

Categorizing Patient Selection, Outcomes, and Indications in a Decade of 405 Profunda Artery Perforator Flaps

Nicholas T. Haddock, MD
Alexis C. Lakatta, BSA
Sumeet S. Teotia, MD

Dallas, TX



Background: Autologous tissue is the only permanent option for breast reconstruction. Whereas abdominal tissue remains popular, considering alternative donor sites ensures comprehensive care tailored to a patient. The thigh has been established as an excellent choice in autologous reconstruction. The authors present a 10-year experience with 405 profunda artery perforator (PAP) flaps.

Methods: An institutional review board–approved 10-year retrospective review of all patients treated with PAP flaps for breast reconstruction was performed. Procedures were carried out by 2 surgeons at the same institution. PAP flaps were divided into 4 consecutive groups with approximately 100 flaps in each group. Demographics, indications, intraoperative data, postoperative complications, revisions, and patient-reported outcomes were recorded and analyzed.

Results: A total of 207 patients (405 PAP flaps) were included. This accounted for 17.2% of all breast reconstruction flaps. A total of 55% of patients underwent a multiflap procedure. The average flap weight was 354.3 g (± 117.2), which decreased significantly over time ($P < 0.001$). Rates of major complications were 9.6% wounds, 4.4% seromas, 4.7% hematomas, and 3.5% infections. Total flap loss was 2%, 67% of which were in stacked cases. Satisfaction routinely improved from before to after surgery.

Conclusions: As available flap donor sites continue to evolve, tailoring breast reconstruction to the individual patient is standard in centers of excellence. The PAP flap has emerged as an excellent choice for autologous-based breast reconstruction through use of proper patient selection and surgical technique. (*Plast. Reconstr. Surg.* 154: 632e, 2024.)

CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, IV.

Breast reconstruction is a critical part of comprehensive care for patients with breast cancer, and autologous tissue is the only truly permanent option. The abdomen will likely always be the most popular choice for breast reconstruction,¹ but adding alternative options to one's practice greatly benefits patients with breast cancer. Many patients are not candidates for abdominally based reconstruction, and without alternative options would have limited access to autologous breast reconstruction. Based on surgeon experience and patient desires, the available alternative options have evolved over time,² with common locations being the buttock,^{3,4} back,^{5–7} and thigh.^{8–13}

In many practices, the thigh has become the preferred secondary donor site. This is likely secondary

to the fact that all thigh flaps can be harvested in supine position with no need for a position change.¹⁴ The profunda artery perforator (PAP) flap was introduced in 2012⁸ and quickly became the preferred option from the thigh. The traditional description was horizontal, but there have been other modifications to this flap, including vertical and oblique.^{12,15,16}

The PAP flap was introduced into our practice in 2012, and we have gained experience over the subsequent 10 years with more than 400 PAP flaps. We present PAP flap indications, evolution of use,

Disclosure statements are at the end of this article, following the correspondence information.

A Video Discussion by Joshua Vorstenbosch, MD, accompanies this article. Go to PRSJournal.com and click on "Video Discussions" in the "Digital Media" tab to watch.

From the Department of Plastic Surgery, University of Texas Southwestern Medical Center.

Received for publication April 12, 2023; accepted September 5, 2023.

Copyright © 2023 by the American Society of Plastic Surgeons
DOI: [10.1097/PRS.00000000000011052](https://doi.org/10.1097/PRS.00000000000011052)

Table 1. Demographic Characteristics and Comorbidities

Characteristics	Values
Race, no. (%)	
Black	14 (6.8)
Hispanic	17 (8.2)
White	161 (78.0)
Asian or other	15 (7.2)
Total	207 (100)
Hypertension, no. (%)	31 (30)
Diabetes, no. (%)	8 (9)
Autoimmune, no. (%)	11 (8)
Smoking status, no. (%)	
Never smoked tobacco	152 (73.4)
Former tobacco smoker	54 (26.1)
Current tobacco smoker	1 (0.5)
Previous abdominal surgery, no. (%)	149 (72.0)
Body mass index, mean $\pm$ SD	25.7 $\pm$ 4.3
Age, mean $\pm$ SD, yrs	51.6 $\pm$ 8.9

and comprehensive outcomes to date, including patient-reported outcomes for the breast.

