Indications and Controversies for Abdominally-Based Complete Autologous Tissue Breast Reconstruction

Blake D. Murphy, MD, PhD, FRCS(C)[a], Isabel Kerrebijn, MSc[a],
Jian Farhadi, MD, FMH (Plast), EBOPRAS[b],
Jaume Masia, MD, PhD[c],
Stefan O.P. Hofer, MD, PhD, FRCS(C)[a,*]

KEYWORDS

- Breast reconstruction • Autologous breast reconstruction • Microsurgical breast reconstruction
- Deep inferior epigastric artery perforator flap • Superficial inferior epigastric artery flap
- Transverse rectus abdominis myocutaneous flap

KEY POINTS

- Abdominally based autologous reconstruction has undergone significant improvements in techniques, safety, and outcomes.
- Through careful optimization of modifiable risk factors and preoperative planning, abdominally based autologous reconstruction can be successfully performed in most patients with few absolute contraindications.
- Based on the available evidence, this should be the preferred reconstructive option in patients requiring postmastectomy radiation, those who are overweight or obese, and those undergoing unilateral reconstruction.

INTRODUCTION

Reconstruction of the breast in either the immediate or delayed setting can be performed in a variety of ways including autologous and alloplastic options. Although patient preference and suitability are the most important factors, other considerations exist when determining what type of breast reconstruction a patient will undergo. In the appropriately selected patient, complete autologous reconstruction using abdominal tissue provides an excellent option while minimizing donor site morbidity. This procedure has been shown to be oncologically safe with excellent patient satisfaction in the appropriately selected and informed patient.[1–3]

The first abdominally based flap was the pedicled transverse rectus abdominis myocutaneous flap (pTRAM), which later evolved to the free TRAM, the muscle-sparing TRAM (MS-TRAM), deep inferior epigastric artery perforator flap (DIEP), and superficial inferior epigastric artery (SIEA) flaps.[4–8] Potential benefits of the pTRAM are that it may be performed more quickly than other abdominally

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[a] Division of Plastic Surgery, University Health Network, 200 Elizabeth Street, 8N-865 Toronto, Ontario M5G 2C4, Canada; [b] Department of Plastic Surgery, St. Thomas' Hospital, Guy's and St. Thomas' Hospitals NHS Foundation Trust, London, UK; [c] Department of Plastic Surgery, Hospital de la Santa Creu I Sant Pau, Universitat Autònoma de Barcelona, Sant Quintí 89, Barcelona 08026, Spain
* Corresponding author.
E-mail address: stefan.hofer@uhn.ca

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based procedures that require microsurgical techniques. However, it is more commonly associated with abdominal wall morbidity and carries an elevated risk of fat necrosis and partial flap loss.[9]

The introduction of the free TRAM led to decreased partial flap loss and fat necrosis compared with the pTRAM. However, these advantages are partially offset by the need for microsurgical expertise, increased operating time, and increased potential for total flap loss.[10] Each of the subsequent iterations of abdominally based free flaps for breast reconstruction were developed to minimize donor site morbidity. MS-TRAM options are found to result in decreased abdominal bulge rates when compared with free TRAM flaps.[11] Modifications to the MS-TRAM led to the DIEP and SIEA flap with the goal of further reducing or eliminating the need for muscle and fascia harvest. However, studies have not conclusively found the benefit of a DIEP over MS-TRAM with respect to donor site morbidity.[11–14] SIEA flaps do not require any subfascial dissection, but are not possible in all patients and have been associated with higher rates of flap failure.[15]

This article focusses on complete autologous breast reconstruction using abdominally based flaps. Techniques using alloplastic reconstruction and autologous tissue from elsewhere are beyond the scope of this article. This article reviews the literature and discusses appropriate indications and contraindications based on available evidence. In addition, some of the current controversies in abdominally based autologous breast reconstruction are highlighted and the evidence supporting or refuting these factors is reviewed. Finally, an overview is provided of the technique used at the authors' institution for autologous reconstruction using abdominal tissue.

INDICATIONS FOR ABDOMINALLY BASED AUTOLOGOUS BREAST RECONSTRUCTION

Abdominal donor sites are the most common site for autologous reconstruction after mastectomy and are considered by some to be the gold standard for breast reconstruction.[1] When choosing a plan for breast reconstruction with a patient, numerous factors need to be considered by the patient, reconstructive surgeon, and the breast oncology surgeon. Patient preference is likely the most important factor, as it has been shown that patient satisfaction is directly related to their preoperative knowledge and contribution to the decision-making process.[3,16] Patient preference must be balanced with safety and reliability of the procedure, the surgeon's experience and skill, and the overall suitability of the patient for the desired procedure (**Box 1**).

