Consecutive 265 Profunda Artery Perforator Flaps: Refinements, Satisfaction, and Functional Outcomes

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**Introduction:** The ideal form of breast reconstruction provides total permanent restoration of the breast mound. When a deep inferior epigastric (DIEP) flap is not an option or does not provide significant volume, a secondary source must be considered. In our practice, the profunda artery perforator (PAP) flap from the thigh has emerged as a second choice. We present our experience with the first 265 PAP flaps used for breast reconstruction at our institution. We specifically focus on refinements, satisfaction, and functional outcomes.

**Methods:** We conducted a retrospective review of the first 265 PAP flaps at our institution. Patient demographics, perioperative data, and postoperative complications were recorded and analyzed. The Breast Q and Lower Extremity Functional Scale (LEFS) were both implemented. Additionally, a satisfaction survey was performed, particularly focused on the donor site.

**Results:** Two hundred sixty-five consecutive PAP flaps were used to reconstruct 244 breasts in 138 patients. The PAP flap was used for bilateral reconstruction (107 patients) and unilateral breast (30 patients). It was used in combination with a second flap as double PAP (21 patients) or combined with a DIEP (62 patients). Mean flap size was 403 g (range: 190–800 g) and mean patient body mass index was 26.5 (range: 18–43). Complications included total flap loss (3%), donor site cellulitis (4.9%), and significant donor site wound (6.8%). Currently, the PAP flap accounts for 16.9% of our autologous breast reconstruction and the DIEP flap accounts for 76.0%. Lower Extremity Functional Scale score was 75/80 (94%) by 6 months. Satisfaction with breast reconstruction was 78.9% and satisfaction with the thigh was 82.1%.

**Conclusions:** The PAP flap is an excellent option for autologous breast reconstruction. Success rate and complications are similar to those of other options. There is no significant loss to lower extremity function and satisfaction with the reconstruction is comparable with other options. (Plast Reconstr Surg Glob Open 2020;8:e2682; doi: 10.1097/GOX.0000000000002682; Published online 7 April 2020.)

**INTRODUCTION**

The ideal form of breast reconstruction provides total permanent restoration of the breast mound. The primary method in which this is accomplished is with autologous tissue, and the gold standard is the deep inferior epigastric flap (DIEP flap). When abdominal tissue is not an option, secondary sources must then be considered. Surgeons have utilized the thighs, buttock, and back as alternative sources for total breast reconstruction. While there is potentially a role for all of these donor locations, the posterior thigh, as a profundal artery perforator flap (PAP flap) is our historical typical second choice. It has previously been shown that the PAP flap provides adequate volume for aesthetic breast reconstruction.1,2

While experience is gained with this flap, we continue to strive to optimize outcomes. Our past reports have focused on the versatility of the flap as a single or stacked flap and technical considerations.3–5 Additionally, we have published on perfusion and perforator mapping of the PAP flap.6,7 Despite all of these works, there are limited data on patient satisfaction and donor site outcomes with this procedure. We have an increasing focus on patient satisfaction and patient reported outcomes in general. In many other disciplines functional outcomes are standard practice, but have not been applied to the PAP flap.

**Disclosure:** The authors have no financial interest to declare in relation to the content of this article.
We present our experience with our first 265 consecutive PAP flaps, present patient and flap parameters, and add additional information on patient reported outcomes and lower extremity functional analysis.

METHODS

We conducted a retrospective review of a prospectively collected database of all breast reconstructions using PAP flaps from January 2013 to June 2019. This study received institutional review board approval. Patient demographics including age, body mass index (BMI), previous abdominal surgery, and history of radiation were included. Perioperative data evaluated were flap weight, perforator number, perforator size, pedicle length, flap harvest time, total operative time, and length of stay. Postoperative complications included total flap loss, fat necrosis, thigh hematomas, thigh seromas, thigh infections, and thigh wounds.

Patient-reported outcomes were sent to the patients at 3, 6, 12, 18, and 24 months. Surveys were also sent to all patients who were >24 months postsurgery at the time of establishment of our system for Redcap (January 1, 2018) based database. Surveys included the Breast Q and Lower Extremity Functional Scale (LEFS). Patients who underwent other procedures on their lower extremity (hip replacement, knee surgery) were excluded from the LEFS analysis. Additionally, we asked questions related specifically to the satisfaction with the thigh donor site.

