

Tram Versus Diep Flaps in Autologous Breast Reconstruction: Donor-Site Morbidity, Flap Outcomes, And Patient-Reported Results

Eduardo Daniel Tafolla Madriz¹, Javier Guzmán Villalón², Monserrat Rendón García², David Arturo Ruiz Villalba³, Omar Espinosa García², Alejandro Alfonso Arreguín Sánchez⁴

¹Centro Médico ISSEMYM “Lic. Arturo Montiel Rojas”.

²Hospital General “Dr. Nicolás San Juan”.

³Hospital General Regional No. 1, IMSS, Chihuahua.

⁴Unidad Médica de Alta Especialidad No. 71, IMSS, Torreón, Coahuila.

ABSTRACT

Autologous breast reconstruction using lower abdominal tissue remains one of the most important options after mastectomy. The transverse rectus abdominis myocutaneous flap and the deep inferior epigastric perforator flap both provide reliable volume, natural contour, and durable long-term reconstruction. However, they differ substantially in abdominal wall morbidity, operative complexity, flap perfusion, and patient selection. The TRAM flap may be pedicled, free, or muscle-sparing, and outcomes vary considerably according to subtype. Pedicled TRAM flaps are technically reliable but sacrifice more rectus abdominis muscle and are associated with higher rates of abdominal bulge, hernia, and need for mesh repair. Free and muscle-sparing TRAM flaps reduce some donor-site morbidity while preserving robust flap perfusion. DIEP flaps preserve the rectus muscle and anterior rectus sheath to a greater extent, generally reducing abdominal wall complications and improving abdominal well-being, especially compared with pedicled TRAM. However, DIEP reconstruction requires perforator dissection, microsurgical expertise, longer operative time, and may be associated with perfusion-related complications in selected anatomy. Current evidence suggests that DIEP is generally preferred when perforator anatomy and surgical expertise allow, while muscle-sparing or free TRAM remains valuable when flap volume, perfusion reliability, or anatomy favors inclusion of muscle. This review summarizes the anatomical basis, indications, outcomes, donor-site morbidity, flap complications, patient-reported outcomes, and practical decision-making between TRAM and DIEP flaps.

KEYWORDS: TRAM flap; DIEP flap; autologous breast reconstruction; abdominal wall morbidity; donor-site complications; microsurgery; breast reconstruction; perforator flap.

ARTICLE DETAILS

Published On:
21 July 2026

Available on:
<https://ijmscr.org/>

INTRODUCTION

Autologous breast reconstruction aims to restore breast volume, contour, and symmetry using the patient's own tissue. Lower abdominal tissue is particularly valuable because it often provides adequate volume, favorable skin quality, and a natural breast shape. The two most important abdominal-based options are the transverse rectus abdominis myocutaneous flap and the deep inferior epigastric perforator flap.

The TRAM flap was historically one of the most widely used autologous breast reconstruction techniques. It transfers

lower abdominal skin and fat with a portion of the rectus abdominis muscle and its vascular supply. It may be performed as a pedicled flap based on the superior epigastric system or as a free flap based on the deep inferior epigastric vessels.

The DIEP flap represents a refinement of abdominal-based reconstruction. It transfers the same lower abdominal skin and fat but preserves the rectus abdominis muscle by dissecting perforators through the muscle to the deep inferior epigastric pedicle. This muscle-preserving design reduces donor-site morbidity but increases technical complexity.

Tram Versus Diep Flaps in Autologous Breast Reconstruction: Donor-Site Morbidity, Flap Outcomes, And Patient-Reported Results

The comparison between TRAM and DIEP is clinically important because both techniques can produce excellent breast reconstruction. The key differences involve abdominal wall morbidity, operative time, flap perfusion, complications, cost, and patient-reported outcomes [1–3].

METHODS

This narrative review was developed from the uploaded literature synthesis comparing TRAM and DIEP flaps. The evidence included retrospective series, systematic reviews, meta-analyses, cost-effectiveness studies, patient-reported outcome studies, and recent comparative analyses. The review focuses on breast reconstruction, although selected evidence from other reconstructive indications is discussed when relevant.