Box 1
Requirements for abdominally based autologous reconstruction

- Informed consent
  - Risks and benefits of the procedure
  - Realistic expectations
  - Alternative treatments
- Adequate abdominal donor tissue
- No known contraindications to the planned procedure

Absolute requirements for complete autologous breast reconstruction in the immediate or delayed setting are limited. The patient's consent and desire to proceed with the procedure coupled with adequate abdominal tissue are among the only requirements. If the patient meets these minimum criteria, history, physical examination, and investigations should follow to ensure there are no specific contraindications that preclude the patient from successfully undergoing the planned procedure. Autologous reconstruction should be considered preferentially in patient groups in which it is found to be superior to alloplastic reconstruction (**Box 2**).

Patients who are overweight or obese and those undergoing postmastectomy radiation therapy, are at an elevated risk of complications in both alloplastic and autologous reconstruction. However, autologous reconstruction is associated with significantly lower complication and complete failure rates than alloplastic options and is found to achieve superior patient satisfaction scores.[17–21] Patients undergoing unilateral breast reconstruction also show increased satisfaction with autologous over alloplastic reconstruction.[22,23] These advantages should be conveyed to the patient during the decision-making process.

CONTROVERSIES FOR ABDOMINALLY BASED AUTOLOGOUS RECONSTRUCTION

Abdominally based autologous breast reconstruction continues to evolve and improve, and in its

Box 2
Indications for autologous over alloplastic reconstruction

- Patient preference
- Postmastectomy radiation patients
- Overweight or obese patients
- Unilateral reconstruction

current iterations, it is regarded by some as the gold standard. Some debate exists among surgeons on which procedure offers the ideal reconstruction. Other potential donor sites for autologous reconstruction are reviewed in separate sections of this issue. In addition to technical refinements of the procedures, advances in preoperative and intraoperative imaging have occurred, although some controversy exists about the utility of these tools (**Box 3**).

Abdominally Based Autologous Breast Reconstruction Options

The goal of abdominally based autologous reconstruction is to obtain an aesthetically pleasing breast while minimizing donor site morbidity. Techniques using abdominal flaps have evolved and continue to be refined in the pursuit of these goals. The progression from pTRAM through MS-TRAM, and DIEP flaps require increasing expertise to obtain reliable results and come at a cost of increased operative time. SIEA flaps allow a rapid flap harvest and complete maintenance of abdominal wall integrity. However, these flaps are not a viable option in most patients and come with increased risk of flap compromise compared with flaps based on the deep inferior epigastric system.[14,15] Some controversy exists about the merits of each of the above techniques and which one offers the optimal balance of risk and reward for the patient. Ultimately, the best procedure is the one the patient chooses and that the surgeon can offer with confidence and safety for that individual based on their risk profile.

Preoperative Imaging

Preoperative imaging in autologous breast reconstruction is accurate and leads to a significantly decreased operating time and fewer complications.[24–26] In addition to identifying dominant perforators supplying the flap, it allows for mapping of the deep inferior epigastric artery through the rectus abdominis muscle to minimize muscle injury and dissection. However, investigations do not come without a monetary cost and the possibility of requiring additional investigations for incidental findings.[27,28]

Computed tomography angiography (CTA) and magnetic resonance angiography (MRA) have become accurate and reliable techniques for free flap planning and have supplanted ultrasonography as the preferred methods. CTA is an accurate method for mapping perforators but is associated with ionizing radiation.[24,29] Recent advances in imaging protocols, computed tomography scanner hardware, and reconstruction algorithms have allowed the dose to be reduced to less than 2 milliSieverts.[30,31] MRA is a viable alternative to CTA, but is limited by accessibility and cost.[32,33]

Intraoperative Imaging

The use of intraoperative indocyanine green fluorescence angiography has gained popularity recently in many areas of surgery. In breast reconstruction, it has proven useful for assessing mastectomy flap necrosis in the setting of immediate alloplastic reconstruction.[34] Although this technology has been applied to numerous areas of autologous reconstruction, little evidence exists to suggest that this technology adds any significant value to the clinical assessment of a flap intraoperatively.[35] However, it may be useful in unusual circumstances in which clinical assessment of the flap is more difficult.[36]

