Farajzadeh *et al.* *Plast Aesthet Res* 2024;11:32
DOI: 10.20517/2347-9264.2024.24

Plastic and Aesthetic Research

Review

Open Access

Check for updates

Optimizing perfusion and volume in autologous breast reconstruction: dual-plane, conjoined and stacked flaps

Matthew M. Farajzadeh, Ara A. Salibian

Division of Plastic & Reconstructive Surgery, University of California, Davis School of Medicine, Sacramento, CA 95817, USA.

Correspondence to: Dr. Ara A. Salibian, Division of Plastic & Reconstructive Surgery, University of California, Davis School of Medicine, 2335 Stockton Blvd., NAOB, 6th Floor, Sacramento, CA 95817, USA. E-mail: asalibian@ucdavis.edu

How to cite this article: Farajzadeh MM, Salibian AA. Optimizing perfusion and volume in autologous breast reconstruction: dual-plane, conjoined and stacked flaps. *Plast Aesthet Res* 2024;11:32. https://dx.doi.org/10.20517/2347-9264.2024.24

Received: 16 Feb 2024 **First Decision:** 8 Jul 2024 **Revised:** 16 Jul 2024 **Accepted:** 26 Jul 2024 **Available Online:** 31 Jul 2024

Academic Editors: Roberto Cuomo, Marten Basta **Copy Editor**: Yanbin Bai **Production Editor**: Yanbin Bai

Abstract

Microsurgical breast reconstruction has continued to evolve to improve outcomes and minimize complications. Dual-plane, conjoined and stacked flaps represent one aspect of this evolution in an effort to improve tissue perfusion and flap volume. Dual-plane flaps combine the superficial and deep circulation in abdominally-based free flaps to augment perfusion. Conjoined flaps use additional pedicles to supply multiple perforasomes combined in a single flap. Stacked flaps utilize separate flaps on individual pedicles to increase volume at a single recipient site. Multiple donor sites, pedicle configurations and recipient vessel choices have been described, primarily focusing on using the cranial and caudal internal mammary system as well as intra-flap anastomoses. Though more technically demanding, dual-plane, stacked and conjoined flaps allow for improvement in flap perfusion and volume, and are important tools for optimizing results in autologous breast reconstruction.

Keywords: Autologous, breast, microsurgery, stacked flap, conjoined flap, dual plane flap, DIEP

INTRODUCTION

Since the description of the free transverse rectus abdominis myocutaneous (TRAM) flap in 1979, microvascular breast reconstruction has continuously evolved to refine outcomes and minimize morbidity[1]. Autologous breast reconstruction has demonstrated consistently high rates of patient satisfaction and superior aesthetic outcomes[2-4]. With the advent of perforator-based techniques, an armament of flap donor site options have expanded reconstructive options for patients, including the abdominally-based deep inferior epigastric artery perforator (DIEP) and superficial inferior epigastric artery (SIEA) flaps; thigh-based profunda artery perforator (PAP) and lateral thigh perforator (LTP) flaps; and lower back/buttock-based superior gluteal artery perforator (SGAP), inferior gluteal artery perforator (IGAP), and lumbar artery perforator (LAP) flaps.

In an effort to improve tissue perfusion and optimize flap volume, particularly in situations of a discrepancy between desired breast size and donor tissue availability, multi-pedicled and multiple flap techniques have been developed. Pennington *et al*. first described a conjoined transverse rectus abdominis myocutaneous (TRAM) flap with intra-flap anastomosis to augment zone IV perfusion in 1993[5]. Today, multiple variations of this technique are used to maximize donor tissue perfusion and volume. Dual-plane flaps most commonly refer to the abdominal donor site where both the deep and superficial systems are harvested. Conjoined flaps utilize multiple pedicles supplying different perforasomes within a single flap. Stacked flaps involve multiple separate flaps that are transferred to the same recipient site for additional volume. Nomenclature does vary significantly in the literature and "stacked" flaps have also been referred to as what some would consider traditional bipedicled flaps.

These techniques can be challenging due to the need for additional flap dissection, numerous anastomoses, multiple pedicles that can affect lie as well as more tedious flap inset and shaping. However, in cases of compromised donor sites, a discrepancy between volume of tissue and area of perfusion and a need for increased overall reconstruction size compared to the availability of donor tissue, these procedures can be invaluable tools to deliver an ideal breast reconstruction. The purpose of this paper is to present a narrative review and discussion of autologous breast reconstruction techniques for optimizing flap perfusion and breast volume.

Dual-Plane abdominal flaps

The variability in the perfusion of the abdomen between the deep and superficial systems is not a new concept. The concern for a superficial dominant flap, however, has primarily been focused on venous drainage and the importance of the superficial inferior epigastric vein (SIEV). Blondeel *et al*. first described the importance of augmenting venous outflow in congested flaps with a large SIEV in 2000[6]. Since then, the use of additional superficial venous outflow in DIEP flaps has become common practice for addressing intrinsic congestion. While SIEV caliber has been suggested to not correlate with a dominant superficial venous system, approaches have focused on algorithmically preserving the SIEV if flap congestion is noted despite an undamaged and patent deep venous system[7,8].

