



Combined perforator flaps for total breast reconstruction – a narrative review and insights from massive weight loss cases

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Background and Objective: Perforator flaps have revolutionized autologous breast reconstruction, introducing both free and pedicled options as well as the potential for combining flaps. These versatile techniques can be utilized in massive weight loss (MWL) patients, effectively addressing both functional and aesthetic challenges by using their excess skin. This review aims to explore literature on combined pedicled and free perforator flaps for total breast reconstruction, and share our own experience in the field.

Methods: A PubMed search up to June 2023 employed Medical Subject Headings (MeSH) terms such as (“combined”) OR (“stacked”) OR (“conjoined”) AND (“perforator flaps”) AND (“breast reconstruction”). Publications in English and Scandinavian languages were manually screened for relevance, and supplemental sources were also reviewed.

Key Content and Findings: Limited studies exist on using combined pedicled and free flaps for total breast reconstruction, although combined free flaps are more common. Perforators around the breast base, offer multiple flap options for single or combined use. In our series of 10 women, four underwent total breast reconstruction with a combination of flip-over internal mammary artery perforator (IMAP) flap and thoracodorsal artery perforator (TDAP) flap. Another subset of four, who were MWL patients, received combined TDAP and superior epigastric artery perforator (SEAP) flaps, along with body contouring procedures such as upper body lifts and vertical abdominoplasties, addressing excess skin and improving silhouette. One remaining MWL patient had deflated breasts restored using TDAP and SEAP flaps, along with an upper and lower body lift and vertical abdominoplasty. The last MWL patient underwent a risk-reducing mastectomy, also reconstructed with TDAP and SEAP flaps, and received an upper body lift and vertical abdominoplasty

Conclusions: Combined perforator flap techniques for combined body contouring and breast reconstruction seems safe and especially suitable for MWL patients. They offer a surgical alternative merging body contouring and breast reconstruction in cases where free flap procedures seem less favorable due to skin laxity and deflation of donor sites. However, limited literature on the topic calls for further studies.

Keywords: Breast reconstruction; thoracodorsal artery perforator flap (TDAP flap); perforator flaps; superior epigastric artery perforator (SEAP); body contouring

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Introduction

Reconstruction with autologous tissue is a widely preferred and a reliable technique for breast reconstruction. It offers numerous potential advantages, such as creating a breast that feels and looks more natural, the ability to match the contralateral native breast in cases of unilateral breast reconstruction, and the avoidance of complications associated with breast implants (1). Autologous breast reconstruction can be carried out using free or pedicled perforator flaps. Pedicled perforator flaps evolved from classic fasciocutaneous and musculocutaneous flaps or from so-called random flaps. One such example is the thoracodorsal artery perforator (TDAP) flap, which originated from the latissimus dorsi (LD) flap. The TDAP flap was introduced by Angrigiani in 1995, as a modification of the LD flap, without the inclusion of the muscle (2). This marked the beginning of a new era in the use of pedicled flaps from the back and usage of pedicled perforator flaps for breast reconstruction. Although the LD flap continues to be a workhorse flap for breast reconstruction worldwide, there is a growing trend towards the use of the TDAP flap to avoid the use of the LD muscle and the associated morbidities related to shoulder and arm function. Even though the evidence comparing the two techniques has shown ambiguous results (3-6). We have used the TDAP in combination with an implant for total breast reconstruction since 2011 and have published several papers about its use as well as surgical refinements for both unilateral and bilateral breast reconstruction (4,7-9). The usage of the LD flap for breast reconstruction has become rare at our department.

Another perforator flap for breast reconstruction that evolved from its adjacent muscle is the deep inferior epigastric perforator (DIEP) flap, which was developed from the transverse rectus abdominis myocutaneous (TRAM) flap (10). Amongst plastic surgeons the DIEP flap is considered the golden standard for autologous breast reconstruction, mostly because of the low donor site morbidities, texture, color, and size of the flap. The DIEP flap holds an advantage over the TDAP flap in that it is a total autologous flap in majority of cases and is rarely combined with an implant. Conversely, the TDAP flap is typically combined with a breast implant for augmentation

of volume and projection (8). The next logical evolution is to combine the TDAP with other pedicled perforator flaps in close proximity to the breast base or within the breast base for total breast reconstruction to avoid the use of implants. To be able to carry this out the patient needs to have abundant tissue in this region, a patient group that possess this quality is massive weight loss (MWL) patients. These patients have abundant tissue for reconstruction within and around the borders of the breast base, which can be raised, shaped, and draped as perforator flaps. In recent years, we have combined the TDAP with other pedicled perforator flaps for breast reconstruction aiming to combine body contouring and reconstructive procedures and also to avoid the use of implants. Many of the patients have been MWL patients. These patients as other patients may have a need for breast reconstruction due to an increased risk of developing cancer, breast cancer or merely for restoration of the breast following MWL. The aim of this review is to elucidate literature regarding the use of combined pedicled perforator flaps for total breast reconstruction and to find inspiration from the usage of stacked free flaps for the same purpose, as well as sharing our own experience with combined pedicled perforator flaps for total breast reconstruction in procedures combining breast reconstruction and body contouring. We present this article in accordance with the Narrative Review reporting checklist (available at <https://gs.amegroups.com/article/view/10.21037/gS-23-397/rc>).