References are numbered according to their first appearance in the manuscript.

Anatomical Basis

TRAM Flap

The TRAM flap includes lower abdominal skin, subcutaneous fat, and variable amounts of rectus abdominis muscle. Its vascular supply depends on the flap subtype.

The pedicled TRAM flap remains attached to the superior epigastric vessels and is tunneled to the chest. It does not require microvascular anastomosis but sacrifices more muscle and relies on a longer vascular pathway, which may influence perfusion of the distal flap.

The free TRAM flap is based on the deep inferior epigastric vessels and transferred to the chest using microvascular anastomosis. It generally has stronger perfusion than the pedicled version.

The muscle-sparing free TRAM flap includes only a small cuff or segment of rectus muscle around the perforators, reducing abdominal wall damage compared with traditional free TRAM.

DIEP Flap

The DIEP flap is based on perforating vessels from the deep inferior epigastric artery and vein. The skin and fat are harvested while preserving the rectus abdominis muscle as much as possible. The perforators are dissected intramuscularly until they join the main deep inferior epigastric pedicle.

The principal advantage is preservation of abdominal wall function. The principal challenge is the need for meticulous perforator selection and dissection.

Surgical Indications

Both TRAM and DIEP flaps are used for immediate or delayed breast reconstruction after mastectomy. They may be used in unilateral or bilateral reconstruction and are especially valuable in patients desiring autologous tissue rather than implant-based reconstruction.

Common indications include:

Patient preference for autologous reconstruction

Need for natural breast contour and ptosis

Prior radiation or anticipated radiation

Implant failure or capsular contracture

Desire to avoid long-term implant maintenance

Adequate lower abdominal donor tissue

Need for durable reconstruction

The decision between TRAM and DIEP depends on abdominal anatomy, perforator quality, prior abdominal surgery, body habitus, required flap volume, comorbidities, surgeon expertise, and patient preference.

Pedicled TRAM Flap

The pedicled TRAM flap is technically reliable and does not require microsurgical anastomosis. It can be useful in centers without microsurgical capability or in patients unsuitable for prolonged microsurgery.

However, the pedicled TRAM sacrifices more rectus muscle and anterior rectus sheath, increasing risk of abdominal weakness, bulge, hernia, and need for mesh reinforcement. Comparative evidence consistently shows greater abdominal morbidity with pedicled TRAM than with DIEP [4,5].

A 12-year clinical retrospective study reported that patients undergoing pedicled TRAM reconstruction were substantially more likely to develop abdominal hernia or bulge compared with DIEP patients, and mesh closure was required more frequently [4].

The pedicled TRAM remains useful in selected circumstances, but in modern microsurgical practice it is often avoided when DIEP or muscle-sparing free TRAM is feasible.

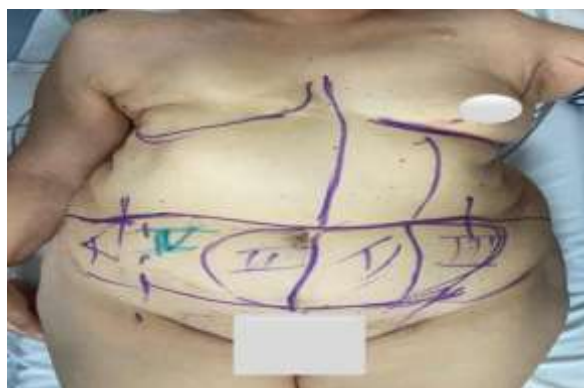


Figure 1. TRAM QUADRANTS



Figure 2. transoperative surgical technique

Free TRAM Flap

The free TRAM flap transfers the flap based on the deep inferior epigastric vessels, providing more direct and robust vascularity than the pedicled TRAM. Because it requires microsurgical anastomosis, it is more technically demanding than pedicled TRAM but may improve perfusion.

Free TRAM may be preferred when perforator anatomy is not ideal for DIEP or when inclusion of some muscle improves vascular reliability. However, it still removes more muscle than DIEP, which may increase abdominal morbidity.