RESULTS

Two hundred sixty-five consecutive PAP flaps were used to reconstruct 244 breasts in 138 patients. The PAP flap was used for bilateral reconstruction (107 patients) and unilateral breast (30 patients). It was used in combination with a second flap as double PAP (21 patients) or combined with another flap (62 patients). Mean flap size was 403 g (range: 190–800 g) and mean patient BMI was 26.5 (range: 18.0–42.9). The perforator number ranged from 1 to 3 (1 in 52.3%, 2 in 40.7%, and 3 in 6.9%). The perforator size was <1.0 mm in 6.1%, 1.0 mm in 17.9%, 1.5 mm in 74.5%, and 2.0 mm in 1.5%. The pedicle length was average 11.2 cm (SD 2.0). Flap harvest time takes an average of 43.1 minutes, with the majority of this time pedicle dissection (25.75 minutes) (Fig. 1).

Flap-related complications included a total flap loss rate of 3%. Six of the 8 flap losses were as part of a stacked flap reconstruction. Of the non-stacked flap reconstruction, 1 was in a patient with BMI > 40, bilateral previous mastectomies and bilateral radiation with failed implant reconstruction. The other was early in our experience and related to an internal mammary issue.

Donor site complications included seromas (4.5%), hematomas (2.6%), infections (4.9%), and significant wounds (6.8%). Seromas were typically treated with drain placement. Hematomas were treated with operative exploration. Infections were typically responsive to oral antibiotics but 3 patients required admission for intravenous antibiotics. The 6.8% wound rate only includes significant wounds that ultimately required a procedure or negative pressure dressing. If we include patients who had eschars and those manageable by local outpatient wound care, this rate increases to 20.9%. Two patients (1.4%) had deep venous thrombosis or pulmonary embolisms.

While the PAP flap is a normal part of our treatment algorithm, it is still a small part of our overall breast reconstruction practice. During this time period, the PAP flap accounted for 16.9% of our autologous breast reconstruction. The large majority of our autologous breast reconstruction is performed with DIEP flaps (76.0%).

There was a 39.0% response rate in postoperative patients with the LEFS. We had individuals respond from multiple time points ranging from 3 to >24 months. We had an average preoperative baseline score of 79. As to be expected, generally function increased with more time.
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after surgery (cumulative score: 3 months 70.3, 6 months 75.3, 12 months 75.5, 18 months 73.4, 24 months 78.3, and after 24 months 79.5) (Fig. 2). Specific areas that were impacted the most were usual hobbies such as recreational or sporting activities (on a 4.0-point scale, the scores were 3 months 2.86, 6 months 3.67, 12 months 3.75, 18 months 3.8, and 24 months 4.0), getting into or out of the car (on a 4.0-point scale the scores were 3 months 3.29, 6 months 3.86, 12 months 3.6, and 24 months 3.67), running on even ground (on a 4.0-point scale the scores were 3 months 3.57, 6 months 3.67, 12 months 3.5, 18 months 3.4, and 24 months 4.0), running on uneven ground (on a 4.0-point scale the scores were 3 months 3.0, 6 months 3.33, 12 months 3.5, 18 months 3.4, and 24 months 4.0), and making sharp turns while running (on a 4.0-point scale the scores were 3 months 2.86, 6 months 3.33, 12 months 3.5, 18 months 3.4, and 24 months 4.0).

As part of the survey, we evaluated satisfaction with the thigh and buttock aesthetics. This included 5 questions with a standard 4-point scale (very dissatisfied, somewhat dissatisfied, somewhat satisfied, and very satisfied) and 2 questions regarding with 3 answer choices. The average total score for patient satisfaction was 17.5 ± 3.4 out of 20; 82.1% of patients stated that the thigh was aesthetically improved or the same, 64.1% of patients felt their thighs were aesthetically improved, 17.9% felt their thighs were the same following PAP flaps, and 73.0% felt that their buttock was either improved or the same following PAP flaps (Table 1).

The Breast Q data are also presented (Table 2). At 12 months or greater from surgery, satisfaction with breast score was 78.9 (SD 18.2), psychosocial well-being was 82.2 (SD 21.6), chest physical well-being was 85.2 (SD 18.8), and sexual well-being was 67.9 (SD 20.9).