Methods

PubMed (Medline) was searched for relevant literature in the period: from the start of each database to June 2023. Both controlled thesaurus terms and natural language terms for synonyms were used. A primary search was performed using the Medical Subject Headings (MeSH) terms (“combined”) OR (“stacked”) OR (“conjoined”) AND (“perforator flaps”) AND (“breast reconstruction”). The search encompassed relevant publications in English or any of the Scandinavian languages. The identified publications were manually screened for their title, abstract, and full text to determine their relevance to the study.

Furthermore, references from the searched articles and

Table 1 The search strategy of the study

Items	Specification
Date of search	2023.06.25
Databases and other sources searched	PubMed (Medline) and Reference lists of relevant articles
Search terms used	((“combined) OR (“stacked) OR (“conjoined) AND (“perforator flaps)) AND (“breast reconstruction)
Timeframe	Start of the database–2023.06
Exclusion criteria	Preclinical studies, reviews and studies not written in English or any of the Scandinavian languages were excluded
Selection process	Two authors independently reviewed the literature based on the title and abstract, excluding irrelevant material at the initial stage. The full text of the selected studies was then carefully examined to confirm their suitability. In case of any discrepancies between the two authors during the selection process, it was resolved through discussion or input from a third author

supplementary sources were also reviewed and any relevant studies were included. The final literature search was conducted on June 25th, 2023. *Table 1* illustrates an overview of the search and screening processes.

Stacked/combined flaps

Definition

In breast reconstruction, the term “stacked flaps” is used when more than one donor site is used for reconstruction of one breast. However, “stacked” generally suggests layering one thing atop of another, a description not always accurate in this context (11). A common method for breast reconstruction with several flaps is a conjoined also called bi-pedicled DIEP flap (12). In this scenario, the flaps are joined together, not layered, hence, they do not technically qualify as “stacked” (11,12). A more accurate definition for multiple-flap breast reconstruction is as following:

- ❖ Conjoined/bi-pedicled flaps: these refer to two connected flaps (double pedicled) from the same donor area. An example of a conjoined flap is a double pedicled DIEP flap, where the whole abdomen is raised as one flap and then folded into the shape of a breast at the recipient site.
- ❖ Combined/stacked flaps: these consist of two distinct flaps from separate donor sites, each with its own pedicle, for instance two separate profunda artery perforator (PAP) flaps or a DIEP flap and a PAP flap used to reconstruct one breast. Another combination could be two or multiple pedicled flaps around the breast base or a pedicled flap combined with a free flap from another donor site.

Combined pedicled perforator flaps for breast reconstruction

There are numerous perforators found within and around the base of the breast and chest wall, and in theory, any of these can be employed to create a flap for breast reconstruction. Some of the most recognized flaps include the flaps based on perforators originating from the intercostal vessels (13). When the flap is based on perforators rising from the muscular segment its named anterior intercostal artery perforator (AICAP) flaps and this flap is best suited for reconstruction of defects located at the medial aspect of the breast. The flap is known as lateral intercostal artery perforator (LICAP) flaps, when it is based on perforators originating from the costal segment. This flap is suited for defects at the lateral aspect of the breast (14). At last we have the medial intercostal artery perforator (MICAP) flaps, also known as internal mammary artery perforator (IMAP) flaps (15). From the lateral chest wall additional flap choice for breast reconstruction is the lateral thoracic artery perforator (LTAP) flap and the TDAP flap (16). Further from the breast base, we encounter the superior epigastric artery perforator (SEAP) flap (17,18). Reconstruction based on the chest wall perforators has since its introduction emerged as a valuable option in breast conserving surgery (13,14,19). Many studies have shown the safety and feasibility of these flaps for partial breast reconstruction in a selected group of women. Besides the functional benefits, the studies have also shown the added advantage of minimal donor site morbidity with excellent aesthetic outcomes and improved patient satisfaction. These techniques offer an excellent opportunity for partial breast reconstruction in women with small-to-moderate-sized breast and may prevent the need for mastectomy. Typically,

only one of the flaps is being used at a time for volume replacement in partial breast reconstruction. However, there is a potential to merge these perforator flaps to increase volume, as demonstrated with stacked flaps (13,14,16,19-21). In practice this combined pedicled perforator flap technique can be utilized for both partial and total breast reconstruction. Combining the chest wall perforators for partial breast reconstruction have been applied in some studies. One common flap combination is the LICAP flap with the LTAP flap to offer additional volume in partial breast reconstruction for defects of the lateral quadrant of the breast, where studies have shown good results (16).

The literature describing the use of combined pedicled perforator flaps for total breast reconstruction is surprisingly scarce. We have published a paper recently in which we have described the possibility of combining the TDAP with a contralateral IMAP/MICAP for total breast reconstruction, In the same paper we also describe the use of the TDAP in combination with a SEAP for total breast reconstruction (22).

Our experience with combined pedicled flaps for breast reconstruction

The inspiration for this article stems from our innovative approach in employing combined pedicled perforator flaps for autologous breast reconstruction or augmentation (22). This method seems suitable for patients in whom traditional reconstructive strategies were seen as less suitable.