Meta-analytic evidence suggests that DIEP may reduce abdominal bulge or hernia risk compared with free TRAM, but some analyses report higher fat necrosis or flap loss with DIEP, reflecting the tradeoff between donor-site preservation and flap perfusion [6].

Muscle-Sparing TRAM Flap

The muscle-sparing TRAM flap occupies an intermediate position between traditional free TRAM and DIEP. It includes a limited amount of rectus muscle around the perforators while preserving more abdominal wall structure than a conventional TRAM.

This technique may narrow the outcome gap between TRAM and DIEP. Several studies suggest that donor-site and flap-related differences between muscle-sparing TRAM and DIEP are smaller than differences between pedicled TRAM and DIEP [7,8].

Muscle-sparing TRAM may be appropriate when perforators are small, intramuscular dissection would be unsafe or excessively time-consuming, or flap perfusion would be more reliable with inclusion of a small muscle segment.

DIEP Flap

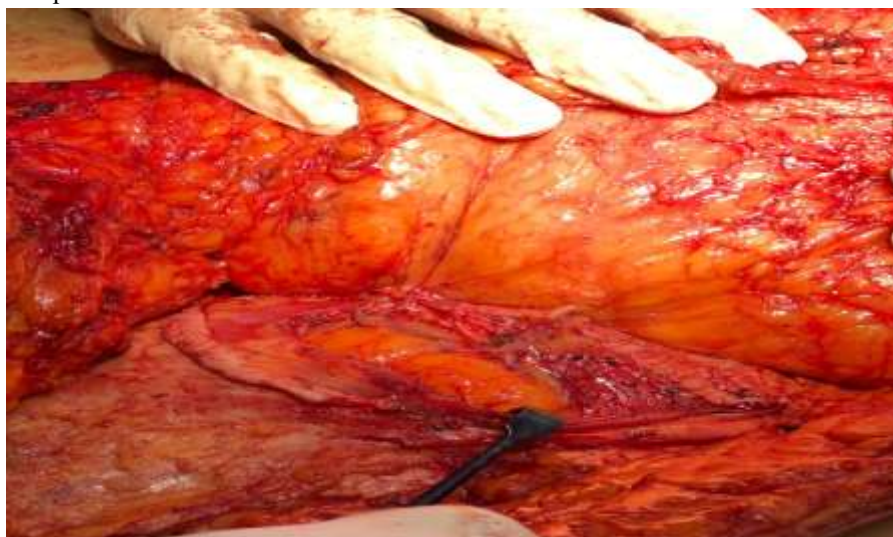


Figure 3. Diep and Diep perforators

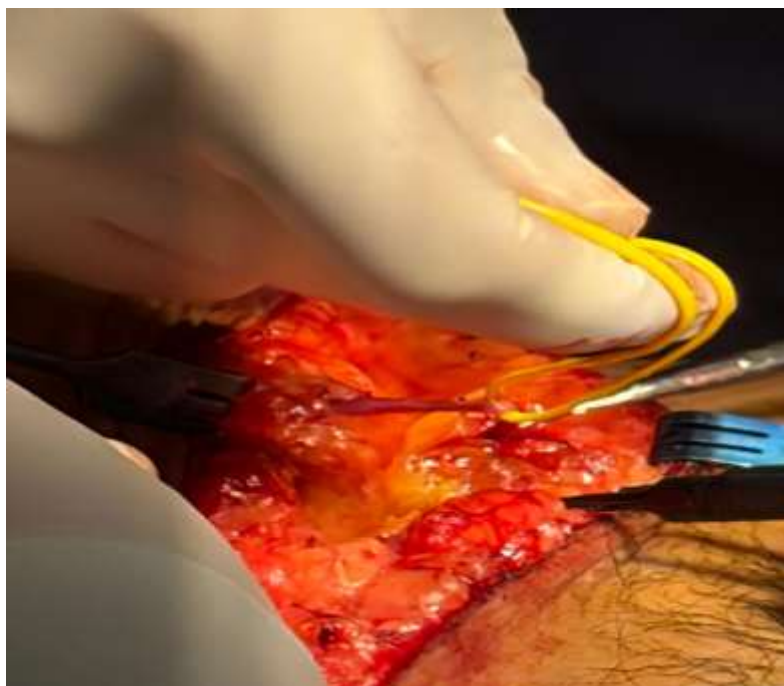


Figure 4. Diep and Diep perforators B

The DIEP flap has become a preferred abdominal-based flap in many microsurgical centers because it preserves the rectus abdominis muscle and reduces abdominal wall morbidity. It can provide excellent breast shape and volume while minimizing functional loss at the donor site.