METHODS

An institutional review board–approved study was performed using a prospectively collected REDCap (Research Electronic Data Capture) database.^{17,18} A retrospective review of all PAP flaps for breast reconstruction was performed. In effort to study the evolution of this experience, the 405 PAP flaps were divided into 4 consecutive groups with roughly 100 PAP flaps per group. All procedures were performed consecutively: group 1, July of 2012 through February of 2016 (42 months); group 2, February of 2016 through January of 2018 (23 months); group 3, February of 2018 through June of 2020 (28 months); and group 4, July of 2020 through September of 2022 (26 months).

Patient demographic characteristics and indications for PAP flap breast reconstruction were documented (Table 1). Both intraoperative and postoperative data were recorded, and all complications were reviewed. Complications were reported per patient instead of per flap in an effort to allow accurate and patient-centric data for preoperative counseling. In addition, the need for subsequent surgery related to a complication or for revision breast reconstruction was reviewed.

BREAST-Q satisfaction surveys were performed as per standard practice. BREAST-Q surveys are automatically sent by email to patients preoperatively and postoperatively at 3, 6, 12, 18, and 24 months. Surveys are optional, so patient response rates vary, and responses are used to

determine trends with overall breast satisfaction after surgery compared with the preoperative baseline. Rasch score equivalents (0 through 100) are used to analyze the data.

Numeric variables were reported using average values and associated standard deviations; categorical variables were reported by number and percentage of patients. Numeric variables were analyzed using independent-samples *t* tests, with a 2-sided *P* value of 0.05 or less considered significant. Categorical variables were analyzed using chi-square, with significance being determined by a *P* value of 0.05 or less. Fat grafting volumes were reported by average per patient given that fat grafting volumes are not always symmetric, and fat grafting is often used to aid in improving symmetry by injecting differing volumes to each breast. Pearson product-moment correlation was used to determine linear association between continuous variables.¹⁹ All data analysis was performed using Excel and IBM SPSS Statistics for Macintosh, version 29.0.²⁰

RESULTS

A total of 207 patients underwent breast reconstruction with 405 PAP flaps. This includes 35 unilateral reconstructions and 172 bilateral breast reconstructions. Twenty-six patients were treated with stacked PAP flaps. Some patients were treated with bilateral reconstruction using asymmetric reconstructions (for example, a unilateral conjoint deep inferior epigastric perforator [DIEP] and stacked PAPs). The PAP flap has historically been our most common secondary flap, accounting for 17.4% of all flaps used for breast reconstruction during this time period. Since the introduction of the lumbar artery perforator (LAP) flap to our practice in December of 2018, this percentage has dropped slightly to 15.6%, and LAP flaps have accounted for 11.6% of all flaps used for breast reconstruction.

Average age was 51.6 $\pm$ 8.9 years and average body mass index (BMI) was 25.7 $\pm$ 4.3. The population was 78% White, 6.8% Black, 8.2% Hispanic, and 7.2% Asian or other race. Common comorbidities included hypertension (15%), diabetes (3.9%), autoimmune condition (5.3%), and history of deep vein thrombosis or pulmonary embolism (3.9%). The majority of the patients were never smokers (73.4%); the rest were former smokers (26.1%) or current smokers (0.4%; 1 patient). A total of 149 patients (72%) had a history of abdominal surgery, including 39 patients (18.8%) with a history of abdominoplasty, abdominal liposuction, or laparotomy, and 20 (9.7%) with

■ Primary ■ Adjunctive ■ Salvage ■ Primary Stacked PAP ■ Primary PAP

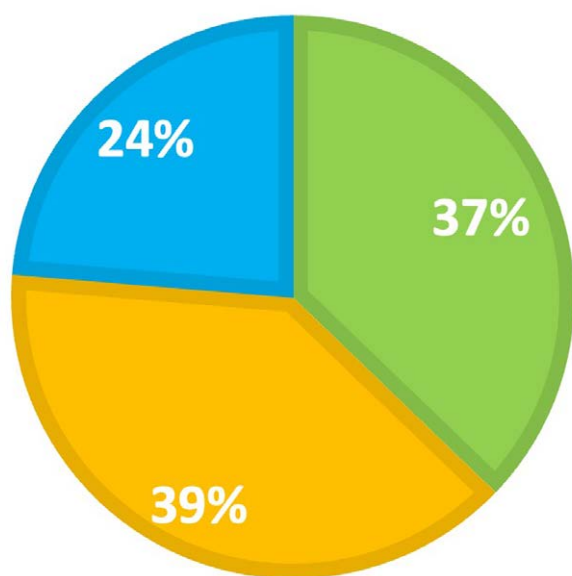


Fig. 1. Percentage of patients undergoing PAP flaps by reconstructive group.

a history of abdominally based autologous flap (ie, transverse rectus abdominis muscle, DIEP, superficial inferior epigastric artery), excluding the abdomen as an option for breast reconstruction. Demographic characteristics and comorbidities can be seen in Table 1.