ABSOLUTE CONTRAINDICATIONS TO COMPLETE ABDOMINALLY BASED AUTOLOGOUS BREAST RECONSTRUCTION

Absolute contraindications to abdominally based autologous breast reconstruction are limited and include patients who are medically unfit for the procedure or whose anatomy precludes them from undergoing the procedure safely. With respect to patient's overall fitness for the procedure, this is a discussion to be shared with the perioperative team including the anesthetist, the surgeon, and the patient (**Box 4**).

Box 3
Controversies in abdominally based autologous breast reconstruction

- Ideal technique—TRAM, MS-TRAM, DIEP, SIEA
- Preoperative imaging
- Intraoperative imaging
- Absolute contraindications
- Relative contraindications

Box 4
Absolute contraindications

- Patient medically unfit for procedure
- Significant abdominal surgery affecting flap vascularity (eg, Maylard approach)
- Patient with unrealistic expectations of results
- Significant delay in treatment of disease

Surgical procedures precluding abdominally based free flaps include those that transect the superficial and deep inferior epigastric system or eliminate perforators from the fascia to the overlying skin and adipose tissue. An example of an approach compromising the deep inferior epigastric system is the Maylard approach, which transects the rectus abdominis and the dominant vascular supply to the lower abdomen. This surgical approach is now rarely used, but may be confused with a more typical Pfannenstiel incision on the skin and should be investigated appropriately with preoperative imaging if any concerns exist.[37]

Unrealistic patient expectations are considered by most surgeons to be an absolute contraindication to elective surgery. If patients have unrealistic expectations despite an extensive informed consent process, surgery should not be offered. Additionally, in rare circumstances in which reconstructive efforts would lead to significant delays in cancer treatment, a consideration for an alternative treatment plan or delayed breast reconstruction would be prudent.

RELATIVE CONTRAINDICATIONS TO COMPLETE ABDOMINALLY BASED AUTOLOGOUS BREAST RECONSTRUCTION

Relative contraindications to any procedure should depend on evidence in the existing literature, the surgeons personal experience, and the patient and surgeon's tolerance for complications or adverse outcomes. Ultimately, most relative contraindications are modifiable and can be minimized or eliminated with appropriate investigations and preoperative planning (**Box 5**).

Prior Abdominal Surgery

Prior abdominal surgery is a commonly cited contraindication to abdominally based free flaps for breast reconstruction. However, preoperative imaging with CTA or MRA can confirm the presence of the vessels and perforators and aid in the preoperative planning.

Midline laparotomy incisions do not lead to increased rate of flap complications in abdominally based free flaps but are associated with increased wound healing problems in the donor site, may impose constraints on flap design, and more commonly necessitate muscle harvest.[38–41] Isolated Pfannenstiel incisions may result in decreased partial flap loss through a delay phenomenon and are not associated with increased flap or donor site complications when the flap is appropriately designed.[42–44] However, the combination of a midline laparotomy and a low transverse Pfannenstiel scar leads to increased complications at both the donor site and the flap.[45] Several studies reviewed patients with prior abdominal surgery and offer an algorithmic approach to modifying flap design or surgical technique to minimize complications.[39,45]

Abdominoplasty is considered by many surgeons to be an absolute contraindication to abdominally based free flaps. However, successful MS-TRAM procedures have been done in patients who have previously undergone a full abdominoplasty.[46,47] Ribuffo and colleagues[48] found in a series of patients that vascular ingrowth does occur after abdominoplasty, although perforators are typically less than 40% of the normal size. Liposuction is also considered by some surgeons to be an absolute contraindication to abdominally based free flaps. However, successful flaps have been reported after abdominal liposuction, suggesting this should be a relative contraindication with appropriate investigations and discussion between the patient and surgeon before proceeding.[49,50]

Box 5
Relative contraindications

- Prior abdominal surgery
- Abdominal contouring procedures (liposuction, abdominoplasty)
- Smoking history less than 1 month
- Hypercoagulable state
- Obesity