Compared with pedicled TRAM, DIEP generally has lower rates of abdominal bulge, hernia, weakness, and mesh requirement [4,5,9]. Patient-reported abdominal well-being also tends to favor DIEP, especially in longer-term follow-up [10].

However, DIEP is not automatically superior in every outcome. It often requires longer operative time, advanced microsurgical skill, and careful perforator dissection. In some series, DIEP has been associated with higher rates of fat necrosis, partial necrosis, or perfusion-related complications, particularly when perforators are small or inadequate [6,11]. Thus, DIEP should be considered a muscle-preserving strategy whose success depends heavily on perforator anatomy and technical execution.

Donor-Site Morbidity

Donor-site morbidity is the most consistent point of difference between TRAM and DIEP flaps.

Important donor-site complications include:

- Abdominal bulge
- Abdominal hernia
- Abdominal wall weakness
- Mesh requirement
- Seroma
- Wound dehiscence
- Delayed healing
- Functional impairment
- Abdominal tightness or bloating

Pedicled TRAM has the highest donor-site burden because it sacrifices the greatest amount of muscle. Free TRAM and muscle-sparing TRAM reduce but do not eliminate this risk. DIEP generally produces the lowest abdominal morbidity because it preserves the rectus muscle and much of the fascial integrity [4,6,10].

Abdominal wall reinforcement with mesh may reduce hernia risk but introduces potential complications, including infection, chronic discomfort, and foreign-body concerns.

Flap Perfusion and Fat Necrosis

Flap perfusion is another major consideration. TRAM flaps, particularly free TRAM and muscle-sparing TRAM, may include more vascularized tissue around the perforators, potentially improving perfusion reliability.

DIEP flaps rely on selected perforators. When perforators are large, well-positioned, and adequate in number, perfusion is excellent. When perforators are small or poorly distributed, the flap may be at greater risk of fat necrosis or partial flap loss.

Fat necrosis is clinically relevant because it can produce palpable firmness, pain, contour deformity, imaging concern, and need for revision. Some comparative analyses have reported that DIEP may have higher fat necrosis than free TRAM in selected populations, although results vary by technique and patient selection [6,11].

Operative Time and Technical Complexity

DIEP flap harvest generally takes longer than pedicled TRAM harvest because it requires intramuscular perforator dissection and microsurgical transfer. Free TRAM also requires microsurgery but may require less meticulous perforator dissection if more muscle is included.

Longer operative time may be relevant in patients with:
Significant cardiopulmonary comorbidity

Tram Versus Diep Flaps in Autologous Breast Reconstruction: Donor-Site Morbidity, Flap Outcomes, And Patient-Reported Results

Advanced age

Obesity

Bilateral reconstruction

Prior abdominal surgery

High anesthetic risk

The technical learning curve is also important. DIEP outcomes improve with microsurgical experience, preoperative imaging, careful perforator selection, and standardized operative workflow.

Hospital Stay and Recovery

Hospital stay comparisons are inconsistent. Some studies report shorter length of stay with DIEP, while others show no significant difference compared with TRAM [5,12].

Recovery depends on flap type, abdominal closure, complications, unilateral versus bilateral reconstruction, pain control, and institutional protocols. Because DIEP preserves muscle, it may allow better abdominal recovery and patient-reported abdominal function, although early postoperative discomfort may still be significant.

Patient-Reported Outcomes

Patient-reported outcomes are essential because technical success does not always reflect functional and quality-of-life results.