The modern "dual plane DIEP"(DP-DIEP) describes an abdominally based perforator flap where the superficial inferior epigastric artery (SIEA) and/or SIEV [Figure 1] is utilized in addition to the deep system to perfuse a flap[9,10]. A retrospective cohort study by Sbitany *et al*. compared 25 DP-DIEP flaps utilizing the SIEA/V with 35 traditional DIEP flaps, and demonstrated a lower rate of fat necrosis in flaps augmented with superficial perfusion[9]. Other authors have argued that hypoperfusion remains solely a venous outflow problem, as originally described, that is improved with SIEV augmentation, without an arterial component[11]. While the need for venous outflow augmentation is indeed most prevalent, the utility of augmenting superficial inflow is likely to be multifactorial and continues to be elucidated.

Deciding to utilize the superficial system to augment both arterial and venous outflow is multifactorial and depends not only on the size of the SIEA, but the amount of tissue harvested in relation to the number, size,

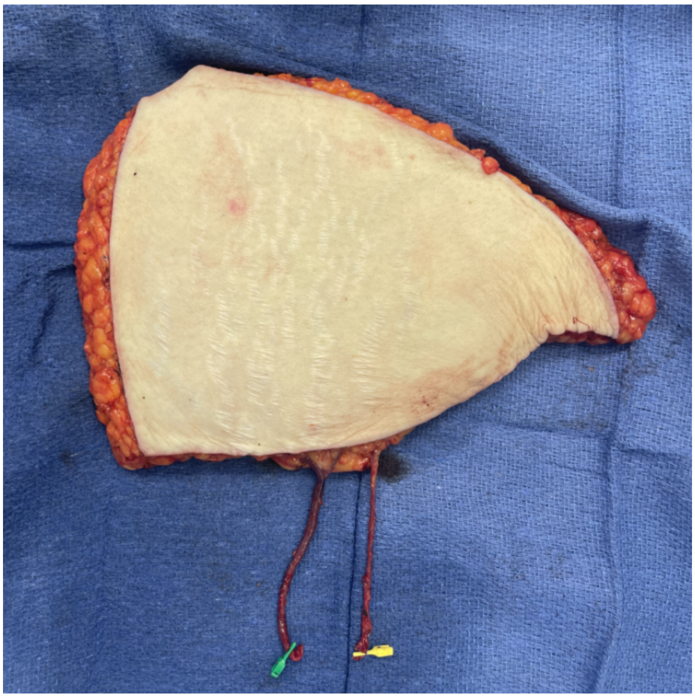

Figure 1. Harvest of the SIEA (yellow bulldog) and SIEV (green bulldog) to their origin in a DIEP flap provides adequate length to allow for multiple different recipient vessel options (intra-flap branch or runoff, caudal IM vessels, etc.). DIEP: deep inferior epigastric artery perforator; SIEA: superficial inferior epigastric artery.

row and centricity of deep perforators utilized. Sbitany *et al*. described assessment of flap perfusion on the deep system in situ, and hypoperfusion of the suprascarpal fat or persistent skin hyperemia as an indicator to augment with the superficial system[9]. While the superficial system should be used in cases that demonstrate clinical hypoperfusion, it can also be utilized to minimize morbidity by limiting the number of deep perforators harvested. Larger flaps that might otherwise require multiple perforators or perforator rows can be harvested on a single dominant perforator while using the SIEA and SIEV for additional perfusion [Figure 2]. Such techniques can help to limit the fascial incisions and to optimize the perfusion of a large amount of tissue harvested on a single perforator based on individual anatomy.

The use of both the deep and superficial system in DIEP flaps with a superficial dominant system or diminutive deep system has also been supported. Hembd *et al*. demonstrated a significantly lower rate of fat necrosis and flap failure with SIEA/SIEV DP-DIEP flaps compared with SIEA flaps[10]. From these findings, the authors advocate for the use of a dual-plane system over superficial-only perfusion if preoperative imaging demonstrates deep system perforators <1.0 mm in size or with intraoperative findings of venous congestion or ICG hypoperfusion[10].

CONJOINED FLAPS

The conjoined flap combines different flap territories that are in close proximity, thus enabling optimization of the balance of perfusion and the amount of tissue harvested[12,13]. Often referred to as bipedicled flaps, a single piece of tissue is harvested, including more than one perforasome based on separate pedicles. Conjoined flaps are most commonly harvested from the abdomen as bipedicled DIEP flaps but can also be from different donor sites. The use of an additional vascular pedicle allows the surgeon to increase the amount of skin and soft tissue harvested while minimizing the risk of fat necrosis in watershed areas.

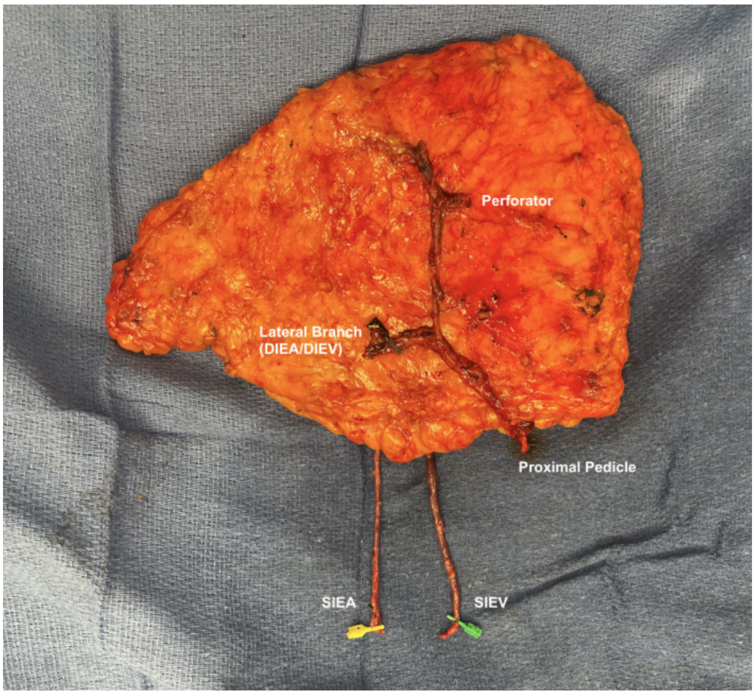

Figure 2. Dual-plane DIEP flap based on single high medial perforator with the SIEA and SIEV anastomosed to the lateral branch of the deep system. DIEP: deep inferior epigastric artery perforator; SIEA: superficial inferior epigastric artery.