Procedures were categorized into 3 reconstructive groups: primary, adjunctive, and salvage (Figs. 1 and 2). Seventy-seven patients (37.2%) underwent primary breast reconstruction with PAP flaps. Eighty-one patients (39.1%) underwent a PAP flap as an adjunctive surgery. These were either performed as a 4-flap procedure or delayed stacked procedure after previous autologous reconstruction with inadequate reconstruction (Fig. 3). Forty-nine patients (23.7%) underwent a PAP flap as a salvage procedure due to a previous failed flap, failed implant, or dissatisfaction with implants resulting in autologous conversion. The large majority of patients undergoing a PAP flap as a salvage procedure ($n = 42$) were undergoing autologous conversion because of complaints or complications associated with implants (Fig. 4).

The average flap weight in this series was 354.3 ± 117.2 g. The experience analysis showed a progressive decrease in flap volume over time (group 1, 425 ± 153 g; group 2, 355 ± 116 g; group 3, 337 ± 98 g; group 4, 300 ± 102 g; $P < 0.001$). BMI also significantly decreased over time (group 1, 26.8 ± 4.4 ; group 2, 26.5 ± 4.3 ; group 3, 25.4 ± 3.9 ; group

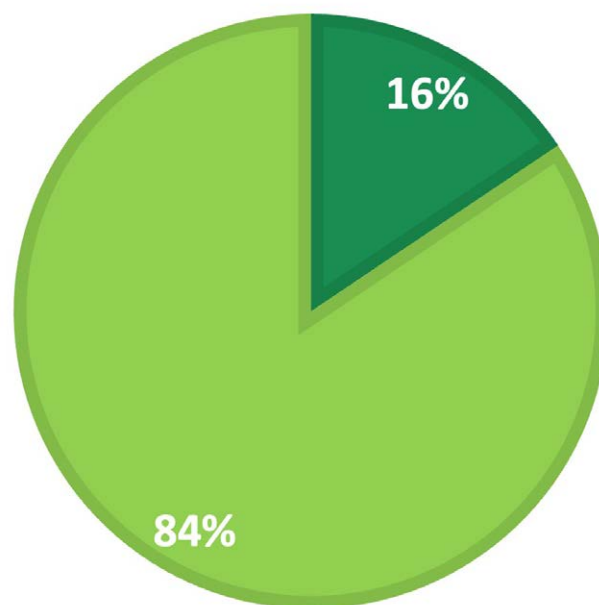


Fig. 2. Percentage of patients undergoing primary PAP reconstruction by category.

■ Delayed Flap/Other ■ Stacked Flap/4-Flap

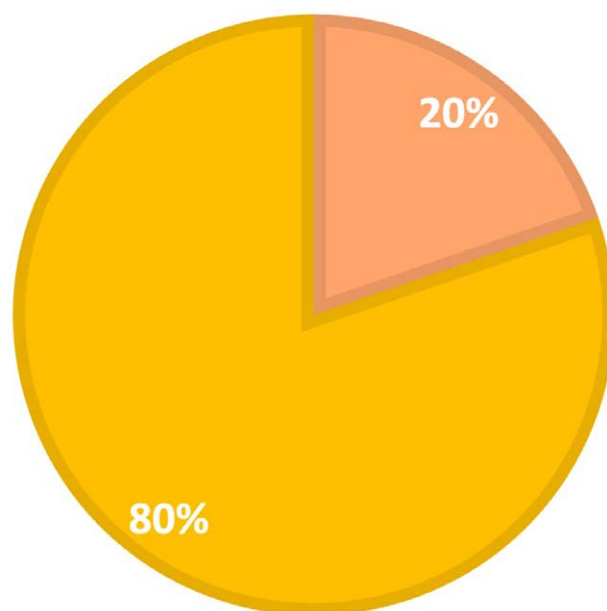


Fig. 3. Percentage of patients undergoing adjunctive PAP flap reconstruction by category.

4, 24.2 ± 4.3 ; $P < 0.01$). One or 2 perforators were used the majority of the time: 50.1% and 41.0%, respectively. This was consistent among all 4 groups. Pedicle length was 10.9 ± 2.2 cm in the total series and was also consistent over the 4 groups.