The Mastectomy Reconstruction Outcomes Consortium study found that abdominal well-being tends to favor DIEP over pedicled and free TRAM over time [10]. Satisfaction with breast appearance may be similar across techniques, because both use lower abdominal tissue and can produce natural breast shape.

Some recent studies using BREAST-Q suggest limited overall differences between muscle-sparing TRAM and DIEP, although specific domains such as abdominal bloating or sexual well-being may favor DIEP in certain subgroups [13]. Overall, DIEP appears most consistently advantageous in abdominal well-being rather than necessarily in breast satisfaction.

Cost Considerations

Cost comparisons are mixed. DIEP may increase operative time and technical resource use, but it may reduce donor-site complications and later abdominal wall repair.

An early cost-effectiveness analysis suggested that DIEP may be more expensive than free TRAM but still cost-effective when quality-adjusted outcomes are considered [14]. More recent hospital-level analyses suggest that costs and length of stay may be similar between DIEP and TRAM in some healthcare systems [15].

Cost should therefore be interpreted according to local reimbursement, operative time, complication rates, length of stay, revision surgery, and long-term abdominal morbidity.

Patient Selection

Patients Who May Benefit Most From DIEP

DIEP may be favored when:

Adequate perforators are present

The patient is physically active

Abdominal wall preservation is a major priority

Bilateral reconstruction is planned

The patient has low tolerance for hernia or bulge risk

Microsurgical expertise is available

Donor tissue volume is adequate without muscle inclusion

Patients Who May Benefit From TRAM or Muscle-Sparing TRAM

TRAM or muscle-sparing TRAM may be favored when:

Perforator anatomy is unfavorable for DIEP

Greater perfusion reliability is needed

Very large flap volume is required

Prior surgery complicates perforator dissection

Operative time must be reduced

Microsurgical perforator expertise is limited

A small amount of muscle inclusion improves safety

The most important principle is that “TRAM” should not be treated as one procedure. Pedicled TRAM, free TRAM, and muscle-sparing TRAM have different risk profiles.

Role of Preoperative Imaging

Preoperative imaging with CT angiography or MR angiography can help identify perforator size, location, intramuscular course, and branching pattern. This is especially useful for DIEP planning.

Benefits include:

Shorter perforator dissection time

Better flap design

Avoidance of inadequate perforators

Improved operative planning

Identification of prior surgical vessel disruption

Imaging does not replace intraoperative judgment but improves planning and may help determine whether DIEP or muscle-sparing TRAM is the safer option.

Complications

Potential complications include:

Flap-related complications

Venous congestion

Arterial insufficiency

Partial flap necrosis

Total flap loss

Fat necrosis

Hematoma

Infection

Need for reoperation

Donor-site complications

Abdominal bulge

Hernia

Seroma

Wound dehiscence

Delayed healing

Mesh infection

Abdominal weakness

Pain or tightness

Breast-site complications

Mastectomy skin flap necrosis

Tram Versus Diep Flaps in Autologous Breast Reconstruction: Donor-Site Morbidity, Flap Outcomes, And Patient-Reported Results

Delayed healing

Contour deformity

Asymmetry

Need for revision or fat grafting

DIEP generally reduces abdominal morbidity but does not eliminate flap-related risk. TRAM may improve perfusion in selected cases but increases abdominal wall morbidity, particularly when more muscle is harvested.

Proposed Decision Algorithm

Assess patient goals: autologous reconstruction, breast size, recovery priorities, and willingness for microsurgery.

Evaluate donor tissue: abdominal volume, scars, body habitus, and abdominal wall status.

Review comorbidities: smoking, obesity, diabetes, vascular disease, prior radiation, and operative risk.

Perform perforator imaging when microsurgical abdominal flap reconstruction is planned.

Favor DIEP when perforators are adequate and abdominal preservation is the priority.

Favor muscle-sparing TRAM when perforators are borderline but muscle preservation remains important.

Consider free TRAM when robust perfusion is needed and donor-site risk is acceptable.

Reserve pedicled TRAM for selected patients or centers where microsurgery is not feasible.

Plan abdominal closure carefully: minimize fascial tension and use mesh selectively.

