap sur-
gery, which usually also requires an implant for
adequate volume. These options are less desirable
for the patient who wishes to avoid use of implants,
and in the case of the latissimus flap, the need for
muscle sacrifice and a scar across the back will
deter many patients. One must also consider the
deforming and dynamic contractile distortion that
a submuscular implant may produce in a recon-
structed breast. A new and tried option for these
patients allows use of more abdominal tissue than
has been possible in the past without sacrifice of
the abdominal rectus.

If only one breast needs to be reconstructed in
the patient with inadequate zone I/III volume, use
of the whole abdominal pannus in a layered con-
figuration can provide an option for reconstruction
with abdominal tissue when standard TRAM/
DIEP techniques fall short. To accomplish this,
adequate perfusion of all zones is required (zones
I to IV). Unfortunately, the perfusion of the abdo-
nominal soft tissue on a single unilateral pedicle
is inadequate, and fat necrosis in the underper-
fused zones can be expected.5,6 Hartrampf zones
II and IV and Holm zones III and IV are those most
at risk and are often discarded in a single-pedicle
flap as a result. Wong et al. have recently shown
some variability in these flow patterns depending
on whether the DIEP flap is based on the medial
or lateral row of perforating vessels7; however, all
referenced studies agree that a single-sided pedi-
cle is inadequate to perfuse the entire abdominal
soft-tissue composite. One solution is to bring the
vascular supply of both hemiabdomens into play,
creating a vascularized and layered tissue com-
site. The bipedicled TRAM flap is one means of
providing this additional blood supply to the extra
tissue burden.8,9 Attempts to address the weak-
nesses of pedicled flap technique with free bi-
pedicled TRAM flaps10 have also been performed,
but both approaches carry with them the problem
of the rectus abdominis muscle sacrifice from both
sides of the abdomen. This is a serious consider-
ation for the patient undergoing onesided breast
reconstruction, and some argue that the benefit
may not be worth the morbidity of sacrificing the
entire abdominal muscle wall.11 Permanent, sig-
nificant truncal weakness and the possibility of
significant abdominal bulge and/or hernia must
be thoroughly disclosed and discussed with the
patient before committing to the bipedicled
TRAM flap.12 Our procedure for autogenous
breast reconstruction in the patient with otherwise
inadequate abdominal fatty tissue volume is de-
scribed in this article, and an experience with 55
patients over a 3-year period is reviewed. The
stacked DIEP free flap combination allows for a
reconstruction that takes advantage of the full soft-
tissue volume of both sides of the abdomen with-
out sacrifice of the abdominal rectus muscles. Two
DIEP free flaps are combined in a layered fashion
in the associated breast pocket with microsurgical
sequential linkage of the two pedicles and result-
ant flow through from the recipient internal mam-
mary vessels.

METHODS

The stacked flap is considered for patients pre-
senting with the need for a single-breast recon-
struction and inadequate abdominal fatty volume in
the hemiabdomen for a routine TRAM or DIEP
flap technique. Our experience has included
those undergoing delayed and immediate recon-
struction, those with previous unsatisfactory im-
plant reconstruction, and those with failed gluteal
artery perforator flap reconstructions. Women
with Poland syndrome may also be especially good
candidates for stacked flap breast reconstruction,
considering the unilateral breast deficiency these
patients suffer.

Clinical examination allows for estimation of
fatty volume in the donor site. When the estimate
of volume in a single-side abdomen falls roughly
between one-third and one-half of the desired fi-
nal breast volume, the stacked flap may be ap-
propriate. Perforators of the deep inferior epiga-
sist system are identified and marked before surgery
with an 8-MHz handheld Doppler probe (Fig. 1).
Computed tomography-guided angiography may
be used to give more presurgical specificity with
respect to planning of microsurgical linkages and
anticipated flap flow source. In particular, the rel-
ative sizes and associated utility of various deep
inferior epigastric perforators and the superficial
inferior epigastric system may be predicted.

Surgery begins with dissection of the flap op-
posite the breast being reconstructed. Inspection
of the superficial system is undertaken first and, if
adequate, dissected just proximal to entry into the
common femoral and ligated. Perforators of the
inset is developed as the surgical dissection progresses. This allows the surgeon to develop the most appropriate plan for vascular construct as the elevation of the flaps progresses. Once the pedicle dissection is complete, attention is directed to the opposite hemiabdomen. This second flap is dissected in manner similar to the first flap without concern for dissection of branch points. It is advisable to dissect the superficial inferior epigastric artery (SIEA) pedicle on the secondary flap, if present, to serve as a backup anastomosis point for connection to the primary flap; but we have found that using the DIEP pedicle for the secondary flap provides an easier inset of the various vascular components. Once the pedicle is dissected free, the flap is harvested as a single composite with ligation of the pedicles at their dissection endpoints.