In MWL patients, the skin becomes lax, and there's a noticeable reduction in subcutaneous volume due to tissue deflation. Additionally, the connective tissue is often overstretched, losing much of its original structure and elasticity. These patients require not just breast reconstruction(s), but also body contouring. Traditional reconstructive techniques like DIEP and LD flaps do not adequately address the need for body contouring. Therefore, utilizing the abundant lax tissue for reconstructive procedures presents a solution, allowing for the restoration of body contours in the same surgical process. The intention behind this approach was to harvest excess tissue as pedicled perforator flaps from areas outside the adjacent breast borders. By uniting two perforator flaps, we could achieve additional volume, bypass the need for an implant, and concurrently perform body contouring or a contralateral breast reconstruction within the same surgical intervention.

For targeted perforator surgery, we recommend the use of

color Doppler ultrasound (CDU). This imaging technique not only facilitates the precise identification of perforator location, but also allows for the detailed visualization of their course. With CDU, we can trace the perforator from the feeding vessel, navigating through the muscle and fascia up to the subcutaneous layer. To be able to perform reconstruction with pedicled perforator flaps it is crucial to gain information about the size and exact location of the perforators. The procedure can only be carried out, if sizable and well-located perforator can be identified in the out-patient clinic. For the purpose, any CDU equipped with a transducer ranging from here it should say: 10 to 18 MHz. proves effective in pinpointing the perforators. However, it is crucial, to adjust the flow velocity settings accurately for small vessels, a method we have described earlier.

The patient cohort comprised 10 women, of these, eight underwent delayed breast reconstruction. One patient had an immediate risk-reducing mastectomy followed by breast reconstruction. Another underwent autologous breast augmentation to address the consequences and complete deflation of the breasts resulting from MWL. In our assessment, each patient was considered for free flap breast reconstruction. However, this approach was deemed unsuitable due to the presence of significant skin laxity and the challenges in reshaping the existing tissue. In line with our department's standards, we refrain from using breast implants for patients who has undergone MWL.

We carried out eight unilateral breast reconstructions on patients deemed less suitable for traditional reconstructive techniques due to the skin laxity. Four patients underwent unilateral breast reconstruction and a breast reduction of a large ptotic contralateral breast. In these cases, the breasts were reconstructed using a combined propeller TDAP from the back, along with a flip-over IMAP flap from the opposite breast. For the latter, the skin and subcutaneous tissue were harvested as a pedicled perforator flap based on the IMAP perforators. Typically, this tissue would otherwise be excised during the breast reduction of the contralateral side. Four patients, who underwent MWL, required a delayed breast reconstruction. These individuals underwent a combined procedure for breast reconstruction and body contouring. The breast reconstruction was performed with a combined propeller TDAP and SEAP flap. Simultaneously, an upper body lift and vertical abdominoplasty were conducted.

Of the remaining two patients, one underwent MWL and presented with completely deflated breasts. To address this, the breasts were restored using combined TDAP and SEAP flaps. Additionally, in the same surgical session, the patient

Table 2 Patients reconstructed/restored with combined pedicled perforator flaps

Patient	Age (years)	Indication	Reconstruction	Flap 1	Flap 2
1	51	DBR	Right	TDAP	IMAP
2	64	DBR	Left	TDAP	IMAP
3	43	IBR, RR, MWL	Bilateral	TDAP	SEAP
4	53	DBR, MWL	Right	TDAP	SEAP
5	60	DBR	Right	TDAP [†]	IMAP
6	57	DBR	Right	TDAP	IMAP
7	33	ABA, MWL	Bilateral	TDAP	SEAP
8	47	DBR, MWL	Right	TDAP	SEAP
9	55	DBR, MWL	Right [‡]	TDAP	SEAP
10	55	DBR, MWL	Left	TDAP	SEAP

[†], tip necrosis TDAP, ABA; [‡], IMAP used for autoaugmentation of left breast. DBR, delayed breast reconstruction; TDAP, thoracodorsal artery perforator; IMAP, internal mammary artery perforator; IBR, immediate breast reconstruction; RR, risk reducing; MWL, massive weight loss; SEAP, superior epigastric artery perforator; ABA, autologous breast augmentation.



Figure 1 A 64-year-old woman required delayed breast reconstruction and had not received any radiation therapy. She also had an enlarged contralateral breast in need of reduction.

underwent an upper body lift, a lower body lift with gluteal autoaugmentation, and a vertical abdominoplasty. The final patient, was also an MWL patient and underwent a bilateral risk-reducing mastectomy, with breast reconstruction using a combination of TDAP and SEAP flaps. Furthermore, the patient's overall body silhouette was enhanced through body contouring techniques, including an upper body lift and vertical abdominoplasty. *Table 2* shows details for the ten patients who received breast reconstruction with pedicled perforator flaps.

Case 1

The patient, a 64-year-old woman, sought delayed breast

reconstruction and had not undergone any radiation therapy. She had a large contralateral breast that required reduction (*Figure 1*). Her abdomen was convex in shape with limited subcutaneous volume in the lower region, making it unsuitable for DIEP flap reconstruction. However, she had a substantial amount of donor tissue in her back. Uninterested in an implant-based solution, our approach aimed for autologous breast reconstruction. The strategy involved combining a propeller TDAP flap with an IMAP flap, using excess subcutaneous tissue and dermis harvested from the lower portion of the contralateral breast.