Complication rates remained fairly consistent over the experience, with no significant decreases over time. Nine patients had thigh hematomas (4.4%) and 11 patients had thigh seromas (5.31%)

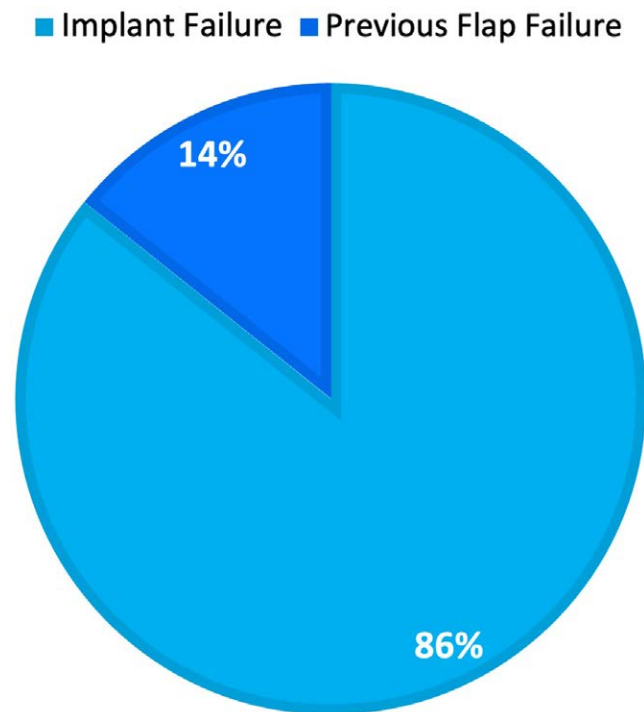


Fig. 4. Percentage of patients undergoing salvage PAP reconstruction by category.

requiring serial in-office drainage or operative drainage. Thigh wounds were far more common, with 27 patients requiring treatment (13.4%). Eight patients had thigh infections (3.9%) requiring intravenous antibiotics. Breast complications occurred less frequently than donor-site complications. Breast seromas were seen in 4 patients (1.9%), breast hematomas in 7 patients (3.4%), breast infections in 6 patients (2.9%), breast wounds in 3 patients (1.5%), and breast fat necrosis in 29 patients (14.0%). Thrombotic events occurred in 3 patients (1.4%). Minor complications not requiring intervention or only requiring local wound care were seen far more frequently in this population, but were not assessed, given that they did not change the course of recovery. Complication data analyzed by number of flaps and number of patients can be seen in [Tables 2 and 3](#), respectively.

Average overall operative time was 427 ± 150 minutes. Average operative time was significantly higher in 4-flap cases (544 ± 123 minutes) as compared with bilateral PAP flaps (340 ± 106 minutes; $P < 0.001$). Unilateral stacked PAP flap cases had a similar average operative time as bilateral PAP flaps at 338 ± 121 minutes. Unilateral PAP flaps took an average of 363 ± 122 minutes. Increased operative time was associated with an increase in postoperative flap complications ($P = 0.006$), although there was no significant increase in donor-site complications ($P = 0.15$). Over the 4

Table 2. Complications by Number of Flaps

Complications	Group 1 (100 Flaps), No. (%)	Group 2 (102 Flaps), No. (%)	Group 3 (102 Flaps), No. (%)	Group 4 (101 Flaps), No. (%)	Total (405 Flaps), No. (%)
Breast seroma	1 (1.0)	3 (2.9)	0 (0.0)	0 (0.0)	4 (1.0)
Thigh seroma	3 (3.0)	4 (3.9)	4 (3.9)	3 (3.0)	14 (3.5)
Breast hematoma	3 (3.0)	1 (1.0)	3 (2.9)	0 (0.0)	7 (1.7)
Thigh hematoma	1 (1.0)	1 (1.0)	5 (4.9)	2 (2.0)	9 (2.2)
Breast infection	1 (1.0)	1 (1.0)	1 (1.0)	3 (3.0)	6 (1.5)
Thigh infection	3 (3.0)	1 (1.0)	3 (2.9)	1 (1.0)	8 (2.0)
Breast wound	0 (0.0)	1 (1.0)	1 (1.0)	1 (1.0)	3 (0.7)
Thigh wound	7 (7.0)	6 (5.9)	11 (10.8)	12 (11.9)	36 (8.9)
Flap loss	3 (3.0)	2 (2.0)	3 (2.9)	0 (0.0)	8 (2.0)