Preparation of the recipient vessels in the breast pocket is undertaken with exposure of the internal mammary artery and vein(s). The flaps are then separated into two separate flaps near the midline for delayed reconstructions. This affords an easier inset along the lower pole of the breast and maximum projection in the completed reconstruction. For immediate reconstruction in a patient with very thin flaps, the composite may be left as one unit and folded. Although the vascular exchange between zones I and III has not been shown to be significant, the added exchange in the folded flap is one more vascular redundancy that is worth consideration. In our experience, a more precise and better-shaped inset is typically possible with separation of the flaps. This should be of no concern when the anastomoses and associated vascular construct is well thought out and precisely performed. This avoids an otherwise squared-off tendency in the lower pole of the breast.

The ipsilateral abdominal flap is then deperitonealized and inset into the breast pocket. The vascular pedicle of the primary flow-through flap is oriented appropriately to provide alignment with the planned anastomotic branch point in the opposing flap (Fig. 3). The secondary flap's DIEP or SIEA pedicle will be anastomosed to the branchpoint or distal pedicle of the primary flap after anastomosis of the primary flap's pedicle to the internal mammary source vessels is complete. Anastomosis is then completed between the venae comitantes of the deep inferior epigastric system and the internal mammary veins. Arterial anastomosis is then carried out with 9-0 nylon. Implantable Doppler probes are applied to the arterial and venous anastomosis sites. Anastomosis of the selected branch point of this primary pedicle to

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**Fig. 1.** Presurgical markings for immediate reconstruction of the right breast with stacked DIEP flaps.

**Fig. 2.** Pedicle dissection for the stacked DIEP flap.
the pedicle of the deeper flap is then completed similarly (Fig. 4). Once complete, the overlying flap is positioned carefully, taking particular care to inspect the vascular arrangement, and inset is completed. Implantable Doppler probes were not applied routinely to the branch point anastomosis in this series because of concern regarding displacement of the vascular construct with Doppler wire removal; however, use for all anastomoses may be considered. Volume of the final reconstructed breast is tailored with trimming of the deeper flap before it is inset and of the superficial flap once anastomosis is complete.

RESULTS

Stacked DIEP flap breast reconstruction was performed on 55 patients over a 3-year period from April of 2004 to April of 2007. Twenty-seven patients underwent immediate reconstruction at the time of mastectomy and 19 had delayed reconstruction after previous mastectomy. Seven patients presented for removal of unsatisfactory implant reconstruction because of either capsular contracture, unsatisfactory aesthetics, or both. Two patients had stacked DIEP reconstruction for failed superior gluteal artery perforator flap replacement. One patient had previously undergone unilateral inferior gluteal artery perforator flap breast reconstruction at an outside institution but refused another inferior gluteal artery perforator flap because of chronic pain in the defatted weight-bearing buttock. She elected to undergo stacked flap reconstruction on return for prophylactic mastectomy on the other breast.

The average patient age was 48 years, with a range of 33 to 77 years. Two patients were active smokers with associated instruction to quit 3 weeks before surgery. Average patient weight was 138 lb,
with a range from 109 to 180 lb. One patient suffered from hypertension, one had Graves' disease, and one had a history of previous deep venous thrombosis. No other significant medical problems were present in this patient population. Notably, nine patients had undergone previous cesarean delivery, four had undergone inguinal hernia repair, and two had undergone appendectomies. Despite these previous abdominal procedures, no problems were encountered with the microvascular dissections.

In those undergoing immediate reconstruction, the average mastectomy weight was 456 g. The average combined weight of both hemiabdominal flaps in these patients was 543 g. The overall average combined flap weights for the entire patient population was 596 g.

Operative time averaged 5 hours 16 minutes, and hospital stay averaged 3 days. Three patients developed postsurgical hematomas, with one requiring return to surgery for evacuation. All hematomas occurred in patients undergoing immediate reconstruction. There were no flap failures or returns to surgery for flap-related problems. Patient satisfaction was high among the studied population, and all reported that they would have elected to undergo the procedure again based on their experience and associated outcome (Figs. 5 and 6).