The cornerstone of a targeted reconstructive procedure lies in utilizing CDU to pinpoint the exact location of the dominant perforators and visualize their intramuscular

pathways. *Table 3* outlines useful advice and techniques for breast reconstruction using pedicled perforator flaps. For perforator mapping, we employed a 14 MHz linear transducer. Our methods for harvesting the propeller TDAP have been detailed in multiple published papers (23,24). In brief, the skin island is strategically designed where the donor tissue in the back is most lax and abundant, usually in an oblique downward orientation. The flap is then elevated either above or below the thin muscle fascia, dissecting in a caudal to cranial direction towards the identified perforators. Dissection typically ends when the flap can reach the recipient site without tension. In cases involving two perforators, the secondary one may need to be dissected through the muscle toward the primary and dominant perforator to facilitate flap rotation. The flap can either be tunneled under the axillary skin or transferred through an incision in the axillary skin to the recipient site. If tunneled, it must be de-epithelialized. The flap can be positioned just above the inframammary fold (IMF) to contribute to the shape and draping of the reconstructed breast, or it can be fully de-epithelialized and used for autoaugmentation. When employing the TDAP as a

propeller flap, it is often necessary to perform secondary debulking or reshaping procedure around the pedicle in the axillary area. The flap's length is influenced by factors such as perfusion and angiosomes, which can ideally be tested using indocyanine green (ICG) and an infrared camera for confirmation. In this particular case, the TDAP was de-epithelialized and then tunneled to the recipient site.

Two sizeable internal mammary artery (IMA) perforators were identified between the ribs. Based on their location, we adjusted the Wise-pattern markup and executed the breast reduction using a modified superomedial-based pedicle for transposing the nipple-areola complex. The IMA flap was elevated using our hydrodissection technique, which is similar to the method we employ for our mastectomies (25). The flap was de-epithelialized, and its length was adjusted based on perfusion, as confirmed using ICG and an infrared camera. It was then tunneled across the midline to the base of the breast on the opposite side (*Figure 2*). The IMA flap was positioned at the breast base, while the TDAP flap was layered over it in a stacked design (*Figure 3*). The patient later underwent a secondary shaping procedure, primarily involving liposuction of the IMA pedicle across the midline to obtain a satisfying cosmetic result (*Figure 4*).

Table 3 Tips & tricks

For MWL patients not eligible for breast reconstruction with a free flap:

- Determine if unilateral or bilateral reconstruction is indicated
- Evaluate body contouring needs and available donor tissue based on patient's body habitus
- Employ CDU to identify perforators
- Estimate the number of flaps for desired breast size

MWL, massive weight loss; CDU, color Doppler ultrasound.

Case 2

This 43-year-old woman, who is also an MWL patient, required delayed breast reconstruction for her right breast, mastopexy for the left breast, an upper body lift, and a vertical abdominoplasty due to skin laxity (*Figure 5*). Traditional reconstructive options included an LD flap from the back, either in combination with an implant or as an extended LD with fat transplantation. Another possibility was a TDAP flap paired with an implant. Although donor

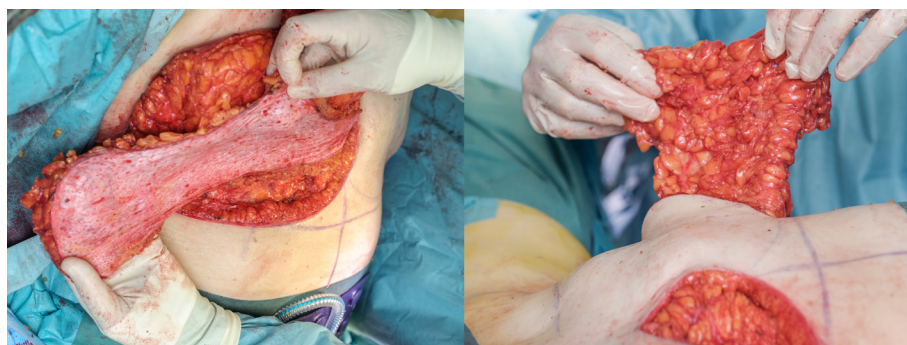


Figure 2 Here, the IMA flap has been lifted and tunneled across the midline to the base of the opposite breast. IMA, internal mammary artery perforator.

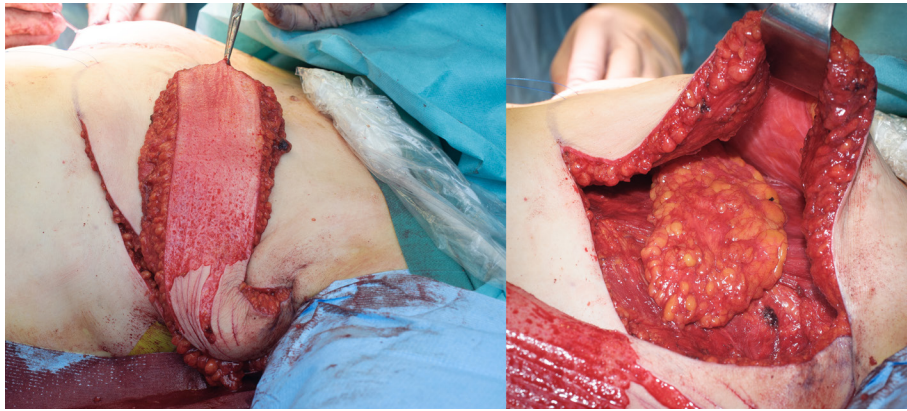


Figure 3 The IMAP flap was placed at the breast's base, with the TDAP flap layered over it in a stacked configuration. IMAP, internal mammary artery perforator; TDAP, thoracodorsal artery perforator.