Cigarette Smoking

Cigarette smoking is a relative contraindication to abdominally based free flap breast reconstruction, and smoking cessation should be attempted preoperatively if time permits. Ideally, a patient should be at least 4 weeks without smoking before proceeding with elective microsurgical reconstruction to minimize complications. Although cigarette smoking may not impact flap complications in free TRAM procedures, it has proven detrimental effects on mastectomy flaps, abdominal donor site wound healing, and hernia and bulge rate and likely has a more significant impact on perforator flaps.[51,52]

Hypercoagulability/Thrombophilia

Hypercoagulability caused by a genetic predisposition is a relative contraindication to elective autologous reconstruction and may be present (diagnosed or undiagnosed) in 5% to 10% of the population. Examples of these genetic conditions predisposing a patient to hypercoagulability include factor V Leiden, protein C deficiency, hyperhomocysteinemia, antiphospholipid antibody syndrome, prothrombin gene mutation, factor VIII elevation, anticardiolipin antibody, and essential thrombocytosis. Wang and colleagues[53] reviewed a total of 58 flaps in patients with known thrombophilia and reported a combined intraoperative and postoperative thrombosis rate of 20%. None of the flaps in this cohort that returned to the operating room for thrombosis were successfully salvaged, resulting in a 15% rate of flap loss in this cohort.

In addition to genetic conditions, numerous medications may also lead to a hypercoagulable state. The most common prothrombotic medications in patients undergoing autologous breast reconstruction are selective estrogen-receptor modulators (eg, tamoxifen) and aromatase inhibitors. As a class of medications, selective estrogen-receptor modulators are known to be prothrombotic with increased risk of venous thromboembolism (VTE).[54] However, the literature regarding their association with microsurgical complications is less clear, with some studies suggesting there is an increased risk of flap thrombosis[55] and other more recent articles suggesting no association.[56,57] The evidence for aromatase inhibitors leading to an increased risk of VTE is less convincing and is unlikely to lead to increased risk of flap complications in microsurgical breast reconsturcion.[56,58]

Obesity

Obesity is a proven risk factor for numerous complications in abdominally based autologous breast reconstruction. As body mass index (BMI) increases, there is a proportional increase in complication rates. A recent meta-analysis of more than 6000 patients found significantly increased risk of almost all complications in obese patients including overall complications, recipient site complications overall, donor site complications overall, donor site wound infection, donor site seroma, abdominal bulge/hernia, mastectomy skin flap necrosis, recipient site delayed wound healing, and partial flap failure.[59] Although complications were higher in this group when compared with patients with normal BMI, alloplastic reconstructions were associated with an even higher complication rate.[60] Despite the elevated risk of complications in obese patients undergoing autologous reconstruction, satisfaction is significantly higher than that in patients undergoing alloplastic reconstruction.[20,21,61]

EVIDENCE BASE FOR ABDOMINALLY BASED AUTOLOGOUS RECONSTRUCTION

- Abdominally based autologous reconstruction offers an oncologically safe procedure with high rates of satisfaction in the properly selected patient.[1–3]
- Autologous reconstruction exceeds alloplastic reconstruction in:
  - Patients undergoing postmastectomy radiation therapy[17,18]
  - Obese or overweight patients[20]
  - Patients with unilateral reconstruction[22,23]
- Abdominally based autologous breast reconstruction can be performed safely in patients with prior abdominal surgery but is not without risk.[40,41]
  - Preoperative imaging should be done to ensure vascularity is intact.
  - Patient and surgeon balance risk and reward of the reconstructive plan.
  - Abdominal contouring procedures should be considered a relative contraindication.
- Relative contraindications should be minimized or eliminated where possible.
  - Smoking cessation should occur at least 4 weeks preoperatively.[51,52]
  - Hematology consultation and optimization should be conducted for patients with known or suspected thrombophilia.[53]
  - Consult oncologist and hold medications associated with increased risk of VTE.[54,55]
- Autologous reconstruction in overweight and obese patients is associated with increased complications but also offers superior patient satisfaction over alloplastic options.[20,21,59]
- Preoperative imaging decreases operating time and complications in perforator flap surgery.[25,26]
- CTA is accurate and associated with a reduced radiation dose with newer protocols; MRA is a viable option where resources exist and is not associated with radiation.[30–32]
- Intraoperative imaging using intraoperative indocyanine green fluorescence angiography offers no proven benefit in outcomes for autologous breast reconstruction.[35,36]

