# Hybrid Microsurgical Breast Reconstruction: HyFIL® & HyPAD<sup>TM</sup> Techniques



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### **KEYWORDS**

- Hybrid breast reconstruction 
   Breast reconstruction 
   Postmastectomy reconstruction
- Autologous reconstruction Implant reconstruction DIEP flap Reconstructive surgery

# **KEY POINTS**

- Patients who desire autologous reconstruction but lack adequate donor site volume to match the
  necessary or desired breast volume present a reconstructive challenge that can be solved with
  hybrid breast reconstruction.
- In hybrid breast reconstruction, acellular dermal matrix and/or implants are used in conjunction with various tissue flaps, most notably the deep inferior epigastric perforator flap, to provide superior clinical and esthetic outcomes for both the breast and donor site.
- The HyFIL® technique is a hybrid breast reconstruction that augments the flap volume with lipofilling and the use of a prepectoral direct-to-implant reconstruction.
- The novel HyPAD<sup>™</sup> technique augments the flap volume with the use of stacked prepectoral acellular dermal matrix in lieu of an implant.

# INTRODUCTION Background

Postmastectomy breast reconstruction has been steadily increasing in the United States, with a 75% increase since 2000.<sup>1</sup> Most patients will pursue implant-based breast reconstruction. Reconstruction options used to be strictly limited by body habitus. However, in the last decade, advancements in microsurgery, the introduction of acellular dermal matrices (ADMs) and meshes, and the increasing use of alternative donor sites have greatly increased the scope of autologous reconstruction. Today, almost every breast can be reconstructed using either autologous or heterologous techniques, influenced by the goals and preferences of the patient.<sup>2</sup> Plastic surgeons must consider factors such as the breast dimensions, patient preference, and patient body habitus when considering which reconstructive option is best.

# Implant Reconstruction

Implant-based breast reconstruction is the simplest and most common form of breast reconstruction. Implants are used in the majority of immediate breast reconstructions<sup>1</sup> and are particularly wellsuited for thin women.<sup>2</sup> A major advantage of implant reconstruction is the relative simplicity of the procedure—it can be completed by most plastic surgeons reliably with a straightforward

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recovery. However, patients with implants may be prone to infection, seroma, rupture, capsular contracture, implant visibility, palpability, and rippling.<sup>3</sup> These complications are more likely in patients undergoing radiation as part of their cancer treatment. Finally, with limited implant longevity, implants likely necessitate 1 or 2 additional surgeries in a woman's lifetime.

#### Autologous Reconstruction

Breast reconstruction using natural tissue, however, is a more invasive procedure with longer operative times and recovery periods. In addition, there is a risk profile and recovery associated with a second surgical site, the flap donor site. Nonetheless, failure rates remain low across all autologous procedure types.<sup>4</sup> With the use of women's own tissue, the autologous-reconstructed breast has the appearance and feel of a soft natural breast, which responds to changes in body habitus similarly to natural breasts.

There are a variety of types of autologous reconstruction methods, with donor tissue originating from different parts of the body (**Fig. 1**). The most common method of autologous reconstruction is the deep inferior epigastric perforator (DIEP) Flap. In DIEP flap reconstruction, the flap is harvested in an elliptical shape extending across the entire lower abdomen. Small incisions are made in the rectus abdominis muscle for vessel access but no muscle or fascia is removed (**Fig. 2**). The major disadvantages of DIEP flap



**Fig. 1.** Possible donor sites for autologous reconstruction. The most common source of autologous reconstruction is the DIEP flap. Alternative donor sites include the lumbar artery perforator (LAP) flap, profunda artery perforator (PAP) flap, TUG flap, and the gluteal artery perforator (GAP) flap.

reconstruction are the prolonged recovery and significant donor scar. Additionally, because the DIEP flap donor site can only be used once, many women choosing DIEP flap breast reconstruction often consider bilateral mastectomies. Alternative donor sites include tissue from the flanks in the lumbar artery perforator flap, the thighs with the profunda artery perforator flap or a transverse upper gracilis (TUG) flap, or the buttocks with the gluteal artery perforator flap.<sup>5-9</sup>