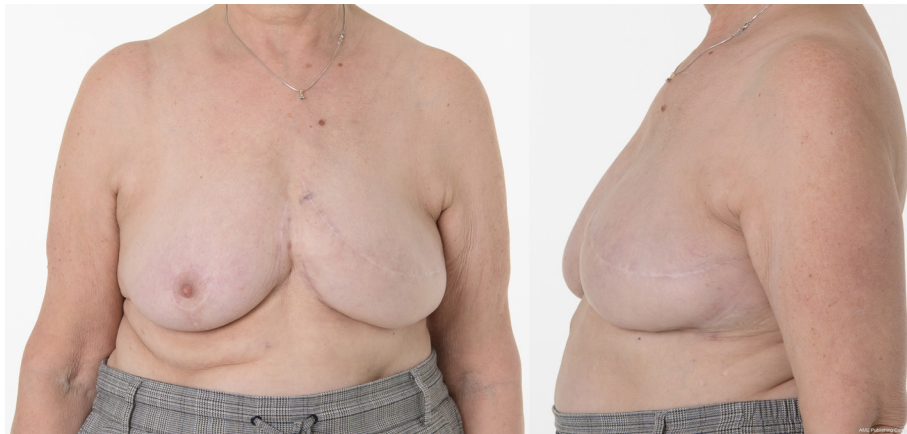


Figure 4 The patient later had liposuction of the IMAP pedicle for better shaping, with the final result illustrated here. IMAP, internal mammary artery perforator.

tissue from the abdomen could be used for a DIEP flap, the tissue in her lower abdomen was too lax and deflated for this purpose. Instead, we chose a combined approach: an upper body lift using lax skin and subcutaneous tissue from the back, harvested as a propeller TDAP, along with a vertical abdominoplasty using tissue from 5 cm above the umbilicus to the xiphoid process, harvested as a SEAP flap. The harvest of the TDAP is described above. The TDAP was placed right above the IMF and used to both shape and drape the reconstructed breast.

The SEAP flap is harvested similarly to the TDAP flap. Based on our experience and ICG testing, optimal flap harvesting occurs approximately 5 cm above the umbilicus; beyond that point, perfusion becomes insufficient. The flap is elevated above the muscle fascia in a cranial direction.

In bilateral cases, the flap can be raised on both sides, or in instances like this one, a single flap can cross the midline, based on one dominant perforator (*Figure 6*). The SEAP perforator is often located 4–5 cm below the ribcage edge and approximately 5 cm from the midline. However, the number, location, and size of the perforators can vary, making targeted surgery guided by CDU essential. In most cases, it is necessary to dissect the perforator through the muscle to its feeding superior epigastric vessels. Often, these feeding vessels need to be divided caudally to the perforator to achieve a more favorable pedicle length. The dissection of the superior epigastric artery (SEA) can be continued between muscle fibers up to the ribcage, where the vessel name transitions to the IMA. Typical pedicle lengths range from 5 to 7 cm. The flap is subsequently



Figure 5 A 43-year-old woman, also an MWL patient, needed delayed reconstruction for her right breast and a mastopexy for the left. Due to skin laxity, she also required an upper body lift and vertical abdominoplasty. MWL, massive weight loss.

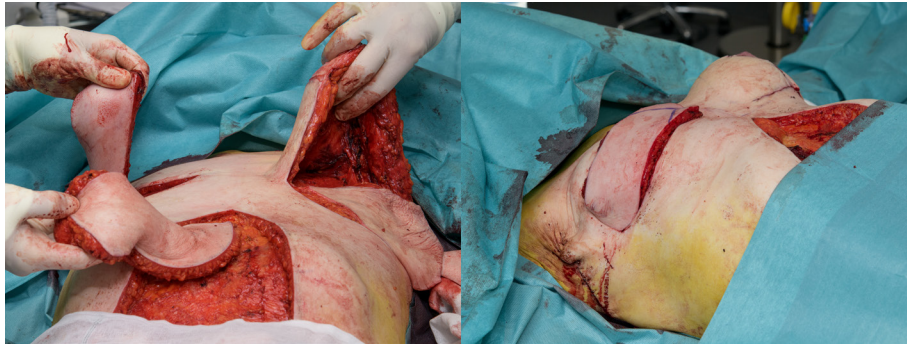


Figure 6 Here raised TDAP, SEAP, and IMAP flaps are seen. TDAP, thoracodorsal artery perforator; SEAP, superior epigastric artery perforator; IMAP, internal mammary artery perforator.