Abdominal donor site

The conjoined DIEP flap utilizes the entire abdomen in a bipedicled design with both the right and left deep inferior epigastric systems to increase the amount of tissue harvested for a unilateral reconstruction while optimizing perfusion [Figure 3]. This technique was initially born out of a need to circumvent midline abdominal scars and subsequently evolved from the extended hemi-abdominal flap to improve perfusion across the midline and address a discrepancy between available donor-site tissue and desired breast volume[14]. The conjoined DIEP is particularly useful in delayed reconstructions or in cases with damaged chest wall skin secondary to radiation, as it provides ample skin for resurfacing.

Multiple studies have demonstrated the safety of unilateral breast reconstruction with the conjoined or bipedicled DIEP flap[15-20]. Compared to extended hemi-abdominal flaps, bipedicled abdominal flaps have been shown to have a lower rate of fat necrosis across the midline[21]. Importantly, donor-site morbidity has also been comparable between single pedicle and bipedicled conjoined flap designs in retrospective studies[22].

Several anastomotic configurations can be implemented, most commonly including the cranial and caudal IM vessels or the use of intra-flap anastomoses for the secondary pedicle. Managing pedicle lie is critical to avoid kinking or twisting[23]. In the case of IM vessel recipients, criss-crossing pedicles to the cranial and caudal IM artery and vein can help avoid sharp angles in the proximal pedicle[21]. Inset and shaping of conjoined abdominal flaps can be challenging, but still focus on the three critical principles of the footprint, conus and skin envelope[24]. Most commonly, conjoined flaps are either folded in the vertical dimension with the caudal flap buried or coned horizontally around the midline. Variations in these patterns can be tailored to achieve the necessary breast height, width, ptosis, projection, and skin replacement[25].

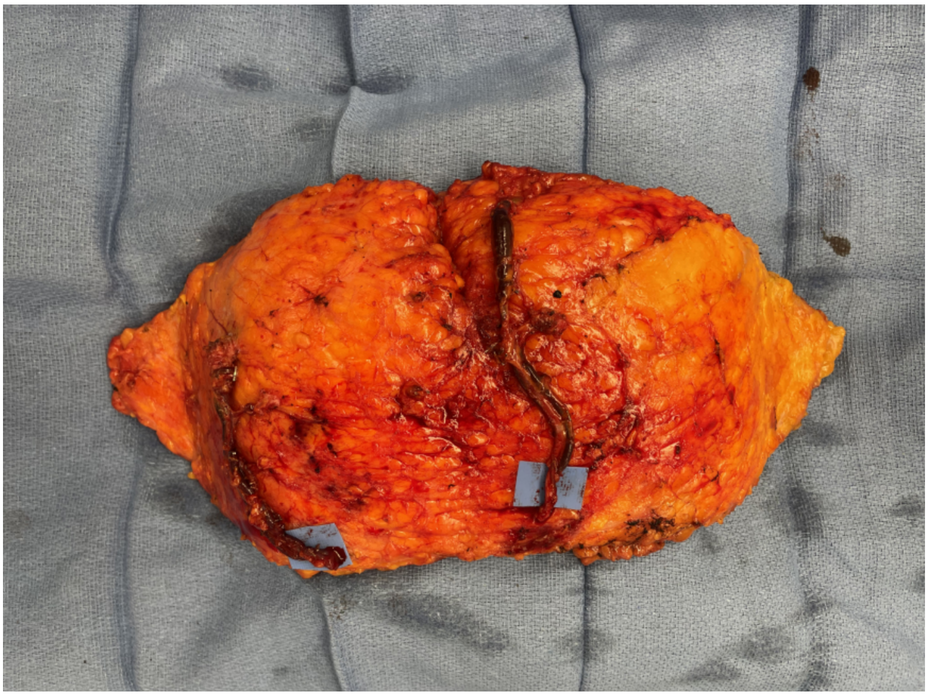

Figure 3. Conjoined or bipedicle DIEP flap for unilateral breast reconstruction. DIEP: deep inferior epigastric artery perforator.

Extended donor sites

The use of additional vessels based on adjacent known perforasomes has also expanded the volume limitations of traditional flaps. The stacked hemiabdominal extended perforator (SHAEP) flap combines the DIEP pedicle with more lateral pedicles to enable additional tissue harvest outside the zone of DIEP perfusion[26]. Multiple perforator combinations have been described, most commonly utilizing the DIEP and deep inferior circumflex artery (DCIA) pedicles[26]. Utilization of the lateral flank perfusion based on the superficial circumflex system can also help recruit more skin and volume when needed [Figure 4].

The lower extremity has also been utilized for conjoined flaps. A 2023 study by Chu *et al*. described harvesting PAP and LTP flaps as a conjoined "L-PAP flap" to optimize coning and projection[12]. The flap utilizes the medial, posterior, and lateral thigh tissues to improve reconstruction volume influenced by body contouring thigh-lift procedures[12]. Additional bipedicled designs in the lower extremity include combinations of the gracilis and PAP flaps, though PAP perforators typically provide robust perfusion of the medial thigh in isolation[27].