# Comparison of Implant and Autologous Reconstruction

Although implant-based breast reconstructions typically require less operating time, leave fewer scars, and avoid the risk of donor site morbidity, many patients prefer the permanence, esthetics, and texture of flap-based breast reconstructions.<sup>10,11</sup> Unlike implant-based reconstruction, autologous methods rarely require additional surgeries for maintenance after the initial set of surgeries required for reconstruction and are associated with greater long-term satisfaction and improved health-related quality of life.<sup>10,11</sup> Additionally, reconstruction failure rates are lower following autologous reconstruction: total flap loss rates are reported to be 0.3% to 1.2%, whereas failed prosthetic reconstruction rates and implant infection range from 1.9% to 2.7%, and up to 44% following radiation.<sup>2</sup>

# Clinical Challenge: Breast and Flap Volume Discordance

Although there are many benefits to microsurgical flap reconstruction, this is not a viable option for all patients. Namely, patients who desire autologous breast reconstruction but lack adequate flap volume to match the necessary or desired breast volume present a reconstructive challenge. Lacking adequate flap volume can severely compromise the functional and esthetic outcome of breast reconstruction. To address this, alternative reconstructive methods may be considered, including fat grafting of autologous flaps, stacked flaps, and hybrid breast reconstruction (HBR).

# FAT GRAFTING

The volume of free flaps can be augmented secondarily via fat grafting. This method has many advantages because it may subvert the need for an implant, and correct contour deformities, asymmetries, and volume deficiencies, all-in-one short outpatient procedure.<sup>12</sup> However, limitations to fat transfer exist including variable fat retention and fat necrosis.<sup>2</sup> Additionally, fat



Fig. 2. DIEP flap breast reconstruction.

transfer donor sites may lack adequate volume for fat grafting.

#### Alternative and Stacked Flaps

Stacked flaps are the combination of multiple flaps to reconstruct the breasts. In unilateral reconstruction, the stacked DIEP is the most commonly used approach, whereby the abdominal flap is used to reconstruct one breast. In bilateral breast reconstructions or those situations where the abdominal donor site is not available, alternative donor sites, with or without stacked flaps, can be used. However, these options are technically more complex, often requiring multiple microvascular anastomoses, longer operative duration, and potentially additional donor-site morbidity.<sup>13,14</sup>

### Hybrid Breast Reconstruction

An innovative solution to the discordance between desired breast reconstruction volume and available donor flap volume is the use of alloplastic and bioprosthetic materials to augment the flap volume in a single-stage hybrid approach. Historically, the latissimus dorsi flap has been used concurrently with an implant. However, this technique requires the sacrifice of a major muscle, which often leads to weakness, reduced mobility, and contour deformity at the donor site.<sup>15</sup> In 2018, Momeni and Kanchwala pioneered a new approach that combines a prepectoral implant secured with ADM along and covered with an abdominal free flap in a single-stage procedure.<sup>16</sup> Similar to previous techniques, this allowed for control of both the soft tissue envelope as well as the size and projection of the breast mound. The novelty of this technique lies in the ability to eliminate the downside of submuscular placement (ie, increased risk of bleeding, pain, and animation deformity) while also reducing the tissue demands on the donor site allowing a more esthetic abdominal closure.<sup>16,17</sup> Alleviating the need to harvest the entire reconstruction volume at the abdomen allows the donor site scar to be lower, well-hidden, and less tight. There is also greater flexibility as surgeons can select an implant size that best meets patient needs. Esthetically, soft tissue coverage over the implant decreases implant palpability, visibility, and rippling.<sup>18,19</sup> Unlike the aforementioned alternative treatment options, the hybrid technique does not significantly increase the duration or complexity of the reconstruction.<sup>2</sup>

Other less established yet possible flap options for HBR include the thoracodorsal artery perforator, transverse rectus abdominus musculocutaneous, TUG, and inframammary adipofascial flaps.<sup>20</sup> Across all types of HBR, the flap provides vascularized soft tissue coverage to optimize appearance, feel, and minimize alloplastic-related complications. The underlying implant or ADM provides core projection and volume.

#### Types of Hybrid Breast Reconstruction

#### HyFIL®: Hybrid Flap, implant, lipofilling

The HyFIL technique combines flap, prepectoral implant, and fat transfer into one integrated procedure (**Fig. 3**). In this technique, a small silicone or saline round implant is inserted in the prepectoral position, secured to the anterior chest wall with ADM, and the flap is placed over the construct. The implant helps enhance the size and projection of the reconstructed breast. Lipofilling is used to improve the appearance and contour of the breasts as needed.