de-epithelialized, tested using ICG, and tunneled to the donor site in the breast base (*Figure 7*). If harvested from both sides of the abdomen, the flap can fully cover the breast base. In unilateral cases, it covers approximately two-thirds of the breast base. Any excessive bulk from the pedicle can be reshaped through liposuction in a secondary procedure. The upper poles of the contralateral left breast were autoaugmented with the ipsilateral de-epithelialized IMAP-flap. At follow up we concluded that the right reconstructed breast needed additional volume in the upper poles (*Figure 8*). If we had known then what we know now, we would likely have used the contralateral IMAP flap as

part of the reconstruction of the right breast, as we could have used additional volume for the upper poles. The patient underwent a secondary procedure for additional autoaugmentation, during which we harvested a brachial artery perforator (BAP) flap from the right side while simultaneously performing bilateral brachioplasties, as shown in *Figure 9*. The BAP flap was then de-epithelialized and tunneled through the axilla (see *Figure 10*). It was positioned between the pectoralis major muscle and the SEAP flap at the base of the breast, thereby adding volume to the upper poles (*Figure 11*). This procedure was recently completed, and follow-up images are not yet available.

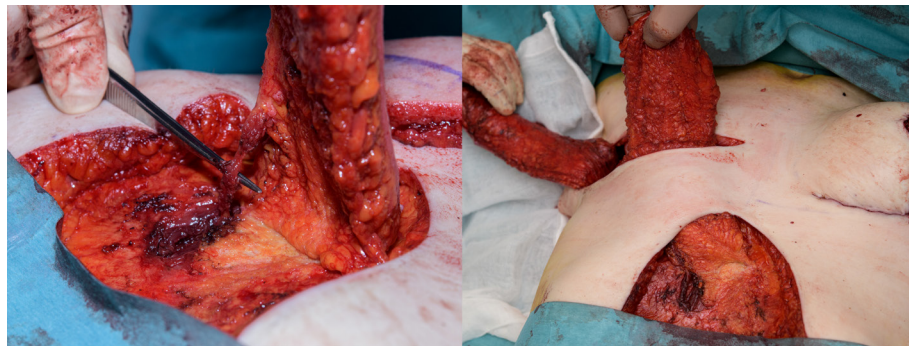


Figure 7 The SEAP flap is raised on one dominant perforator than de-epithelialized and tunneled to the donor site in the breast base. SEAP, superior epigastric artery perforator.



Figure 8 Upon follow-up, it was concluded that the reconstructed right breast required more volume in the upper poles.

Figure 12 illustrates the four types of pedicled flaps used in our cases, highlighting the specific perforators.

Combined pedicled and free flaps for breast reconstruction

Another option for total breast reconstruction with the chest wall perforator flaps, is to combine them with free flaps for volume augmentation to match the native contralateral breast. Angrigiani has published the use of a pedicled TDAP combined with a free TDAP, as stacked flaps for breast reconstruction. In their study, 14 female patients underwent unilateral breast reconstruction with stacked TDAP flap, where the ipsilateral flap is transferred

as an island and the contralateral TDAP flap is raised as a free flap. At follow up, the results were good with similar appearance and volume as the native contralateral breast and almost no donor site morbidity (26). Another study from 2018 introduces the possibility of combining a pedicled LICAP flap with a free flap from the abdomen for unilateral breast reconstruction. The article showed that by combining the flaps it was possible to obtain more volume and increased projection without prolonging the time for surgery (27). Combining pedicled flaps with free flaps for breast reconstruction can be a good option when the surgeon wants to avoid increased complexity of surgery and greater risk for complications as is the case with stacked free

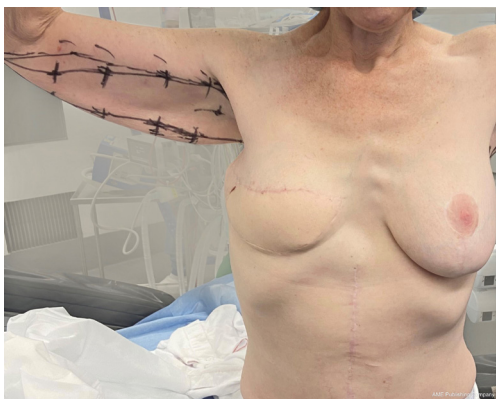


Figure 9 The patient had a follow-up procedure for further autoaugmentation, where a BAP flap was harvested from the right side, along with concurrent bilateral brachioplasties. BAP, brachial artery perforator.



Figure 11 The immediate result of this autoaugmentation is shown in this figure.



Figure 10 The BAP flap was de-epithelialized and tunneled through the axilla and positioned between the pectoralis muscle and the SEAP flap. BAP, brachial artery perforator; SEAP, superior epigastric artery perforator.

flaps. Although the combination of pedicled and free flaps for breast reconstruction is less complex than stacked free flaps, the literature on this subject is remarkably scarce.