STACKED FLAPS

Stacked flaps typically consist of two physically separate flaps with isolated pedicles which are then anastomosed independently[14,28-30]. The individual flaps are shaped and inset to obtain the desired breast conus, volume, and footprint. The use of multiple flaps can help provide additional projection, overall volume, and skin resurfacing, depending on the need.

Single donor site

When the abdomen is utilized as a single donor site, the vast majority of reports have utilized a conjoined or bipedicled design.[29] However, splitting the abdomen and stacking hemiabdominal flaps is also a reported technique.[14] In such cases, the flaps are often placed on top of each other with an unmonitored buried flap,

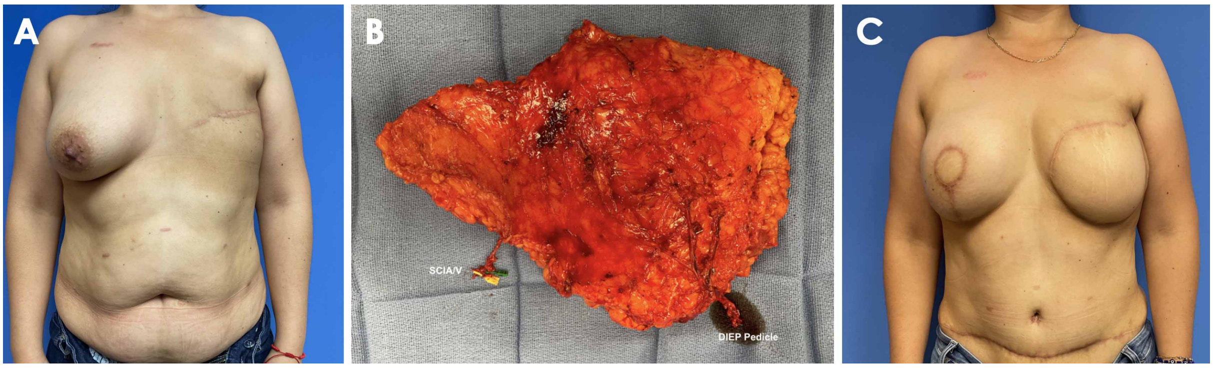

Figure 4. A: 35-year old female with a history of left total mastectomy and radiation planned for right prophylactic mastectomy. B: Left ShAEP flap using medial DIEP perforators and SCIA/SCIV planned to resurface and restore volume to radiated left chest (A small right DIEP flap for concomitant immediate right prophylactic mastectomy reconstruction was performed). C: 6-month postoperative photo prior to nipple reconstruction and tattooing.

though alternative means of monitoring, including flow coupler and Doppler blood flow monitors, are possible.

Some techniques preferentially call for splitting a conjoined flap into two independent stacked flaps[31]. DellaCroce *et al*. suggest that the folding of the bipedicled flap may actually compromise the shared blood supply and that separation of the flaps allows for independent inset and enhanced ability to shape the reconstruction[32]. While conjoined flap do offer less maneuverability and flexibility for inset, multiple techniques have been described to optimize shaping for both conjoined and stacked abdominally-based flaps[25].

Multiple donor sites

Independent stacked flaps are most commonly used from multiple donor sites. In autologous breast reconstruction, the lower extremity, particularly the medial thigh, is frequently utilized[33]. Flaps harvested from the medial thigh typically include the transverse upper gracilis (TUG), diagonal upper gracilis (DUG), and PAP flap[33]. The PAP flap was first described for breast reconstruction in 2012 and since then has become the second or third choice for autologous breast reconstruction after DIEP[34]. In cases where the abdominal donor site is unavailable or insufficient, the stacked PAP flap provides ample skin and soft tissue for unilateral reconstructions [Figure 5]. A retrospective series of 20 stacked PAP flaps by Haddock *et al*. reported an average combined flap weight of 685.5 g[28]. The long pedicle in the PAP flaps affords multiple options for recipient vessels. Flaps are typically anastomosed to the cranial and caudal IM vessels, though the thoracodorsal system or intra-flap anastomoses can also be utilized if necessary[28,35]. Stacked LTP flaps have similarly been described to provide adequate skin and volume in unilateral reconstructions[36].

The use of multiple flaps per breast lends itself to many opportunities for improving volume in autologous breast reconstruction. Several different configurations and donor sites for bilateral breast reconstruction have been described with stacking flaps at each recipient site, performing "four-flap reconstructions". Dellacroce *et al*. described bilateral stacked DIEP and SGAP flaps with intra-flap anastomoses effectively resulting in a body lift four-flap reconstruction[37]. More recently, a similar configuration of stacked DIEP and LAP flaps has also been described for a circumferential four-flap body lift reconstruction[38].