**DISCUSSION**

In biological terms, a chimera is an organism that has two or more different populations of genetically distinct cells. Each population of cells keeps its own character, and the resulting animal is a mixture of tissues. The combination of flaps with independent pedicles or single vascular sources into composite flaps with associated microvascular linkages has been referred to as "chimeric" assembly of a reconstructive composite for whatever the need may be that cannot be addressed by a single flap. This principle may be used to incorporate multiple tissue types or to overcome volume limitations of a single tissue type. Flaps are typically linked in a daisy-chain fashion, with a final common anastomosis to the recipient blood supply. The DIEP and SIEA flaps have also been well described as techniques to provide for natural tissue breast reconstruction without the associated morbidity of muscle tissue sacrifice. The combination of these principles in a large series with repeated success has not been previously described.

Attempts to accomplish the transplant of added abdominal fatty volume for patients with insufficient soft tissue for a routine flap procedure have ranged from bipedicled TRAM flaps to two pedicle free TRAM flaps anastomosed to indepen-

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**Fig. 5.** The patient is shown before and after mastectomy of the left breast with immediate stacked DIEP flap reconstruction, subsequent nipple reconstruction, and right mastopexy for symmetry. The combined weight of the two abdominal flaps was 508 g.
dent source vessels. Tseng et al. described a three-case series where arterial and venous turbocharging of various configurations in DIEP and TRAM flaps was accomplished to overcome vascular insufficiency. Blondeel and Boeckx reported a single case where bilateral DIEP pedicles were dissected to allow transfer of an entire abdominal pannus with a midline infraumbilical scar. The flaps were not separated or layered. The artery of the second pedicle was anastomosed end-to-side to that of the primary flap's artery, and the venous anastomosis of the two flaps was accomplished with a Y connection of the flap comitantes to a transposed cephalic vein. The opinion of Blondeel and Boeckx was that the comitantes of the internal mammary are too small for use as the venous outflow conduit for the flaps. Our experience, as referenced in this series, is that they are always adequate, and if a bailout venous outflow is required, a superficial inferior epigastric vein anastomosed to an intercostal vein will relieve any signs of congestion. This was not required in this series but has been used by our group in the past with single flap DIEPs for this problem. Agarwal and Gottlieb reported on a series of 14 patients where bipedicled flaps using combinations of DIEP and TRAM dissections allowed for transfer of zones I through IV in large-breasted women. The flaps were not stacked or layered, and each flap was anastomosed to a separate vascular system, ranging from the serratus branch to the thoracodorsals and the internal mammary vessels. Our series differs in that all of our flaps are stacked/layered and usually separated entirely from one another and the flaps are anastomosed to a single common feeding vascular source. Figus et al. reported a single case combining a DIEP flap and a superficial inferior epigastric artery flap for a single breast reconstruction to overcome limitations from a vertical midline infraumbilical scar. Schoeller et al. reported similarly for midline scarring challenges with crossover anastomosis from the DIEP to a contralateral paraumbilical perforator. Ali et al. described a setup in a case where the primary flap was used to feed an overlying flap with a branch chain anastomosis. The composite was then plugged into the subscapular system. This arrangement is concerning because any problem in the flow within the pedicle arrangement puts the flap with exposed skin paddle and outer contour effect in jeopardy. If there is a problem in the branch chain anastomosis, it is our opinion that the flap that would be compromised in this setting would be the underlying "filler" flap. That way, the outer flap can be salvaged and, if necessary, the volume lost from an underlying flap problem can be replaced with an implant at the second stage.

The stacked flap gives the woman with a need for more tissue than can be transferred from the abdominal donor site with a TRAM flap or standard DIEP or superficial inferior epigastric artery flap another option for autogenous tissue reconstruction. The bipedicled TRAM flap has been described to provide a reach toward the goal of added volume transfer, but the need for sacrifice
of all of the rectus muscle in the abdomen and the large tunnel for pedicle passage and variable success make this an undesirable modality for most patients, and produces more morbidity than would seem reasonable. Multiple case reports have touched on the various methodologies that may be used to overcome vascular challenges in microsurgical free tissue flap breast reconstruction. Our experience reviews the repeated use of the stacked DIEP flap in a large number of patients with high success rates and superb aesthetic outcomes over a relatively short period. High patient satisfaction rates offset the added hour and a half of the operation and the associated technical demands on a well-experienced microsurgeon.

CONCLUSIONS

Stacked DIEP free flap breast reconstruction is a reproducible, safe, and innovative yet technically demanding solution for patients seeking autogenous breast reconstruction with otherwise inadequate abdominal fatty volume. Avoidance of sacrifice of both muscular columns in the abdominal donor site is a major advantage over the pedicled TRAM flap. Another significant advantage, in contrast to the pedicled TRAM flap, is the freedom to inset the flaps independently to place fill and projection into the most desirable locations within the breast pocket, thereby maximizing the aesthetic outcome. These benefits provide a uniquely versatile autogenous solution for the woman in need of greater breast volume with minimized morbidity.

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