Multiple free flaps for breast reconstruction

Breast reconstruction with multiple free flaps is an emerging technique and publications on the subject is increasing. Combining multiple free flaps is usually considered in patients that require unilateral breast reconstruction, where

a fairly large contralateral breast needs to be matched but the patient has scarce tissue in the lower abdomen. Usually, the techniques available for reconstruction in these cases include: free flap with an implant, secondary lipofilling to the free flap or reducing the contralateral breast. However, by raising bipediced flaps or stacked free flaps more tissue is incorporated in the free flaps and this makes it possible to reconstruct a breast entirely with autologous tissue in this patient group (11). The use of conjoined DIEP flaps is the most common method in multiple free flap breast reconstructions (28-30). The technique of raising the entire lower abdomen based on two vascular pedicles was initially outlined by Arnez and his team in 1992, where they implemented it with the bipediced free TRAM flap (31). Subsequently, in 1994, Blondeel first introduced this approach to abdominal perforator flaps, specifically in their description of the DIEP flap (32). Since then, there has been a surge of published studies affirming the safety and feasibility of the bipediced DIEP flap. Various strategies for forming the flap and the vascular anastomoses (33). Furthermore, recent research has demonstrated the feasibility of combining abdominal-based free flaps with other free flaps such as the PAP flap (34), transverse upper gracilis (TUG) flap (35), or lumbar artery perforator (LAP) flap (36). There are even studies where free flaps have been combined without involving abdominal tissue at all (11). This exciting field continues to expand and evolve, offering increasingly refined options for breast reconstruction.

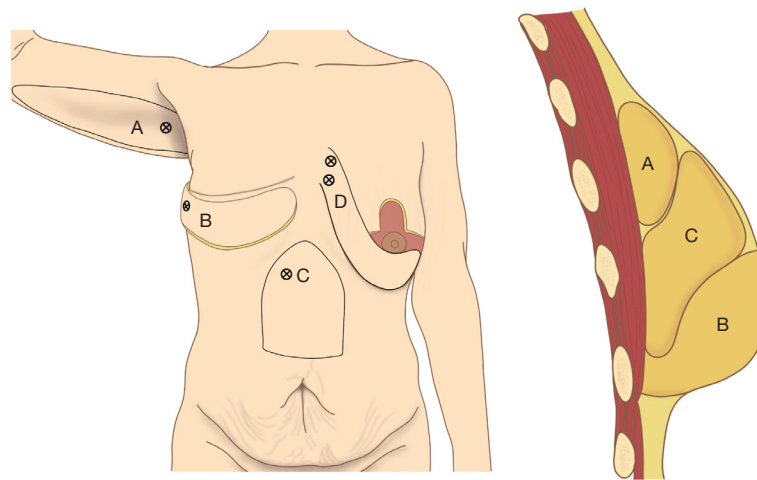


Figure 12 In total, the patient underwent two procedures for left breast reconstruction, incorporating a TDAP flap (B), a SEAP flap (C), and a BAP flap (A). A mastopexy on the left side was also conducted, using an IMAP flap (D) to add volume to the upper pole. TDAP, thoracodorsal artery perforator; SEAP, superior epigastric artery perforator; BAP, brachial artery perforator; IMAP, internal mammary artery perforator.

Autologous breast reconstruction in MWL patients

Obesity is a global epidemic and the number of patients wanting weight loss through bariatric surgery, diet or medication is increasing worldwide (37). However, a common and nearly inevitable consequence of substantial weight loss is excess skin, which poses ongoing body image issues for many patients (38). We can expect that a considerable percentage of these patients will seek consultations with plastic surgeons specifically for addressing the challenges related to MWL and the resultant excess skin (38-40).

The excess skin can cause a range of functional and cosmetic challenges that are often more frustrating for individuals than their previous obese state. Notably, nearly all MWL patients suffer from breast ptosis and experiences significant breast volume deficiency (40). As a consequence, a proportion of the MWL patients will need restoration of their breast shape and sometimes breast volume. However, there is also MWL patients that would need breast reconstruction due to an increased risk of developing breast cancer or to treat breast cancer. In some cases, the ptotic breasts of MWL patients can be addressed with different mastopexy techniques, and the choice of surgery depends on the extent of volume loss and remaining breast volume (41-43). If the patients have adequate residual breast tissue, autoaugmentation with gland reshaping is a suitable

option (42,43). However, in patients where breast volume is lacking, surgery with breast implants may be needed. Nevertheless, it is important to be cautious with breast implants in MWL patients, as they have a higher risk of complications (40). An option for patients that lack residual breast volume is breast restoration with flaps, this can be achieved with free flaps or pedicled flaps. The abundant loose tissue in the area around the breast and chest wall in MWL patients is as mentioned nourished by perforator arteries, such as the thoracodorsal, lateral thoracic, and intercostal arteries and these perforators are usually large in this patient group due to their massive weight. This make MWL patients optimal candidates for breast reconstruction/restoration with combined pedicled perforator flaps. Selecting combined pedicled perforator flaps from the chest wall area for breast reconstruction can effectively address the body contouring needs of MWL patients in this region (Figure 13). For instance, a bilateral mastectomy can be performed, and the breasts can be reconstructed using combined pedicled perforator flaps such as TDAP, SEAP or flaps based on the intercostal arteries. This approach not only reconstructs the breasts but also allows the patient to simultaneously undergo an upper body lift and/or a vertical abdominoplasty, providing comprehensive body contouring benefits. In a study by Isola *et al.*, nine MWL patients underwent autologous breast augmentation mastopexy with perforator flaps from the lateral chest wall area and an upper body lift procedure simultaneously. They showed