Four-flap reconstructions have classically utilized bilateral stacked DIEP and PAP flaps. In these cases, the PAP flap typically restores the lower pole contour while the hemi-abdominal DIEP is rotated 90 degrees for

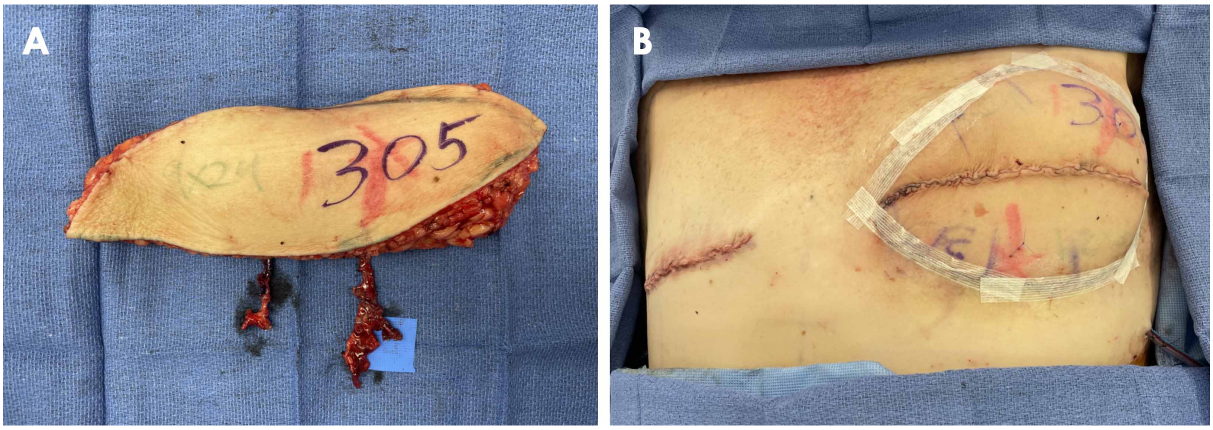

Figure 5. Stacked PAP flaps in a patient with prior bilateral mastectomy as well as a history of circumferential body lift with severe left chest wall radiation. A: A large proximal branch of one flap (blue background) is utilized as recipients for the second flap. B: Left stacked PAP reconstruction and right tissue expander placement in first stage of delayed reconstruction.

the upper pole, mimicking the shape of a mastectomy specimen[39]. Recently, studies have advocated for asymmetric four-flap reconstructions in cases of bilateral reconstruction, utilizing a conjoined bipedicled DIEP on the side requiring additional skin resurfacing and stacked PAP flaps on the contralateral side[39,40].

RECIPIENT VESSELS

Recipient vessels are a critical consideration when planning stacked and conjoined flaps, given the need for additional anastomoses. The most commonly used vessels in a systematic review of 2,006 flaps were the cranial and caudal internal mammary (IM) vessels [Figure 6][29]. A 2011 study by Stalder *et al*. showed that the anterograde and retrograde IMAs are adequate to perfuse a flap with a reported 97.5% success rate[35]. Their study also showed that the retrograde IM mean arterial pressure (MAP) is 74%-78% that of the anterograde[28,35]. If sizeable IM perforators are identified, these can also be utilized for secondary anastomoses [Figure 7][41]. A recent study by Teotia *et al*. examining anastomotic configurations in stacked flaps revealed a higher rate of postoperative venous compromise in caudal IM anastomoses, though this was attributed to vessel lie[42]. The caudal IM vein, however, has been demonstrated as a reliable means of outflow in multiple studies, and regression analysis of recipient vessels in a systematic review of stacked and conjoined flaps demonstrated that choice of recipient vessel was not associated with an increased risk of anastomotic complications[29,35,43-45].The use of intra-flap anastomoses is also common. Multiple options exist based on the needed vessel caliber, including the use of large branches in DIEP or PAP pedicles or the cranial runoff in DIEP flaps. This technique has been described for multiple different flap types, including sole SIEV venous outflow augmentation, conjoined abdominal flaps, stacked DIEP/GAP flaps, stacked PAP reconstruction, and bilateral stacked DIEP/PAP flap reconstruction with high success rates[11,37,46,47]. With intra-flap secondary anastomoses, it is important to remember that vascular issues in the primary pedicle would result in potential compromise of both flaps.

If the IM vessels are not suitable for use, additional options include the ipsilateral subscapular (SC) system comprising thoracodorsal or serratus vessels[28,35]. Utilization of the lateral thoracic vessels has also been described[48]. Finally, the contralateral IM vessels can also be used through a subcutaneous tunnel across the sternum[49].

CONCLUSION

Modern autologous reconstruction has evolved toward the goal of improving aesthetic outcomes and