Table 3. Complications by Number of Patients

Complications	Group 1 (53 Patients), No. (%)	Group 2 (51 Patients), No. (%)	Group 3 (52 Patients), No. (%)	Group 4 (51 Patients), No. (%)	Total (207 Patients), No. (%)
Breast seroma	1 (1.9)	3 (5.9)	0 (0.0)	0 (0.0)	4 (1.9)
Thigh seroma	2 (3.8)	3 (5.9)	4 (7.7)	2 (3.9)	11 (5.3)
Breast hematoma	3 (5.7)	1 (2.0)	3 (5.8)	0 (0.0)	7 (3.4)
Thigh hematoma	1 (1.9)	1 (2.0)	5 (9.6)	2 (3.9)	9 (4.3)
Breast infection	1 (1.9)	1 (2.0)	1 (1.9)	3 (5.9)	6 (2.9)
Thigh infection	3 (5.7)	1 (2.0)	3 (5.8)	1 (2.0)	8 (3.9)
Breast wound	0 (0.0)	1 (2.0)	1 (1.9)	1 (2.0)	3 (1.4)
Thigh wound	4 (7.5)	5 (9.8)	9 (17.3)	9 (17.6)	27 (13.0)

Table 4. Complications by Hypothermia and Operative Time

Complications	Hypothermia (<36°C) Time ^a	Operative Time ^a
Flap loss	0.51	0.12
Flap complications	0.01 ^b	0.01 ^b
Breast seroma	0.53	0.26
Breast hematoma	0.47	0.42
Breast infection	0.1	0.26
Breast wound	0.57	0.63
Donor-site complications	0.33	0.15
Thigh seroma	0.7	0.12
Thigh hematoma	0.45	0.77
Thigh infection	0.06	0.36
Thigh wound	0.38	0.41

^aValues are *P* values from independent samples *t* tests.^bSignificant.**Table 5. Total Revisionary Procedures by Subtype^a**

Procedure	No.
Fat grafting	256
Implant revision	13
Skin or scar revision	210
Reduction	47
Fat necrosis excision	16
Flap repositioning	38

^aIncludes all revisions to completion of reconstruction, including multiple revisions per patient and multiple types of revisions in a single surgery.

groups, flap success rate ranged between 96% and 99%, with a total success rate of 98% (8 flap losses out of 405). Of the 8 flap losses, 7 were as part of a multiflap reconstruction and 4 were buried flaps.

Hypothermia was common, with an average intraoperative time of 321 ± 150 minutes under 36°C. Approximately 90 patients (43.5%) were hypothermic for the duration of their PAP flap procedure; only 6 patients remained normothermic throughout the entire procedure. Patients with longer hypothermic times also experienced a significantly higher rate of postoperative flap complications ($P = 0.005$) but no corresponding increase in donor-site complications ($P = 0.33$). Four-flap patients spent a significantly longer portion of the operation hypothermic than their bilateral PAP flap counterparts (406 ± 174 versus 271 ± 129 ; $P < 0.001$). Patients with fat necrosis had longer operative times (508.6 ± 157.4 minutes versus 413.0 ± 144.3 minutes; $P = 0.004$) and spent more time hypothermic on average (403.5 ± 159.9 minutes versus 306.6 ± 167.7 minutes; $P = 0.001$). Complications analyzed by operative time and hypothermia time can be seen in Table 4.

Breast revision procedures were performed in 80.6% of patients: 65 patients underwent 1 revision, 60 had 2 revisions, and 42 had 3 or more revisions. The maximum number of revision procedures in this population was 5 (4 patients).

Approximately 34% of patients required some form of thigh revision surgery, which was routinely performed at the same time as a revisionary breast surgery. Fat grafting, followed by skin and scar revisions were the most commonly performed revision procedures (Table 5). In patients who opted to undergo fat grafting, the average total volume grafted, including patients undergoing multiple fat grafting sessions, was 326 ± 232 mL, with a range of 30 to 1200 mL. Unilateral stacked PAP flap cases had the lowest average fat grafting volume (321 ± 176 mL). Patients who underwent unilateral PAP flap reconstruction had a higher average fat grafting volume (412 ± 226 mL; $P = 0.21$). Average total fat grafting volumes were not significantly different between 4-flap and bilateral PAP flap cases (329 ± 255 mL, 336 ± 244 mL; $P = 0.89$). Patients with low or normal BMI had significantly lower average fat grafting volumes than patients classified as overweight or obese on the BMI scale (279.4 ± 184.5 mL versus 365.5 ± 260.9 mL; $P = 0.028$). On Pearson product-moment correlation analysis comparing BMI and fat grafting volumes, there was a weak but positive significant correlation ($r = 0.319$, $P < 0.001$).