### HyPAD™: Hybrid Flap, Prepectoral Acellular Dermal Matrix

There is a growing community of women who wish to avoid an implant in breast reconstruction, citing concerns related to breast implant-associatedanaplastic large cell lymphoma and breast implant illness. Further, implants are associated with higher complication rates, discomfort, and repeat procedures due to contracture, rupture, seroma, malposition, and rippling.<sup>21</sup>

Patients who wish to avoid implants but lack adequate donor site volume were previously left without a suitable reconstruction option. The Hybrid Flap and Prepectoral Acellular Dermal Matrix (HyPAD<sup>TM</sup>) technique combines the DIEP flap with stacked prepectoral ADM in the place of an implant (Fig. 4). The stacked ADM serves the similar purpose as a small implant, but to a lesser degree, providing soft tissue augmentation of the flap and core projection (Fig. 5). ADM has a variety of sizes and thickness levels: the authors preferentially use the rectangular 16 cm  $\times$  20 cm extra thick perforated sheet, which can add 75 to 140 mL of additional volume to the breast. The ADM is simply folded 3 or 4 time onto itself to create a rectangular pad that is 6 to 8 layers thick. More recently, we have used a more complex folding pattern to create a rounder shaped pad of ADM. These pads can typically add a 1.5 to 2 cm of central projection to the reconstructed breast mound. The placement of the ADM is entirely in the prepectoral region, along the vertical meridian at the



Fig. 3. The HyFIL® (hybrid flap, implant, lipofilling) technique combines flap, prepectoral implant, and fat transfer into one integrated procedure.



Fig. 4. The HyPAD<sup>™</sup> (hybrid flap, prepectoral acellular dermal matrix) technique combines flap reconstruction with stacked prepectoral ADM to provide additional volume augmentation and core projection.

inframammary fold. This allows for optimal breast projection. Furthermore, the ADM serves as a barrier to protect the flap and vascular pedicle should patients decide to further augment the reconstruction with an implant at a later stage of reconstruction.

ADM is commonly used across multiple surgical disciplines, including implant-based reconstruction and has been shown to have multiple advantages.<sup>22,23</sup> ADM improves control over the inferior pole and implant position and provides

additional soft tissue coverage.<sup>24-28</sup> Biologically, ADM has been shown to incorporate the recipient tissue, undergoing processes of revascularization and recellularization with minimal complications.<sup>22</sup> It is particularly well-suited for breast reconstruction because it comes in different thicknesses, sizes, and shapes, so it can be customized to fit the specific needs of a patient. Reported complications from ADM include hematoma, infection, and seroma.<sup>26</sup> Given the benefits of ADM in breast reconstruction, it has now routinely been



**Fig. 5.** In the HyPAD® (hybrid flap, prepectoral acellular dermal matrix) technique, the stacked ADM serves the similar purpose as a small implant, but to a lesser degree, providing soft tissue augmentation of the flap and core projection. Various angles (*A-D*) of the stacked ADM construct are shown. The stacked ADM is compared to a silicone breast prosthesis (*E*).

incorporated into hybrid reconstruction. It is important to note that the use of ADM in breast reconstruction is off label and all patients are counseled about this during the informed consent process.

#### Evaluation

When assessing a patient's candidacy for receiving an autologous flap reconstruction, surgeons may consider the volume of the flap available at the donor site relative to the desired breast reconstruction volume. Patients fall into 1 of 3 categories based on this relationship, with implications for the course of treatment. The volume of the donor site flap may be (1) greater than, (2) equal to, or (3) less than the volume of the desired breast reconstruction. Patients in the first or second category may be treated with traditional autologous reconstruction. Patients in the third category are considered for possible HBR. Alternatively, these patients can be considered for alternative/stacked flaps or traditional implantbased reconstruction.<sup>17</sup> Careful preoperative assessment of a patient's desired breast volume, existing native breast dimensions, and body habitus can help guide the surgeon and patient's expectations of treatment options and esthetic outcome.29

One pertinent consideration for HBR is timing. Immediate, delayed, and delayed-immediate with tissue-expander placement HBRs have all been completed successfully.<sup>20</sup> Conceptually, placing the implant and acellular dermis at the time of the flap placement allows layering of the multiple lamellae (breast skin, flap, ADM, implant) as the surgeon dictates. If an implant is placed secondarily, the scar between each of these layers must stretch to accommodate the implant and there may be some restriction to pocket expansion.