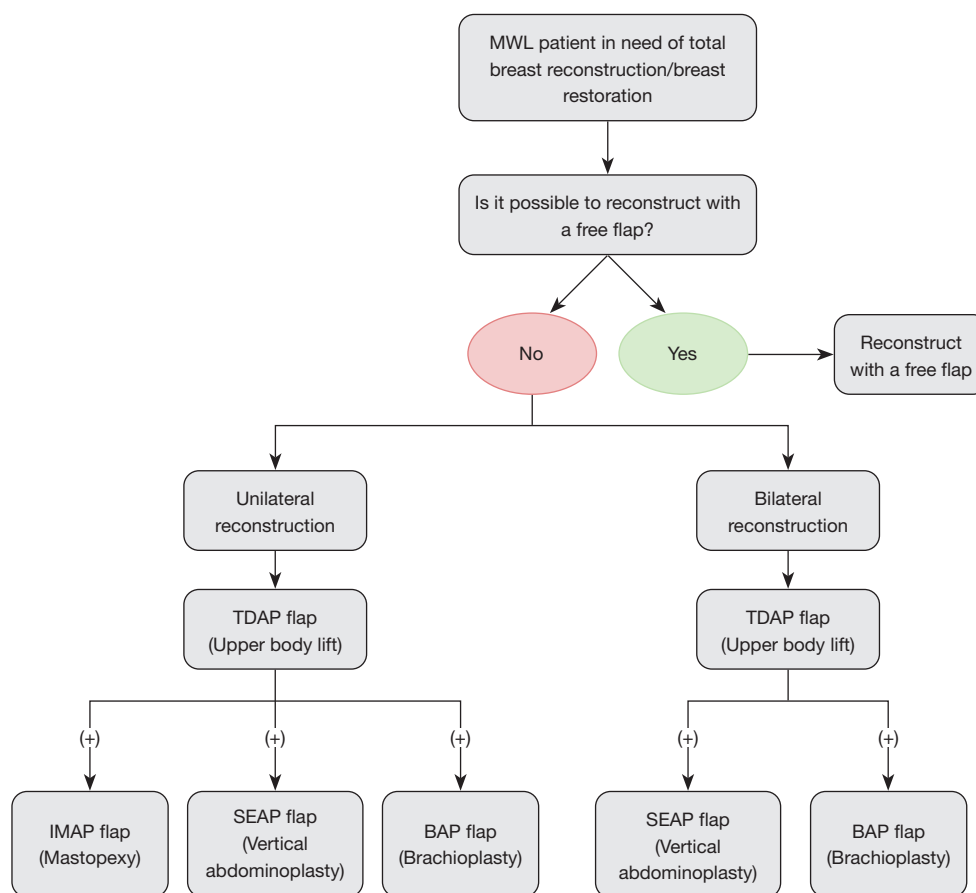


Figure 13 Algorithm for choosing pedicled perforator flaps for total breast reconstruction in MWL patients. MWL, massive weight loss; TDAP, thoracodorsal artery perforator; IMAP, internal mammary artery perforator; SEAP, superior epigastric artery perforator; BAP, brachial artery perforator.

that post-MWL, upper body anomalies can be corrected effectively using a combined method of an upper body lift and autologous breast reconstruction with chest wall perforator flaps, in some cases combined flaps and in other cases single flaps (44).

For patients whose body structure does not allow breast reconstruction using combined pedicled perforator flaps from the chest wall, free flaps should be considered. Studies have shown that performing reconstruction with free flaps in MWL patients is both safe and feasible (45). The free flaps should be raised from areas where the patient has redundant excess skin due to MWL. In this way, the patients breast volume loss is addressed and excess tissue is removed simultaneously, resulting in an improved body silhouette. DellaCroce *et al.*, in their study, demonstrated the feasibility of using a combination of the DIEP flap and the gluteal artery perforator flap for breast reconstruction.

This approach also simultaneously offered the advantage of a lower body lift. However, despite its safety, feasibility, and the additional benefit of enhanced body contour, they concluded that this stacked free flap technique was a quite challenging approach (46). A study by Haddock *et al.*, demonstrated that the body lift technique can be successfully performed by stacking DIEP flaps with LAP flap. Applying this four-flap technique in two patients for bilateral breast reconstruction, they were able to simultaneously provide the patients with a circumferential lower body lift (47).

Conclusions

The introduction of perforator flaps in breast reconstruction surgery has spurred an important evolution in the field. Today, numerous methods exist for autologous breast

reconstruction, including the application of combined and stacked flaps, including both free and pedicled options. The area surrounding the chest wall is particularly rich in potential perforator flap sites, making it an ideal region to apply these techniques, especially in MWL patients. Autologous breast reconstruction techniques in MWL patients provide dual advantages by addressing the functional and aesthetic challenges posed by excess skin and loss of breast volume. Not only does this allow for comprehensive breast reconstruction using the patient's own tissues, but it also facilitates substantial body contouring benefits.

Our experience in applying combined perforator flap techniques in breast reconstruction for ten patients has demonstrated its safety and feasibility in catering to the needs of MWL patients. Opting for reconstruction with combined pedicled flaps can be a suitable alternative, when free flaps are less preferable due to donor site issues or the need for simultaneous body contouring. *Figure 13* displays a flowchart outlining the various reconstruction choices available to MWL patients undergoing breast reconstruction in our department. Despite the promising results, the literature reveals a noticeable scarcity of studies investigating the use of combined pedicled perforator flaps in breast reconstruction. This area holds substantial promise, and more studies are needed to explore its potential in delivering reliable results for a selected patient group.

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