BREAST-Q scores were assessed globally given inconsistent response rates among the 4 groups. BREAST-Q surveys showed a significant increase in satisfaction from preoperative to postoperative surveys at all time periods ($P < 0.01$ at 3, 6, and 12 months). Average preoperative satisfaction was 47 ± 24.2 (Rasch equivalent scale, 1 to 100) and average postoperative satisfaction was 82 ± 12 at 3 months, 77.6 ± 20 at 6 months, and 72 ± 19.5 at 12 months. Patient satisfaction at 18 and 24 months was not assessed because of low response rates.

DISCUSSION

The PAP flap has become established as a workhorse option for breast reconstruction.⁹ With proper patient selection and technical execution, this flap is an excellent primary option in autologous breast reconstruction. Use of computed tomography angiography has further allowed a patient-centered approach to choosing donor sites for autologous reconstruction.²¹ Despite increasing donor-site options, the PAP flap has continued to be the second most common donor site in our patient population over the past decade.

PAP flaps can be used in patients with a history of abdominal surgery, such as abdominoplasty, laparotomy, or liposuction, and are also frequently used in patients with lower BMI (Figs. 4 and 5). The most common reason to select a PAP flap over a DIEP flap is inadequate abdominal tissue,



Fig. 5. A 48-year-old woman underwent bilateral nipple-sparing mastectomy and delayed immediate reconstruction with bilateral PAP flaps. The patient underwent 2 revisionary procedures, which included a thigh revision and fat grafting to the breasts (420 g total). (Above) Anterior view. (Below) Posterior view.

necessitating another donor site. Patients with inadequate abdominal tissue who desire volume can either undergo a PAP flap alone (primary PAP flap procedure) or a stacked flap procedure using both PAP and DIEP flaps or PAP and LAP flaps (adjunctive PAP flap procedure). The BMI for DIEP flaps has previously been cited to range from 28 to 29, whereas the PAP flap recipients in this practice have a lower average BMI, at 25.7.²² This finding reiterates the importance of taking a patient-centered approach to autologous breast reconstruction to

attain optimal results depending on the patient's body habitus and desired volume (Fig. 6).

Donor-site wound-healing complications are the most common complication after breast reconstruction with PAP flaps. Others have discussed oblique or vertically oriented skin patterns for PAP flaps.^{8,23,24} Wound dehiscence rates using these techniques are approximately 11%, which is similar to the donor-site wound rate seen in our patient population.²³ The benefit of the horizontal scar is that it is fairly well hidden in the gluteal



Fig. 6. A 47-year-old woman underwent bilateral mastectomy and reconstruction with bilateral PAP flaps. The patient underwent 1 revisionary surgery that included nipple reconstruction, thigh revision, mastopexy, and fat grafting (240 total). Nipple tattoos present. (Above) Anterior view. (Below) Posterior view.

fold in most patients. This benefit outweighs the potential benefits of the alternative approaches and more visible scars when considering the long-term implications. Either way, patient counseling is critical to manage expectations with the donor-site scars and the potential for wound complications.

There was no significant reduction in wound complications in the progressive groups. There should be improvements in both patient selection and technical skill over the decade, which would

result in a reduction in wound complications. The flap size and patient BMI decreased over time, which is likely related to more careful patient selection and the introduction of the LAP flap. The introduction of the LAP flap offered an additional truncal-based flap and as a result allowed more careful selection criteria for PAP flaps. Multiple different techniques have been implemented over the decade in effort to reduce thigh wound complication rates. This included various types of sutures

and suturing techniques, compression, and negative-pressure dressings, but none of these methods has made a significant improvement. Compression increases comfort for many patients during the recovery period and presumably decreases seroma rates, but no data exist to support this.

Practice patterns evolve over time. The LAP flap was added to our breast reconstructive armamentarium in December of 2018. Our annual PAP flap numbers did not decrease, but this additional secondary option affected use of the PAP flap. When analyzing the group in blocks of 100 flaps, there was a large decrease in time to reach 100 flaps after group 1 (42 to 23 months). This is likely based on experience and development of the practice. In the remaining time periods, the time to reach 100 flaps slightly increased, which could be attributed to an increase in LAP flap operations. The LAP flap has not replaced the PAP flap in practice, but has increased in popularity within our patient population, due to the aesthetic contour it provides to both the donor and recipient site. In addition, because of the variety of free flaps offered in this practice, patients presenting for secondary breast reconstruction are common. This potentially increased number of patients undergoing breast reconstruction after initial reconstruction may partially explain the relatively high rates of PAP flaps and LAP flaps.