MY PERSONAL APPROACH FOR ABDOMINALLY BASED AUTOLOGOUS RECONSTRUCTION

Preoperative Considerations

- No BMI cutoff for autologous reconstruction
- Smoking cessation at least 4 weeks in delayed reconstruction and if time permits in immediate reconstruction
- CTA imaging for all patients
- No contraindications with prior abdominal surgeries if CTA shows intact vessels
- Informed consent process with surgical team, including breast reconstruction nurse
- Prothrombotic medications held for 2 weeks preoperatively and restarted once ambulating well postoperatively

Perioperative Considerations

- Streamlined approach with consistent nursing team
- Minimum instruments required, eliminate unnecessary items
- VTE prophylaxis—Preoperative subcutaneous heparin injection (5000 units), thromboembolism deterrent compression stockings, daily low-molecular-weight heparin injection beginning on postoperative day #0 for duration of hospital stay

Intraoperative Considerations

- Simultaneous mastectomy/vessel preparation and abdominal flap harvest
- Internal mammary vessel access by partial third rib or fourth resection
- Goal to perform a true DIEP in all patients with no muscle or fascia harvest, preserving motor nerves when possible
- Very rare use of superficial system as primary vascular supply, rare use of SIEA or superficial inferior epigastric vein (SIEV) as secondary vascular supply
- Rare conversion to MS-TRAM (only to balance risk of fat necrosis/flap failure in select patients)
- Minimize length of fascial incision, do not extend below arcuate line
- Progressive tension barbed suture for abdominal flap closure, minimize/eliminate abdominal drains
- Extremely rare use of intraoperative perfusion imaging

Postoperative Considerations

- Enhanced Recovery After Surgery Pathway
  - Multimodal analgesia plus patient controlled analgesia (PCA)
  - Early ambulation and oral intake on postoperative day 1
  - Discharge home postoperative day 3 (unilateral) or day 4 (bilateral)
- Homecare nursing for wound checks and drain removal (<30 mL/d)
- Follow-up at 3 weeks

DISCUSSION

Current Status of Evidence for Abdominally Based Autologous Reconstruction

- Abdominally based autologous breast reconstruction is an oncologically safe procedure and provides good patient satisfaction and long-term results in the properly selected patient.
- Many of the relative contraindications to autologous breast reconstruction are modifiable factors, and optimization of these factors allows safe autologous reconstruction in most patients.
- Autologous breast reconstruction is proven to be superior to alloplastic options for patients requiring postmastectomy radiation, obese or overweight patients, and those undergoing unilateral reconstruction.

Future Direction to Improve Clinical Practice for Abdominally Based Autologous Reconstruction

Abdominally based free flaps offer an excellent solution for breast reconstruction in the appropriate patient. Although refinements in techniques and the advent of new flaps have decreased donor site morbidity, further improvements in these areas are required to improve patient satisfaction and outcomes. Preoperative imaging for planning and intraoperative imaging for real-time assessment of perfusion are 2 examples of areas that may be further improved and result in a reduction of complications and improved outcomes.

Indications for autologous breast reconstruction have expanded as the techniques have been refined and risks and complications have been reduced. Primary fat grafting into free flaps and the combination of using multiple flaps in thin patients have further expanded the indications for autologous reconstruction to those who were previously not considered candidates. Unfortunately, for numerous reasons beyond patient preference, the proportion of patients undergoing autologous reconstruction has continued to decrease in recent years when compared with alloplastic reconstruction.[62]

Finally, improvements in the recovery after abdominally based autologous reconstruction should be further advanced and optimized to improve patient outcomes. The Enhanced

Recovery After Surgery initiative has improved postoperative recovery, resulting in earlier discharge, fewer complications, and fewer readmissions to hospital.[63,64] Wider adoption and refinements of these pathways can optimize patient recovery, resulting in improved patient outcomes, lower costs, and improved satisfaction.

SUMMARY

Abdominally based autologous reconstruction has undergone significant improvements in techniques, safety, and outcomes. Through careful optimization of modifiable risk factors and preoperative planning, abdominally based autologous reconstruction can be successfully performed in most patients with very few absolute contraindications. Based on the available evidence, this should be the preferred reconstructive option in patients requiring postmastectomy radiation, those who are overweight or obese, and those undergoing unilateral reconstruction. Further improvements in patient access to autologous breast reconstruction, preoperative imaging and planning, intraoperative assessment of tissue, and enhanced recovery after surgery will yield further improvements in patient results.

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