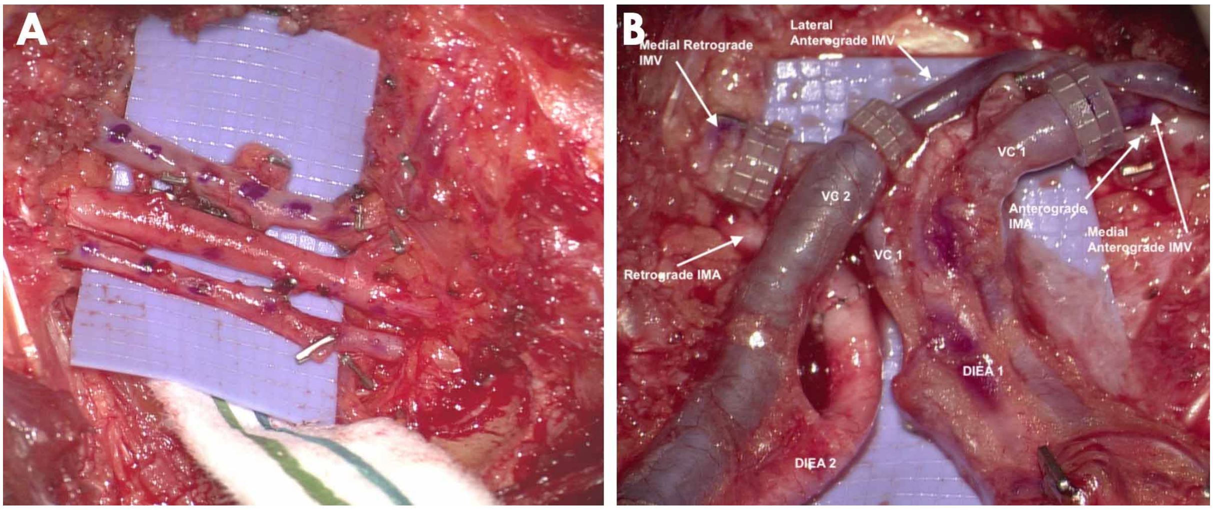

Figure 6. Anastomosis of a conjoined, bipedicled DIEP to the cranial and caudal internal mammary vessels. A: Wide rib-to-rib exposure of internal mammary vessels; B: Completed anastomosis with hemiabdomen 1 anastomosed to anterograde IMA, VC's anastomosed to anterograde medial IMV and retrograde medial IMV and hemiabdomen 2 anastomosed to retrograde IMA and anterograde lateral IMV. DIEP: deep inferior epigastric artery perforator.

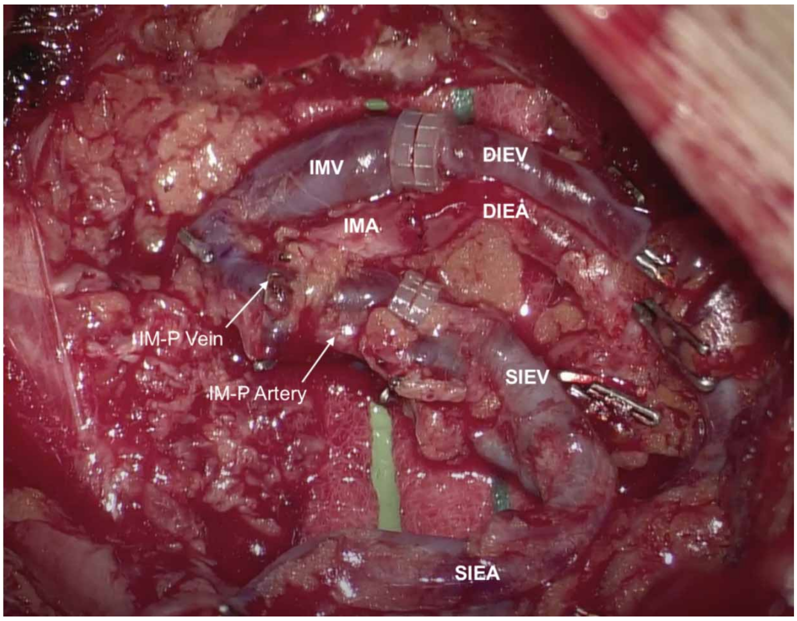

Figure 7. Anastomosis of dual-plane DIEP flaps with DIEA/V and SIEA/V pedicles. The DIEA/V are anastomosed to the cranial IM vessels and the SIEA/V are anastomosed to an IM perforator artery and vein. DIEP: deep inferior epigastric artery perforator; IM-P: IM-perforator.

minimizing donor site morbidity with microsurgical techniques. Dual-plane, conjoined and stacked flaps represent the continued innovation in this field, as well as the understanding and manipulation of perforator anatomy to achieve these goals. While the combinations of different types of flaps, pedicle designs, and anastomotic configurations are endless, the principles of perforator flap autologous reconstruction are continuous throughout these procedures. These modern techniques serve as tools to further assist the microsurgeon in tailoring individual reconstructive plans to each patient's unique needs and desires.

DECLARATIONS

Authors' contributions

Made substantial contributions to the conception and design of the study and contributed significantly to the writing of the study: Salibian AA
Performed data acquisition, literature review, and contributed significantly to the writing of the study, as well as providing administrative, technical, and material support: Farajzadeh MM

Availability of data and materials

Not applicable.

Financial support and sponsorship

None.

Conflicts of interest

Salibian AA is a research consultant for Abbvie, Inc. There were no internal or external funding sources for this study. All other listed authors declared that there are no conflicts of interest.

Ethical approval and consent to participate

The UC Davis IRB Administration has reviewed the manuscript, and IRB review is not required. Consent has been obtained for the use of images contained in the publication.

Consent for publication

Consent for publication has been obtained.