However, single-stage, immediate reconstruction has the highest risk of implant-induced pedicle compression and the greatest restriction on implant size from both the mastectomy skin and flap pedicle.<sup>20</sup> In practice, we have not found this to be a major issue. Conversely, delayed implant insertion allows for less pressure on the mastectomy skin flaps but requires additional procedures, adding an anesthetic burden on the patient and increasing the difficulty of pocket dissection for the surgeon.<sup>19</sup> Delayed implant placement cases have a mean of 4, and as many as 6, total procedures to obtain the final result.<sup>30</sup> In addition, delayed implant placement may be difficult in the patient who receives postoperative radiation. Generally, we have chosen to use smaller implant in the 120 to 200 cc range for most patients. In the rare setting where a patient wants additional volume, it is much simpler at a second surgery to release an existing pocket to accommodate a larger implant than to create a new pocket in a scarred plane in close proximity to the pedicle or to dissect a new submuscular pocket. If the decision to do a delayed implant is made intraoperatively, placing a sheet of ADM under the flap pedicle may allow for easier preservation of the pedicle during the second procedure. Finally, there have been several reports of pedicle division at the time of implant placement without undue sequelae to the flap.

#### DISCUSSION

There are numerous indications for HBR, with the most common being discordance between donor flap volume and desired breast reconstruction volume.<sup>16</sup> This can occur in women who are thin, have large or ptotic breasts, have had previous abdominal surgeries, and/or desire larger breast reconstruction volumes.

The use of a hybrid approach with concurrent free flap transfer with implant and/or ADM placement allows for a single-stage procedure that achieves a desirable look and feel while limiting donor site morbidity and postoperative implantrelated problems including palpability, rippling, capsular contracture, and reconstructive failures.<sup>2</sup> HBR poses unique advantages and limitations as a reconstructive technique.

HBR offers an augmented flap volume while maintaining the look and feel of a natural breast.<sup>17,31</sup> HBR avoids the pitfalls of other alternative reconstruction techniques, including the technical complexity of stacked flaps and the additional morbidity of alternative donor flaps. For some women, a primary benefit of autologous reconstruction is the avoidance of an implant, and the monitoring and subsequent procedures that come with it. To this end, the use of an implant in the HyFIL technique may seem counterproductive. The novel HyPAD technique presents a possible solution to achieve additional tissue augmentation without an implant.

Compared with implant-based reconstruction, the advantages of HBR include restoration of the natural breast contour, adaptation to changes in body weight, and a lower complication rate.<sup>20</sup> Benefits of HBR are even more significant for patients with irradiated breasts including fewer complications and better cosmesis.<sup>2</sup> The main disadvantage of HBR is the additional cost compared with implant or tissue reconstruction performed alone. However, the initially high surgical and financial costs are offset in the long term as the soft tissue coverage reduces the need for secondary procedures due to implant complications.  $^{\rm 32-34}$ 

DIEP flap reconstruction is often advertised on the Internet as a "tummy-tuck" reconstruction. However, this may be misleading because the need to harvest enough volume for breast reconstruction often means that the resulting scar is higher and less esthetically pleasing than in abdominoplasty patients.<sup>17</sup>

In select HBR cases, the entire reconstruction volume does not need to be harvested from abdominal tissue because alloplastic material is used to augment the free flap volume. This can result in a lower, less tight, and more esthetically pleasing scar.

Even volume ratios of 1:5 between the implant and flap provide significant cosmetic benefit through improved core projection.<sup>35</sup> This ratio allows the soft tissue of the flap to adequately camouflage the implant. Additionally, mastectomy skin flap necrosis is more easily managed in patients who undergo HBR, without the need for additional surgeries.<sup>16</sup> The addition of an implant to stacked-DIEP procedure for unilateral reconstruction in patients with inadequate donor site volume for single-flap DIEP also showed improved volume and projection to the autologous procedure alone.<sup>36</sup>

The complexity of breast reconstruction contributes to a high rate of revisionary procedures. HBR has been shown to significantly increase the success of these adjunct procedures, including autologous fat grafting and nipple reconstruction when compared with implant methods alone.<sup>17</sup> Autologous fat grafting is a treatment option for volume deficiencies and implant palpability and/or rippling. However, fat grafting to an implantreconstructed breast, which only has a thin skin envelope, often leads to unsatisfactory results because most of the fat is reabsorbed. In HBR, fat can be deposited directly into wellvascularized flaps, leading to a greater volume and better take of the grafts.<sup>17</sup>