**DISCUSSION**

The PAP flap is an excellent option for breast reconstruction with autologous tissue (Figs. 3–5). Flap size is adequate for breast reconstruction in appropriately selected patients. When patients do not have adequate thigh volume, the PAP flap can be combined as 2 PAP

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**Table 1. Patient-reported Satisfaction for Posterior Thighs and Buttock following Breast Reconstruction with PAP Flaps**

| Questions                                      | Very Dissatisfied (%) | Somewhat Dissatisfied (%) | Somewhat Satisfied (%) | Very Satisfied (%) |
|------------------------------------------------|-----------------------|---------------------------|------------------------|-------------------|
| How your thigh looks when unclothed?           | 7.7                   | 5.1                       | 38.5                   | 48.7              |
| The position of your scar?                     | 5.1                   | 0.0                       | 25.6                   | 69.2              |
| How your thigh scars look?                     | 7.7                   | 5.1                       | 35.9                   | 51.3              |
| How your thigh looks in clothes?               | 5.1                   | 0.0                       | 12.8                   | 82.1              |
| How your buttock looks?                        | 2.6                   | 5.1                       | 29.5                   | 71.8              |
| Do you feel your thighs were aesthetically improved? | 17.9                 | 17.9                      | 64.1                   |                   |
| Do you feel your buttock shape was aesthetically improved? | 27.0                 | 48.6                      | 24.3                   |                   |
flaps\(^4\) or with other flaps\(^5\) (Figs. 6–8). Flap and donor site complications are comparable with other free tissue breast reconstruction options, and with experience can be limited.

We present similar flap and patient parameters in comparison to our early experience.\(^1\) With comfort we have utilized the PAP flap in more stacked flap situations. We have, however, noted more flap-related problems in these patients. Of the 8 flap losses, 6 of them were in a stacked-flap setting. All but 1 of these was a buried flap with a cook implantable Doppler that did not change and therefore salvage was not possible. The single non-stacked and non-buried PAP flap loss was an unusual delayed loss after discharge on postoperative day 6, in which the patient woke up with venous congestion.

In our literature, much of the focus for abdominal-based reconstruction has centered on the donor site and specifically on limiting complications.\(^8\) The abdomen is clearly the most common donor site\(^5\); so, it is of paramount importance to focus on the outcomes of the abdominal donor site. However, there are very limited data on the donor sites of alternative flaps. One of our primary goals in this series is to evaluate the satisfaction and functional outcomes with the lower extremity following a PAP flap.

The Breast Q has been used to evaluate multiple types of breast reconstruction in multiple practices.\(^10\)\textsuperscript{–}\textsuperscript{12} Normative data have also been published to help with comparison to breast reconstruction patients.\(^13\) The PAP reconstruction patients fared favorably in comparison to normative data with all relevant Breast Q segments. The only data point in this patient series that was lower than normative data was physical well-being of the chest. Generally, this supports the use of the PAP flap for breast reconstruction based on satisfaction with the patient’s breast.

The LEFS is a validated assessment tool for lower extremity musculoskeletal conditions.\(^14\) The score is based on a maximum of 80 and the minimum level of a
detectable change is 9 points (90% confidence). Patients within the first 3 months following breast reconstruction with PAP flaps had a clear functional impairment (LEFS 70.3). By 6 months, the LEFS score increased to 75.3, which is no longer below the level considered significant for a detectable change. At all time points past 6 months, the scores were within normal limits. Additionally, the cosmetic impact to the thighs and buttock is generally perceived favorably (Figs. 9–14).

Our postoperative protocol for PAP flaps is very similar to our protocol with DIEP flaps. Currently, we use an enhanced recovery pathway with limited narcotics. Our typical goal for date of discharge is postoperative day 2. Our patients go into a compression garment postoperatively. We encourage ambulation on postoperative day 1, but we restrict our patients from any strenuous activities for 6 weeks. At that point, many of our patients begin exercise training, which increases with time. Subjectively, many
patients will initially feel tight in their thighs, but it is rare that they require any physical therapy.

In our practice, we are gaining experience with the lumbar artery perforator flap and find that this is an additional excellent alternative option as well. In the right patient, this donor location can give more tissue than a PAP flap but there are significant drawbacks. The lumbar artery perforator flap requires a position change and typically a vascular graft to avoid the potential neuropraxia from harvesting a long pedicle. In

Fig. 6. Forty-two-year-old woman with left DCIS. She was treated with left nipple sparing mastectomy and delayed-immediate reconstruction with bilateral stacked PAP flaps. She underwent subsequent liposuction contouring and symmetry fat injection (anteroposterior view before and after at 3 months following surgery).