REFERENCES

1. Holmström H. The free abdominoplasty flap and its use in breast reconstruction. An experimental study and clinical case report. *Scand J Plast Reconstr Surg* 1979;13:423-27. DOI PubMed
2. Eltahir Y, Werners LLCH, Dreise MM, Zeijlmans van Emmichoven IA, Werker PMN, de Bock GH. Which breast is the best? *Plast Reconstr Surg* 2015;135:43-50. DOI PubMed
3. Jeevan R, Browne JP, Gulliver-Clarke C, et al. Surgical determinants of patient-reported outcomes following postmastectomy reconstruction in women with breast cancer. *Plast Reconstr Surg* 2017;139:1036e-45e. DOI
4. Liu C, Zhuang Y, Momeni A, et al. Quality of life and patient satisfaction after microsurgical abdominal flap versus staged expander/implant breast reconstruction: a critical study of unilateral immediate breast reconstruction using patient-reported outcomes instrument BREAST-Q. *Breast Cancer Res Treat* 2014;146:117-26. DOI
5. Pennington DG, Nettle WJ, Lam P. Microvascular augmentation of the blood supply of the contralateral side of the free transverse rectus abdominis musculocutaneous flap. *Ann Plast Surg* 1993;31:123-6; discussion 126. DOI PubMed
6. Blondeel PN, Arnstein M, Verstraete K, et al. Venous congestion and blood flow in free transverse rectus abdominis myocutaneous and deep inferior epigastric perforator flaps. *Plast Reconstr Surg* 2000;106:1295-9. DOI
7. Sadik KW, Pasko J, Cohen A, Cacioppo J. Predictive value of SIEV caliber and superficial venous dominance in free DIEP flaps. *J Reconstr Microsurg* 2013;29:57-61. DOI PubMed
8. Galanis C, Nguyen P, Koh J, Roostaeian J, Festekjian J, Crisera C. Microvascular lifeboats: a stepwise approach to intraoperative venous congestion in DIEP flap breast reconstruction. *Plast Reconstr Surg* 2014;134:20-7. DOI PubMed
9. Sbitany H, Lentz R, Piper M. The "Dual-plane" DIEP flap: measuring the effects of superficial arterial and venous flow augmentation on clinical outcomes. *J Reconstr Microsurg* 2019;35:411-6. DOI PubMed
10. Hembd A, Liu Y, Haddock NT, Teotia SS. Abandoning the SIEA flap for the dual-plane DIEP reduces fat necrosis and flap failure. *Plast Reconstr Surg* 2023;151:958-68. DOI PubMed
11. Davies AJ, Emam AT, Colavitti G, Wilson S. The "Dual-plane" DIEP flap: measuring the effects of superficial arterial and venous flow augmentation on clinical outcomes. *J Reconstr Microsurg* 2019;35:e1. DOI PubMed
12. Chu CK, Largo RD, Lee ZH, et al. Introduction of the L-PAP flap: bipedicled, conjoined, and stacked thigh-based flaps for autologous breast reconstruction. *Plast Reconstr Surg* 2023;152:1005e-10e. DOI

