

Breast Reconstruction Techniques: Historical Evolution and Current Surgical Practice

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ABSTRACT

Breast reconstruction has become an integral component of the comprehensive management of patients undergoing mastectomy for breast cancer. Over the past decades, reconstructive techniques have evolved significantly, transitioning from simple pedicled flaps to sophisticated microsurgical procedures that aim to restore breast volume, symmetry, and patient quality of life. The objective of this review is to analyze the current therapeutic options for breast reconstruction in plastic and reconstructive surgery, emphasizing developments from 2020 to 2025, while also providing a historical overview of the principal reconstructive flaps, including their original descriptions and clinical evolution. Implant-based reconstruction and autologous tissue reconstruction using pedicled and free flaps are discussed in terms of indications, advantages, disadvantages, and associated complications. A comparative analysis of the most commonly used techniques is presented, highlighting patient selection criteria and surgical outcomes. Understanding the strengths and limitations of each reconstructive option allows the reconstructive surgeon to individualize treatment and optimize functional and aesthetic results.

KEYWORDS: Breast Reconstruction; Autologous Flaps; Implant-Based Reconstruction; Microsurgery; Oncoplastic Surgery

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I. INTRODUCTION

Breast cancer remains the most common malignancy among women worldwide, and mastectomy continues to be a necessary component of treatment in a significant proportion of patients. Breast reconstruction plays a fundamental role in restoring body image, psychological well-being, and quality of life. Advances in plastic and reconstructive surgery have expanded the available options for breast reconstruction, allowing procedures to be tailored according to oncologic treatment, patient anatomy, and individual preferences.

Given the comprehensive anatomical and vascular information provided in the comparative tables included in this review, no illustrative figures were incorporated, prioritizing detailed surgical data and evidence-based analysis over schematic representation.

II. HISTORICAL EVOLUTION OF BREAST RECONSTRUCTION

A. Early Pedicled Flaps

The earliest breast reconstruction procedures were based on local tissue rearrangement and pedicled flaps. One of the most influential techniques was the latissimus dorsi (LD) flap, originally described by Tansini in 1906. This flap provided reliable vascularity based on the thoracodorsal vessels and became a cornerstone of breast reconstruction, particularly in patients requiring moderate volume replacement or those with limited abdominal donor tissue. The LD flap remains relevant today, often combined with implants to enhance volume.

B. Abdominal-Based Flaps

The transverse rectus abdominis myocutaneous (TRAM) flap was described by Hartrampf, Schefflan, and Black in 1982.¹

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Initially utilized as a pedicled flap, the TRAM revolutionized breast reconstruction by allowing transfer of sufficient autologous tissue to recreate a natural breast mound. Subsequent evolution led to the free TRAM flap, which improved perfusion and versatility but remained associated with donor-site morbidity due to partial or complete sacrifice of the rectus abdominis muscle. These limitations prompted the development of muscle-sparing techniques.

C. Microsurgical and Perforator Flap Era

The introduction of microsurgical techniques marked a significant advancement in breast reconstruction. The deep inferior epigastric perforator (DIEP) flap, first described by Koshima and Soeda in 1989² and later popularized by Allen and Treece in 1994³, allowed preservation of the rectus muscle while maintaining reliable perfusion. The superficial inferior epigastric artery (SIEA) flap, described by Grotting in the early 1990s⁴, further minimized donor-site morbidity but was limited by anatomical variability.

Alternative donor sites expanded reconstructive options for patients unsuitable for abdominal flaps. The superior and inferior gluteal artery perforator (SGAP and IGAP) flaps were described by Allen and Tucker in 1995⁵. The transverse upper gracilis (TUG) flap was introduced by Yousif et al. in 1992⁶, and the profunda artery perforator (PAP) flap was later described by Angrigiani and colleagues in 2012⁷. These flaps broadened reconstructive strategies while maintaining microsurgical principles.

III. CURRENT THERAPEUTIC OPTIONS (2020–2025)

A. Implant-Based Reconstruction

Implant-based breast reconstruction remains a widely used option, particularly in patients who are not candidates for autologous reconstruction. This approach typically involves the placement of a tissue expander followed by a permanent implant or direct-to-implant reconstruction. Advantages include shorter operative time and avoidance of donor-site morbidity, while disadvantages include higher rates of capsular contracture and potential complications associated with radiation therapy.

B. Autologous Tissue Reconstruction

Autologous reconstruction using pedicled or free flaps provides durable and natural results. Techniques such as DIEP, muscle-sparing TRAM, PAP, and TUG flaps are selected based on patient anatomy, prior surgeries, and reconstructive goals. Autologous reconstruction is particularly advantageous in patients who have received or will receive radiotherapy.

IV. COMPARATIVE ANALYSIS OF RECONSTRUCTIVE TECHNIQUES

Comparative analysis of breast reconstruction techniques demonstrates distinct advantages and limitations between implant-based and autologous reconstruction. Implant-based reconstruction offers shorter operative times and reduced initial morbidity but is associated with higher long-term complication rates, particularly in irradiated patients. Autologous reconstruction provides superior long-term aesthetic outcomes and patient satisfaction, at the cost of increased surgical complexity.