Monitor outcomes: include flap survival, abdominal morbidity, patient-reported outcomes, and revision needs.

DISCUSSION

The comparison between TRAM and DIEP flaps is best understood as a balance between abdominal wall preservation and perfusion reliability. DIEP is generally superior for donor-site morbidity, especially compared with pedicled

TRAM. This advantage is clinically meaningful because abdominal bulge and hernia can impair function and quality of life.

However, DIEP is not universally superior in all outcomes. It is technically demanding, takes longer, and depends on perforator anatomy. In some patients, a muscle-sparing TRAM may provide a safer balance by preserving most abdominal wall function while improving flap perfusion.

The evidence also shows why TRAM subtype matters. Pedicled TRAM has the clearest disadvantage in abdominal morbidity. Free TRAM and muscle-sparing TRAM often approach DIEP outcomes, making individualized decision-making essential.

Patient-reported outcomes support this interpretation. DIEP often improves abdominal well-being, while breast satisfaction may be similar between techniques. Therefore, the most important question is not simply which flap creates a better breast, but which flap provides the safest reconstruction with the least donor-site harm for a specific patient.

CONCLUSION

DIEP and TRAM flaps remain central options in autologous breast reconstruction. DIEP generally offers lower abdominal donor-site morbidity, improved abdominal well-being, and better preservation of rectus muscle function, particularly when compared with pedicled TRAM. However, DIEP requires advanced microsurgical expertise and favorable perforator anatomy. TRAM flaps, especially free and muscle-sparing variants, remain valuable when greater perfusion reliability or technical feasibility is needed. The optimal choice should be individualized according to anatomy, perforator quality, flap volume requirements, comorbidities, surgeon experience, and patient priorities.

Table 1. Practical Comparison of TRAM and DIEP Flaps

Feature	Pedicled TRAM	Free TRAM	Muscle-sparing TRAM	DIEP flap
Vascular basis	Superior epigastric system	Deep inferior epigastric system	Deep inferior epigastric system with limited muscle harvest	Deep inferior epigastric perforators
Microsurgery required	No	Yes	Yes	Yes
Rectus muscle sacrifice	Highest	Moderate	Low to moderate	Minimal
Abdominal morbidity	Highest risk of bulge or hernia	Lower than pedicled TRAM but higher than DIEP	Often close to DIEP	Lowest overall
Perfusion reliability	Reliable but may be less robust distally	Robust	Robust	Excellent when perforators are adequate
Fat necrosis risk	Variable	Often lower than DIEP in some series	Variable	May increase when perforators are limited
Operative time	Shorter	Longer	Longer	Often longest

Tram Versus Diep Flaps in Autologous Breast Reconstruction: Donor-Site Morbidity, Flap Outcomes, And Patient-Reported Results

Feature	Pedicled TRAM	Free TRAM	Muscle-sparing TRAM	DIEP flap
Donor-site function	Greatest impairment	Moderate impairment	Limited impairment	Best preservation
Best use	When microsurgery is unavailable or unsuitable	When robust perfusion is needed	When perforator anatomy is borderline	When abdominal preservation is priority
Main limitation	Abdominal wall morbidity	Muscle sacrifice	Still sacrifices some muscle	Technical complexity and perforator dependence