In our practice, aesthetically focused revision procedures are a standard part of the process to

optimize results. These procedures are patient-dependent and are only performed to the patient's preference, which is why approximately one-fifth of our patients choose to forego additional surgery. There are many possible revisionary procedures that can be performed, including skin excision, flap repositioning, reduction, fat grafting, scar revision, and excision of fat necrosis, but patients most commonly opt for fat grafting to the upper pole of the breast, as well as minor skin and scar revisions. Whereas some patients are satisfied with results immediately after their initial PAP flap surgery, many lose volume in the upper pole as swelling decreases, which is likely why fat grafting is the most commonly performed revisionary procedure after a PAP flap. The PAP flap does not have the same ability to cover the entire base of the breast as do some other flaps with larger surface area. In addition, given that fat grafting success rates are marginal, many patients choose to undergo multiple fat-grafting procedures until their breasts reach the desired contour and volume. Patients with higher BMI have larger average fat-grafting volumes than their lower-BMI counterparts. Therefore, those patients are able to undergo more fat grafting because of body fat disposition.

Perioperative hypothermia has previously been correlated with increased complications, particularly in relation to wound healing and infection.²⁵ Given that PAP flaps have a relatively high occurrence of donor-site complications,⁹ with thigh wounds being the most common in this study, we initially theorized this could be partially attributed to the large portion of time patients spend hypothermic intraoperatively. Autologous tissue breast reconstruction inherently requires significant patient exposure given the multiple operative sites. This is particularly relevant to PAP flaps, as most of the core body is at least partially exposed, creating an increased risk for hypothermia (Fig. 7). Although increased time spent hypothermic was associated with a significant increase in overall flap complications and breast fat necrosis, it was not associated with a significant increase in donor-site complications. Hypothermia may negatively affect wound healing, but this was not seen in this study, perhaps because the increased rate of thigh wound complications after PAP flaps is not secondary to derangement in typical wound-healing physiology. The functionality of the thigh in daily activities, friction and increased tension from movement, and positional pressure all likely contribute to wound-healing issues. Increased operative time was also associated with a significant increase in overall flap complications and breast fat necrosis, which is consistent with previous literature.^{22,26}



Fig. 7. Typical positioning for PAP flap breast reconstruction.

CONCLUSIONS

A patient-centric approach to autologous microsurgical breast reconstruction based on a patient's anatomy and personal preference is now standard of care. Many patients want to avoid implant-based reconstruction, but without secondary options, this is not always possible. The PAP flap provides an excellent autologous option for those who do not have typical abdominally based options, with roles in primary autologous reconstruction, adjunctive reconstruction with another flap, and as a salvage reconstruction. Over the past decade, with proper patient selection, the PAP flap has remained a safe, versatile, and effective choice for autologous breast reconstruction.

Nicholas T. Haddock, MD

Department of Plastic Surgery
University of Texas Southwestern Medical Center
1801 Inwood Road
Dallas, TX 752390
nicholas.haddock@utsouthwestern.edu
Instagram: @haddockMD, @htbreastrecon

Sumeet S. Teotia, MD

Department of Plastic Surgery
University of Texas Southwestern Medical Center
1801 Inwood Road
Dallas, TX 752390
sumeet.teotia@utsouthwestern.edu
Instagram: @drsumeetteotia, @htbreastrecon

DISCLOSURE

The authors have no financial interests to disclose. No funding was received for this article.