13. Hallock GG. Branch-based conjoined perforator flaps. *Plast Reconstr Surg* 2008;121:1642-9. DOI PubMed
14. Ali RS, Garrido A, Ramakrishnan V. Stacked free hemi-DIEP flaps: a method of autologous breast reconstruction in a patient with midline abdominal scarring. *Br J Plast Surg* 2002;55:351-3. DOI
15. Agarwal JP, Gottlieb LJ. Double pedicle deep inferior epigastric perforator/muscle-sparing TRAM flaps for unilateral breast reconstruction. *Ann Plast Surg* 2007;58:359-63. DOI PubMed
16. Beahm EK, Walton RL. The efficacy of bilateral lower abdominal free flaps for unilateral breast reconstruction. *Plast Reconstr Surg* 2007;120:41-54. DOI PubMed
17. Hamdi M, Khuthaila DK, Van Landuyt K, Roche N, Monstrey S. Double-pedicle abdominal perforator free flaps for unilateral breast reconstruction: new horizons in microsurgical tissue transfer to the breast. *J Plast Reconstr Aesthet Surg* 2007;60:904-12; discussion 913. DOI
18. Chang EI, Kronowitz SJ. Dual-pedicle flap for unilateral autologous breast reconstruction revisited: evolution and optimization of flap design over 15 years. *Plast Reconstr Surg* 2016;137:1372-80. DOI PubMed
19. Koolen PG, Lee BT, Lin SJ, Erhard HA, Greenspun DT. Bipedicle-conjoined perforator flaps in breast reconstruction. *J Surg Res* 2015;197:256-64. DOI PubMed
20. Seth AK, Koolen PGL, Sultan SM, Lee BT, Erhard HA, Greenspun DT. Unilateral autologous breast reconstruction with bi-pedicled, conjoined deep inferior epigastric perforator flaps. *J Reconstr Microsurg* 2019;35:145-55. DOI PubMed
21. Salibian AA, Bekisz JM, Frey JD, et al. Comparing outcomes between stacked/conjoined and non-stacked/conjoined abdominal microvascular unilateral breast reconstruction. *Microsurgery* 2021;41:240-9. DOI
22. Uda H, Tomioka YK, Sarukawa S, et al. Abdominal morbidity after single- versus double-pedicled deep inferior epigastric perforator flap use. *J Plast Reconstr Aesthet Surg* 2016;69:1178-83. DOI
23. Rosa J, Sherif RD, Torina PJ, Harmaty MA. Use of both antegrade and retrograde internal mammary vessels in the bipedicled deep inferior epigastric perforator flap for unilateral breast reconstruction. *J Plast Reconstr Aesthet Surg* 2017;70:47-53. DOI PubMed
24. Blondeel PN, Hijjawi J, Depypere H, Roche N, Van Landuyt K. Shaping the breast in aesthetic and reconstructive breast surgery: an easy three-step principle. *Plast Reconstr Surg* 2009;123:455-62. DOI PubMed
25. Patel NG, Rozen WM, Chow WT, et al. Stacked and bipedicled abdominal free flaps for breast reconstruction: considerations for shaping. *Gland Surg* 2016;5:115-21. DOI PubMed
26. Beugels J, Vasile JV, Tuinder SMH, et al. The stacked hemiabdominal extended perforator flap for autologous breast reconstruction. *Plast Reconstr Surg* 2018;142:1424-34. DOI
27. Ciudad P, Maruccia M, Orfaniotis G, et al. The combined transverse upper gracilis and profunda artery perforator (TUGPAP) flap for breast reconstruction. *Microsurgery* 2016;36:359-66. DOI
28. Haddock NT, Cho MJ, Gassman A, Teotia SS. Stacked profunda artery perforator flap for breast reconstruction in failed or unavailable deep inferior epigastric perforator flap. *Plast Reconstr Surg* 2019;143:488e-94e. DOI PubMed
29. Salibian AA, Nolan IT, Bekisz JM, et al. A systematic review and meta-analysis of microvascular stacked and conjoined-flap breast reconstruction. *J Reconstr Microsurg* 2021;37:631-42. DOI
30. Haddock NT, Teotia SS. Modern approaches to alternative flap-based breast reconstruction: stacked flaps. *Clin Plast Surg* 2023;50:325-35. DOI PubMed
31. DellaCroce FJ, Sullivan SK, Trahan C. Stacked deep inferior epigastric perforator flap breast reconstruction: a review of 110 flaps in 55 cases over 3 years. *Plast Reconstr Surg* 2011;127:1093-9. DOI PubMed
32. Dellacroce FJ. Reply: alternative method for volume improvement in autologous breast reconstruction. *Plastic and Reconstructive Surgery* 2011;128:778e-9e. DOI
33. Dayan JH, Allen RJ Jr. Lower extremity free flaps for breast reconstruction. *Plast Reconstr Surg* 2017;140:77S-86S. DOI PubMed
34. Allen RJ, Haddock NT, Ahn CY, Sadeghi A. Breast reconstruction with the profunda artery perforator flap. *Plast Reconstr Surg* 2012;129:16e-23e. DOI PubMed
35. Stalder MW, Lam J, Allen RJ, Sadeghi A. Using the retrograde internal mammary system for stacked perforator flap breast reconstruction: 71 breast reconstructions in 53 consecutive patients. *Plast Reconstr Surg* 2016;137:265e-77e. DOI PubMed
36. Tessler O, Guste J, Bartow MJ, et al. Stacked lateral thigh perforator flap as a novel option for autologous breast reconstruction. *Plast Reconstr Surg* 2019;143:1601-4. DOI
37. DellaCroce FJ, Sullivan SK, Trahan C, Jenkins CE. Body lift perforator flap breast reconstruction: a review of 100 flaps in 25 cases. *Plast Reconstr Surg* 2012;129:551-61. DOI PubMed
38. Haddock NT, Kelling JA, Teotia SS. Simultaneous circumferential body lift and four-flap breast reconstruction using deep inferior epigastric perforator and lumbar artery perforator flaps. *Plast Reconstr Surg* 2021;147:936e-9e. DOI PubMed
39. Mayo JL, Allen RJ, Sadeghi A. Four-flap breast reconstruction: bilateral stacked diep and pap flaps. *Plast Reconstr Surg Glob Open* 2015;3:e383. DOI PubMed PMC
40. Evgeniou E, Teotia SS, Haddock NT. Asymmetric four-flap breast reconstruction with DIEP flaps and PAP flaps. *Plast Reconstr Surg* 2022;150:1236e-9e. DOI PubMed
41. Follmar KE, Prucz RB, Manahan MA, Magarakis M, Rad AN, Rosson GD. Internal mammary intercostal perforators instead of the true internal mammary vessels as the recipient vessels for breast reconstruction. *Plast Reconstr Surg* 2011;127:34-40. DOI PubMed
42. Teotia SS, Dumestre DO, Jayaraman AP, Sanniec KJ, Haddock NT. Revisiting anastomosis to the retrograde internal mammary system in stacked free flap breast reconstruction: an algorithmic approach to recipient-site selection. *Plast Reconstr Surg*

2020;145:880-7. DOI

43. Venturi ML, Poh MM, Chevray PM, Hanasono MM. Comparison of flow rates in the antegrade and retrograde internal mammary vein for free flap breast reconstruction. *Microsurgery* 2011;31:596-602. DOI PubMed
44. Kerr-Valentic MA, Gottlieb LJ, Agarwal JP. The retrograde limb of the internal mammary vein: an additional outflow option in DIEP flap breast reconstruction. *Plast Reconstr Surg* 2009;124:717-21. DOI PubMed
45. Li S, Mu L, Li Y, et al. [Clinical study of the hemodynamics of both ends (proximal and distal) of internal mammary artery and its following-up]. *Zhonghua Zheng Xing Wai Ke Za Zhi* 2002;18:140-142. PubMed
46. Berrino P, Casabona F, Adami M, Muggianu M. The “parasite” TRAM flap for autogenous tissue breast reconstruction in patients with vertical midabdominal scars. *Ann Plast Surg* 1999;43:119-26. DOI PubMed
47. Martinez CA, Fairchild B, Secchi-Del Rio R, Boutros SG. Bilateral outpatient breast reconstruction with stacked DIEP and vertical PAP flaps. *Plast Reconstr Surg Glob Open* 2021;9:e3878. DOI PubMed PMC
48. Muto M, Satake T, Tsunoda Y, et al. Lateral thoracic vessel as a recipient vessel in immediate breast reconstruction after nipple/skin-sparing mastectomy: experience with 270 flaps. *Plast Reconstr Surg* 2023;151:1157-67. DOI
49. Opsomer D, D'Arpa S, Benmeridja L, Stillaert F, Noel W, Van Landuyt K. Bilateral DIEP flap breast reconstruction to a single set of internal mammary vessels: technique, safety, and outcomes after 250 flaps. *Plast Reconstr Surg* 2019;144:554e-64e. DOI PubMed