Fig. 7. Oblique view before and after at 3 months following surgery.
our practice, we are utilizing this flap as yet another alternative in ideally selected patients and gaining increasing experience. The introduction of the PAP flap in our practice did not decrease the volume of DIEP flaps, but extended autologous reconstruction in a set of patients not suitable for DIEP or DIEP-only flap (in stacked flap experience). Hence, the PAP flap continues to be refined and serve as an excellent choice while maintaining its versatility in small to medium sized reconstruction.

CONCLUSIONS

The PAP allows for total breast reconstruction with autologous tissue with generally high satisfaction. This is accomplished with minimal long-term functional impact to the thighs.
Fig. 10. Donor site following bilateral PAP flap harvest (oblique view before and after at 3 months following surgery).

Fig. 11. Donor site following bilateral PAP flap harvest (lateral view before and after at 3 months following surgery).
Fig. 12. Donor site following bilateral PAP flap harvest (anteroposterior view before and after at 3 months following surgery).

Fig. 13. Donor site following bilateral PAP flap harvest (oblique view before and after at 3 months following surgery).
REFERENCES

1. Haddock NT, Gassman A, Cho MJ, et al. 101 consecutive profunda artery perforator flaps in breast reconstruction: lessons learned with our early experience. Plast Reconstr Surg. 2017;140:229–239.

2. Allen RJ, Haddock NT, Ahn CY, et al. Breast reconstruction with the profunda artery perforator flap. Plast Reconstr Surg. 2012;129:16e–23e.

3. Haddock N, Nagarkar P, Teotia SS. Versatility of the profunda artery perforator flap: creative uses in breast reconstruction. Plast Reconstr Surg. 2017;139:606e–612e.

4. Haddock NT, Cho MJ, Gassman A, et al. Stacked profunda artery perforator flap for breast reconstruction in failed or unavailable deep inferior epigastric perforator flap. Plast Reconstr Surg. 2019;143:488e–494e.

5. Teotia SS, Cho MJ, Haddock NT. Salvaging breast reconstruction: profunda artery perforator flaps using thoracodorsal vessels. Plast Reconstr Surg Glob Open. 2018;6:e1837.

6. Wong C, Nagarkar P, Teotia S, et al. The profunda artery perforator flap: investigating the perforasome using three-dimensional computed tomographic angiography. Plast Reconstr Surg. 2015;136:915–919.

7. Haddock NT, Greaney P, Otterburn D, et al. Predicting perforator location on preoperative imaging for the profunda artery perforator flap. Microsurgery. 2012;32:507–511.

8. Cho MJ, Teotia SS, Haddock NT. Predictors, classification, and management of umbilical complications in DIEP flap breast reconstruction. Plast Reconstr Surg. 2017;140:11–18.

9. Healy C, Allen RJ Sr. The evolution of perforator flap breast reconstruction: twenty years after the first DIEP flap. J Reconstr Microsurg. 2014;30:121–125.

10. Dean NR, Crittenenden T. A five year experience of measuring clinical effectiveness in a breast reconstruction service using the BREAST-Q patient reported outcomes measure: a cohort study. J Plast Reconstr Aesthet Surg. 2016;69:1469–1477.

11. Pusic AL, Matros E, Fine N, et al. Patient-reported outcomes 1 year after immediate breast reconstruction: results of the mastectomy reconstruction outcomes consortium study. J Clin Oncol. 2017;35:2499–2506.

12. Santosa KB, Qi J, Kim HM, et al. Long-term patient-reported outcomes in postmastectomy breast reconstruction. JAMA Surg. 2018;153:891–899.

13. Mundy LR, Homa K, Klassen AF, et al. Breast cancer and reconstruction: normative data for interpreting the BREAST-Q. Plast Reconstr Surg. 2017;139:1046e–1055e.

14. Mehta SP, Fulton A, Quach C, et al. Measurement properties of the lower extremity functional scale: a systematic review. J Orthop Sports Phys Ther. 2016;46:200–216.

15. Binkley JM, Stratford PW, Lott SA, et al. The lower extremity functional scale (LEFS): scale development, measurement properties, and clinical application. North American orthopaedic rehabilitation research network. Phys Ther. 1999;79:371–383.

16. Opsomer D, Stillart F, Blondeel P, et al. The lumbar artery perforator flap in autologous breast reconstruction: initial experience with 100 cases. Plast Reconstr Surg. 2018;142:1e–8e.

Fig. 14. Donor site following bilateral PAP flap harvest (lateral view before and after at 3 months following surgery).