Following skin-sparing mastectomy, nipple reconstruction and micropigmentation can be performed to create a realistic-looking nipple–areolar complex. However, projection, which is a key hall-mark of the natural nipple, is inevitably lost over time.<sup>37</sup> This is especially true for pure-implant reconstruction but also presents a challenge in autologous reconstruction. HBR, however, alleviates this difficulty with ample soft tissue and projection from the implant underneath.<sup>17</sup>

Flap reconstruction is often recommended over implant reconstruction in women with irradiated breasts. HBR provides a reasonable alternative for these patients who also need the additional volume from alloplastic material. The flap coverage from HBR protects the implant, minimizing the risk of capsular contracture, implant exposure, and wound breakdown.<sup>17</sup> In a series of 1000 irradiated breasts, HBR cases had significantly lower rates of implant loss (5% vs 30.3%) and reconstructive failure (15.2% or 10.0% vs 42.2%, respectively) than implant-only reconstructions.<sup>38</sup>

Reported postoperative complications from HBR include fat necrosis, mastectomy skin necrosis, flap loss, and venous congestion. The rates of nonimplant-related complications in HBR are in line with autologous reconstruction rates.<sup>17</sup> With implants in HBR, complications relating to the use of implants in the short term include hematoma, infection, and malposition.<sup>17,39</sup> The rates of implant-related complications and revisions for size are lower in HBR compared with implant-only reconstruction.<sup>17</sup> The use of ADM is associated with a further decrease in implant complication rates.<sup>26</sup>

A significant limitation of the HyFIL technique is the introduction of implant-associated complications and monitoring. The novel HyPAD technique addresses these concerns by replacing the small implant with a piece of stacked ADM for flap projection and augmentation. However, the thickest ADM sheets can still only provide about 90 to 140 mL of additional volume, whereas implants range in volume from 120 to 800 cc, depending on manufacturer. Therefore, A HyFIL approach may be preferable to the HyPAD technique in patients who need greater than 140 mL of additional core projections of the breast.

Another disadvantage of the HyPAD technique is the initial high cost associated with ADM. However, ADM reconstruction is associated with lower costs compared with non-ADM implant reconstruction at 2 years postoperatively, likely in part to fewer complications and reoperations.32-34 Additionally, the food and drug administration (FDA) recommends that patients with prosthetic implants obtain screening breast MRIs 5 years after implantation and every 2 to 3 years after to evaluate for rupture. This contributed to total health-care costs of more than US\$33 million in 2010.<sup>40,41</sup> Costs continue to increase for implants that rupture or expire and require surgical correction.<sup>42</sup> Thus, while initial costs of the ADM-based reconstruction may be similar or slightly higher than prosthetic implant use, the decrease in complications and screening makes their use at least cost-effective, if not advantageous to the patient and the surgeon. Finally, as a relatively new technique, there is a paucity of long-term outcome studies evaluating HBR complications and patient satisfaction. Future prospective, long-term studies are essential to optimize the clinical and esthetic outcomes of this technique. The use of ADM in breast reconstruction, although widespread, remains off label under current FDA guidelines.

#### SUMMARY

In breast reconstruction, discrepancies between the donor site flap volume and the desired breast reconstruction volume can pose a significant challenge.<sup>43–47</sup> HBR serves to address this concern with the addition of a prepectoral implant and/or ADM to a flap reconstruction. Prosthetic implants used in conjunction with various tissue flaps, most notably the DIEP flap, provide superior outcomes for both the breast and abdomen. With a HyFIL® technique, the use of vascularized soft tissue camouflages the implant while the implant provides the desired core projection and volume. However, the excess costs, follow-up screenings, and complication rates of the implant itself warrant consideration. The novel HyPAD<sup>™</sup> technique augments the flap volume with the use of stacked prepectoral ADM, thus potentially avoiding many of the issues related to implants. Overall, HBR techniques expand the candidacy for autologous reconstruction methods and can help improve outcomes and patient satisfaction from breast reconstruction.

# CLINICS CARE POINTS

- Women who desire autologous reconstruction but lack adequate flap volume to match the necessary or desired breast volume may be good candidates for HBR.
- Careful preoperative assessment of a patient's desired breast volume, existing native breast dimensions, and body habitus can help guide the surgeon and patient's expectations of treatment options and esthetic outcome.
- HBRs are good alternatives to implant only breast reconstruction or breast reconstruction with alternative flaps. It is associated with good esthetic outcomes and low overall complication rates compared with alternative flap types.<sup>20,35</sup>

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