REFERENCES

- Allen RJ, Treece P. Deep inferior epigastric perforator flap for breast reconstruction. *Ann Plast Surg*. 1994;32:32–38.
- Haddock NT, Suszynski TM, Teotia SS. An individualized patient-centric approach and evolution towards total autologous free flap breast reconstruction in an academic setting. *Plast Reconstr Surg Glob Open* 2020;8:e2681.
- Allen RJ, Tucker C Jr. Superior gluteal artery perforator free flap for breast reconstruction. *Plast Reconstr Surg*. 1995;95:1207–1212.
- Heitmann C, Levine JL, Allen RJ. Gluteal artery perforator flaps. *Clin Plast Surg*. 2007;34:123–130; abstract vii.
- Haddock NT, Dumestre D, Teotia SS. Lumbar artery perforator flap: video surgical sequence. *Plast Reconstr Surg Glob Open* 2020;8:e2680.
- Haddock N, Teotia S. Lumbar artery perforator flap: initial experience with simultaneous bilateral flaps for breast reconstruction. *Plast Reconstr Surg Glob Open* 2020;8:e2800.
- Opsomer D, Vyncke T, Ryx M, Van Landuyt K, Blondeel P, Stillaert F. Donor site morbidity after lumbar artery perforator flap breast reconstruction. *J Reconstr Microsurg*. 2021;38:129–136.
- Allen RJ, Haddock NT, Ahn CY, Sadeghi A. Breast reconstruction with the profunda artery perforator flap. *Plast Reconstr Surg*. 2012;129:16e–23e.
- Haddock NT, Teotia SS. Consecutive 265 profunda artery perforator flaps: refinements, satisfaction, and functional outcomes. *Plast Reconstr Surg Glob Open* 2020;8:e2682.
- Tuinder SMH, Beugels J, Lataster A, et al. The lateral thigh perforator flap for autologous breast reconstruction: a prospective analysis of 138 flaps. *Plast Reconstr Surg*. 2018;141:257–268.
- Schoeller T, Huemer GM, Wechselberger G. The transverse musculocutaneous gracilis flap for breast reconstruction: guidelines for flap and patient selection. *Plast Reconstr Surg*. 2008;122:29–38.
- Dayan JH, Allen RJ Jr. Neurotized diagonal profunda artery perforator flaps for breast reconstruction. *Plast Reconstr Surg Glob Open* 2019;7:e2463.
- Dayan JH, Allen RJ Jr. Lower extremity free flaps for breast reconstruction. *Plast Reconstr Surg*. 2017;140:77S–86S.
- Haddock NT, Gassman A, Cho MJ, Teotia SS. 101 Consecutive profunda artery perforator flaps in breast reconstruction: lessons learned with our early experience. *Plast Reconstr Surg*. 2017;140:229–239.
- Hunsinger V, Lhuire M, Haddad K, et al. Medium- and large-sized autologous breast reconstruction using a fleur-de-lis profunda femoris artery perforator flap design: a report comparing results with the horizontal profunda femoris artery perforator flap. *J Reconstr Microsurg*. 2019;35:8–14.
- Artz JD, Atamian EK, Mulloy C, Stalder MW, Zampell J, Hilaire HS. Use of the vertical profunda artery perforator flap to capture the dominant perforator: a cadaver dissection and imaging study. *J Reconstr Microsurg*. 2021;38:284–291.
- Harris PA, Taylor R, Minor BL, et al.; REDCap Consortium. The REDCap consortium: building an international community of software platform partners. *J Biomed Inform*. 2019;95:103208.
- Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap): a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42:377–381.
- Laerd Statistics. Pearson's product moment correlation: statistical tutorials and software guides. Available at: <https://statistics.laerd.com/statistical-guides/pearson-correlation-coefficient-statistical-guide.php>. Accessed July 17, 2023.
- IBM SPSS Statistics for Macintosh, version 29. Armonk, NY: IBM; 2022.
- Haddock NT, Dumestre DO, Teotia SS. Efficiency in DIEP flap breast reconstruction: the real benefit of computed tomographic angiography imaging. *Plast Reconstr Surg*. 2020;146:719–723.
- Haddock NT, Teotia SS. Efficient DIEP flap: bilateral breast reconstruction in less than four hours. *Plast Reconstr Surg Glob Open* 2021;9:e3801.
- Largo RD, Chu CK, Chang EI, et al. Perforator mapping of the profunda artery perforator flap: anatomy and clinical experience. *Plast Reconstr Surg*. 2020;146:1135–1145.
- Mohan AT, Zhu L, Sur YJ, et al. Application of posterior thigh three-dimensional profunda artery perforator perforasomes in refining next-generation flap designs: transverse, vertical, and s-shaped profunda artery perforator flaps. *Plast Reconstr Surg*. 2017;139:834e–845e.
- Kurz A, Sessler DI, Lenhardt R. Perioperative normothermia to reduce the incidence of surgical-wound infection and shorten hospitalization: study of wound infection and temperature group. *N Engl J Med*. 1996;334:1209–1215.
- Allan J, Goltsman D, Moradi P, Ascherman JA. The effect of operative time on complication profile and length of hospital stay in autologous and implant-based breast reconstruction patients: an analysis of the 2007–2012 ACS-NSQIP database. *J Plast Reconstr Aesthet Surg*. 2020;73:1292–1298.