TABLE I. COMPARISON BETWEEN IMPLANT-BASED AND AUTOLOGOUS BREAST RECONSTRUCTION

Parameter	Implant-Based Reconstruction	Autologous Reconstruction
Aesthetic durability	Moderate	High
Donor-site morbidity	None	Present
Impact of radiotherapy	Significant	Minimal
Long-term revision rate	Higher	Lower
Operative time	Shorter	Longer
Hospital stay	Shorter	Longer

TABLE II. COMPARISON OF COMMON AUTOLOGOUS FLAPS USED IN BREAST RECONSTRUCTION

Flap Type	Donor Site	Source Artery	Mean Pedicle Length (cm)	Mean Arterial Diameter (mm)	Venous Drainage	Main Advantages	Main Disadvantages	Typical Indications
DIEP	Lower abdomen	Deep inferior epigastric artery perforators	8–12	2.5–3.0	Deep inferior epigastric vein	Muscle preservation, large volume, durable results	Technical complexity, longer operative time	Adequate abdominal tissue
MS-TRAM	Lower abdomen	Deep inferior epigastric artery	10–14	2.5–3.5	Deep inferior epigastric vein	Reliable perfusion, easier dissection	Partial muscle sacrifice	Limited perforators

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Flap Type	Donor Site	Source Artery	Mean Pedicle Length (cm)	Mean Arterial Diameter (mm)	Venous Drainage	Main Advantages	Main Disadvantages	Typical Indications
PAP	Posterior thigh	Profunda femoris artery perforators	6–10	1.8–2.5	Profunda femoris vein	Hidden scar, good tissue quality	Limited volume	Thin patients
TUG	Medial thigh	Medial circumflex femoral artery	6–8	1.5–2.0	Medial circumflex femoral vein	Consistent anatomy	Short pedicle, limited volume	Small–moderate breasts
LD	Dorsal region	Thoracodorsal artery	8–12	2.0–3.0	Thoracodorsal vein	Reliable vascularity, versatile	Limited volume	Salvage or combined reconstruction
SGAP	Upper gluteal region	Superior gluteal artery perforators	6–10	2.0–2.5	Superior gluteal vein	Muscle preservation, good projection	Technical difficulty	No abdominal donor site
IGAP	Lower gluteal region	Inferior gluteal artery perforators	7–11	2.0–2.5	Inferior gluteal vein	Adequate volume	Sitting discomfort	Selected thin patients

TABLE III. COMMON COMPLICATIONS IN BREAST RECONSTRUCTION ACCORDING TO TECHNIQUE

Technique	Early Complications	Late Complications
Implant-based	Infection, seroma, skin necrosis	Capsular contracture, implant rupture
DIEP	Venous congestion, fat necrosis	Abdominal bulge, contour deformity
MS-TRAM	Partial flap loss, hematoma	Abdominal wall weakness
PAP	Seroma, wound dehiscence	Thigh contour irregularities
TUG	Lymphocele, delayed healing	Scar widening
LD	Seroma	Shoulder weakness, contour deformity
SGAP / IGAP	Venous congestion	Buttock contour deformity

TABLE IV. COMPARATIVE VASCULAR ANATOMY OF COMMON AUTOLOGOUS FLAPS USED IN BREAST RECONSTRUCTION

Flap	Arterial Source	Typical Number of Perforators	Pedicle Course	Anastomosis Preference
DIEP	Deep inferior epigastric artery	1–3 dominant	Intramuscular (rectus)	Internal mammary vessels

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Flap	Arterial Source	Typical Number of Perforators	Pedicle Course	Anastomosis Preference
MS-TRAM	Deep inferior epigastric artery	Multiple	Intramuscular	Internal mammary vessels
PAP	Profunda femoris artery	1–2	Septocutaneous / intramuscular	Internal mammary or thoracodorsal
TUG	Medial circumflex femoral artery	1 dominant	Musculocutaneous	Internal mammary vessels
LD	Thoracodorsal artery	Multiple	Axial	Thoracodorsal vessels
SGAP	Superior gluteal artery	1–2	Intramuscular	Internal mammary vessels
IGAP	Inferior gluteal artery	1–2	Intramuscular	Internal mammary vessels

V. SURGICAL INDICATIONS AND PATIENT SELECTION

Appropriate patient selection is essential to optimize reconstructive outcomes. Factors such as body mass index, smoking status, comorbidities, previous abdominal surgery, and oncologic treatment plans must be considered. A multidisciplinary approach involving oncologic surgeons and plastic surgeons is critical.

VI. COMPLICATIONS AND OUTCOMES

Complications associated with breast reconstruction vary according to the selected technique and patient-related factors. Implant-based reconstruction is commonly associated with capsular contracture, infection, implant malposition, and reconstructive failure, particularly in the setting of adjuvant radiotherapy. Autologous reconstruction may present complications such as partial or total flap loss, fat necrosis, seroma, hematoma, and donor-site morbidity. Recent studies published between 2020 and 2025 demonstrate that microsurgical breast reconstruction performed in high-volume centers is associated with low flap loss rates and high patient-reported satisfaction.^{8,9} Long-term outcomes favor autologous reconstruction, especially in irradiated patients, with improved aesthetic durability and quality-of-life.

CONCLUSIONS

Breast reconstruction has evolved into a highly specialized field offering multiple reliable options for patients undergoing mastectomy. Knowledge of the historical development, current techniques, and patient-specific considerations is essential for optimal surgical planning. Future advancements are expected to further refine outcomes and expand reconstructive possibilities.

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