REFERENCES

- I. Knox ADC, Ho AL, Leung L, Tashakkor AY, Lennox PA, Van Laeken N, Macadam SA. Comparison of outcomes following autologous breast reconstruction using the DIEP and pedicled TRAM flaps: a 12-year clinical retrospective study and literature review. *Plast Reconstr Surg.* 2016;138:16-28. doi:10.1097/PRS.0000000000001747
- II. Jeong W, Lee S, Kim J. Meta-analysis of flap perfusion and donor-site complications for breast reconstruction using pedicled versus free TRAM and DIEP flaps. *Breast.* 2018;38:45-51. doi:10.1016/j.breast.2017.12.003
- III. He WY, Eter LE, Yesantharao P, Hung B, Owens H, Persing SM, Sacks JM. Complications and patient-reported outcomes after TRAM and DIEP flaps: a systematic review and meta-analysis. *Plast Reconstr Surg Glob Open.* 2020;8:e3120. doi:10.1097/GOX.00000000000003120
- IV. Garvey PB, Buchel EW, Pockaj BA, Casey WJ, Gray RJ, Hernández JL, Samson TD. DIEP and pedicled TRAM flaps: a comparison of outcomes. *Plast Reconstr Surg.* 2006;117:1711-1719. doi:10.1097/01.prs.0000210679.77449.7d
- V. Dias MB, Valente MLS, De Sousa Dórea B, Legramanti RJD, Barroso NF, Júnior AR, et al. Comparative outcomes of DIEP versus TRAM flaps in autologous breast reconstruction: a systematic review. *J Med Biosci Res.* 2025. doi:10.70164/jmbr.v2i5.909
- VI. Man LX, Selber JC, Serletti JM. Abdominal wall following free TRAM or DIEP flap reconstruction: a meta-analysis and critical review. *Plast Reconstr Surg.* 2009;124:752-764. doi:10.1097/PRS.0b013e31818b7533
- VII. Bajaj AK, Chevray PM, Chang DW. Comparison of donor-site complications and functional outcomes in free muscle-sparing TRAM flap and free DIEP flap breast reconstruction. *Plast Reconstr Surg.* 2006;117:737-746. doi:10.1097/01.prs.0000200062.97265.fb
- VIII. Nelson JA, Guo Y, Sonnad SS, Low DW, Kovach SJ, Wu LC, Serletti JM. A comparison between DIEP and muscle-sparing free TRAM flaps in breast reconstruction: a single surgeon's recent experience. *Plast Reconstr Surg.* 2010;126:1428-1435. doi:10.1097/PRS.0b013e3181ef8b20
- IX. Tan SS, Lim J, Yek J, Ong WC, Hing CH, Lim TC. The deep inferior epigastric perforator and pedicled transverse rectus abdominis myocutaneous flap in breast reconstruction: a comparative study. *Arch Plast Surg.* 2013;40:187-191. doi:10.5999/aps.2013.40.3.187
- X. Erdmann-Sager J, Wilkins EG, Pusic AL, Qi J, Hamill JB, Kim HM, Guldbrandsen G, Chun YS. Complications and patient-reported outcomes after abdominal-based breast reconstruction: results of the Mastectomy Reconstruction Outcomes Consortium study. *Plast Reconstr Surg.* 2018;141:271-281. doi:10.1097/PRS.00000000000004016
- XI. Kroll SS. Fat necrosis in free transverse rectus abdominis myocutaneous and deep inferior epigastric perforator flaps. *Plast Reconstr Surg.* 2000;106:576-583. doi:10.1097/00006534-200009010-00008
- XII. Cai A, Suckau J, Arkudas A, Beier JP, Momeni A, Horch RE. Autologous breast reconstruction with TRAM or DIEP flaps: an analysis of the 100 most cited articles. *Med Sci Monit.* 2019;25:3520-3536. doi:10.12659/MSM.914665
- XIII. Yoshitake T, Matsunaga N, De Kerckhove M, Tomita S, Fujii M, Terao Y. Comparison of breast reconstruction using muscle-sparing TRAM and DIEP flaps assessed with the BREAST-Q questionnaire. *Aesthet Surg J Open Forum.* 2025;7. doi:10.1093/asjof/ojaf042
- XIV. Thoma A, Veltri K, Khuthaila D, Rockwell G, Duku E. Comparison of the DIEP flap and free TRAM flap in postmastectomy reconstruction: a cost-effectiveness analysis. *Plast Reconstr Surg.* 2004;113:1650-1661. doi:10.1097/01.PRS.0000117196.61020.f0
- XV. Foppiani JA, Alvarez HA, Kim EJ, Escobar-Domingo M, Taritsa I, Schuster K, et al. The value of microvascular breast reconstruction: cost equivalence of TRAM and DIEP flaps implications in the era of CMS reforms. *Microsurgery.* 2024;44. doi:10.1002/micr.31185