

# Inset techniques for the DIEP flap – what improves aesthetic outcomes?

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## Summary

**Introduction:** The deep inferior epigastric perforator (DIEP) flap is widely considered as the gold standard in breast reconstruction. The inset technique of the DIEP flap is crucial in determining the overall aesthetic outcome; however, to date no systematic review is available that comprehensively assesses the various techniques. **Evaluation of topic:** A systematic review was performed according to the PRISMA guidelines. The methodology is outlined within our published protocol (Prospero CRD42023449477). Included articles met a minimal criterion comprising of the intervention (DIEP free flap for breast reconstruction) and outcomes (aesthetic and clinical outcomes). Six articles were included in this review, with a total of 346 patients and a follow-up ranging from 6 months to 4 years. Four articles were of a prospective case series study design, one article was a randomized controlled trial, and one article was a case-control study. The risk of bias was assessed to be high in the case series, but low and moderate in the randomized controlled trial and case-control study respectively. **Conclusion:** Although limited by the quality of the evidence, the single aesthetic unit principle, dual-plane inset, elimination of the need for a skin paddle, appropriate flap positioning and rotation, and algorithmic in-setting may all improve the aesthetic outcome of DIEP free flaps.

## Key words

DIEP free flap – breast reconstruction – microsurgery

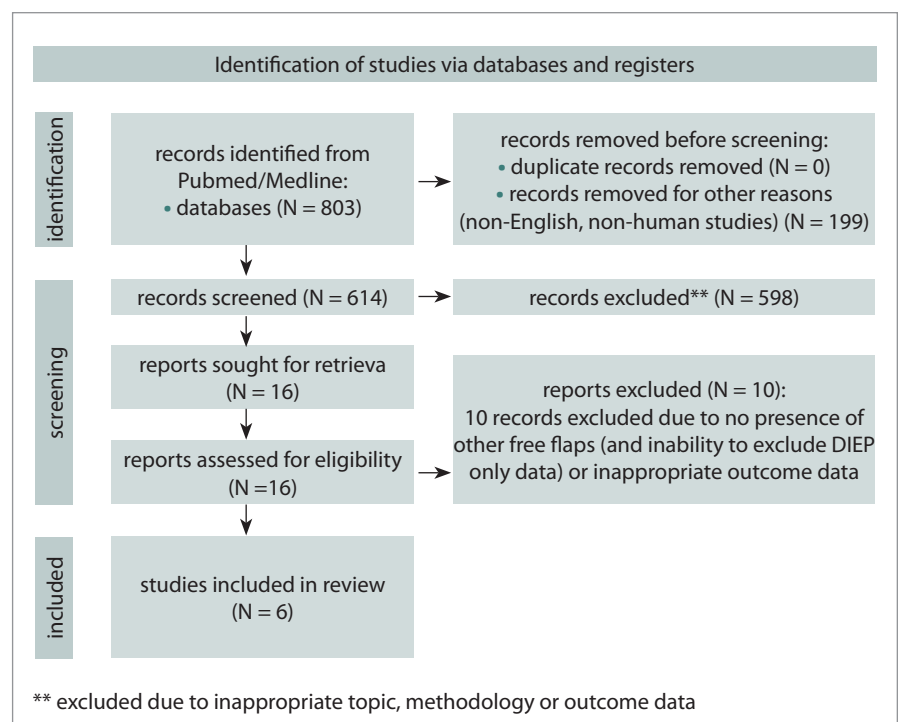
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## Introduction

The deep inferior epigastric perforator (DIEP) flap is a workhorse for breast reconstruction. A critical aspect of this procedure is the inset technique, which determines the flap's final contour and shape, and as such both the aesthetic and clinical outcome. Residents and novice plastic surgeons often go through their own evolutionary process before settling to a particular inset technique and approach. To date, there are several nuances to flap inseting and no agreed gold standard approach. This review will summarise the existing body of evidence related to DIEP flap inseting techniques to guide plastic surgery residents and surgeons at the beginning of their careers.

## Evaluation of the topic

A systematic review was performed according to PRISMA guidelines. The meth-



Scheme 1. PRISMA flowchart.

Tab. 1. Included articles characteristics and patient demographics.

Article	Study design	Risk of bias	Number of patients	Mean age (years)	BMI (mean)	Follow-up length (months)	Timing of reconstruction	Patient inclusion criteria
Gravvanis et al., 2015 [1]	RCT (group A: single plane inset; group B: dual plane inset)	low	50 (25 patients in each group)	group A: 41.1 ± 1.5 group B: 41.8 ± 1.1	group A: 28.1 ± 0.9 group B: 28.9 ± 0.7	group A: 29 ± 2.11 months group B: 28.82 ± 2.02	minimum of 6 months between radiotherapy and reconstruction	BMI ≤ 30 age ≤ 50
Gravvanis et al., 2016 [2]	prospective case series	high	42	42.8 ± 2.2	29.3 ± 1.5	28.3 ± 4.1	average 8.3 months between radiotherapy and reconstruction	BMI ≤ 30 age ≤ 50
Razzano et al., 2019 [3]	prospective case series	high	70	55 ± 8.6	26.6 ± 2.9	17.9	immediate reconstruction	not reported
Atzeni et al., 2022 [4]	case-control (group A and B, with and without using a standardised inset algorithm respectively)	moderate	120 (60 patients in each group)	group A: 55.5 ± 6 group B: 54.3 ± 7	group A: 26.1 ± 2.8 group B: 26 ± 3	minimum 3 years follow-up	immediate reconstruction	not reported
Francis et al., 2022 [5]	prospective case series (group A: skin paddle; group B: no skin paddle but with delayed primary retention suture)	high	24 patients (12 patients in each group)	group A: 42.6 group B: 45.2	group A: 22.5 group B: 21.9	group A: 49.3 months group B: 14.4 months P < 0.05	immediate reconstruction	patients with nipple sparing mastectomy only
Dung et al. 2023 [6]	case series	high	40 patients	43.4 ± 8.46	21.88 ± 1.81	range of 6–24 months given	immediate reconstruction	not reported

BMI – body mass index

odology is outlined within our published protocol (Prospero CRD42023449477). A total of 803 records were screened (Scheme 1). Six articles were included in this review, with a total of 346 patients and a follow-up ranging from 6 months to 4 years [1–6]. A summary of included studies and results can be found in Tab. 1 and 2 respectively.

Gravvanis et al. (2015) conducted a randomized controlled trial to investigate whether single or dual-plane inset was superior, whilst adhering to the single aesthetic unit principle (Fig. 1) [1].

Dual-plane flap inset was found to have minor scarring, a more natural transition, better breast contour, better overall breast appearance and higher patient satisfaction scores (P < 0.05). The authors went on to present a prospective case series of patients with dual-plane inset in 2016, revealing high patient satisfaction at 2 years post-surgery, especially with regards to upper pole fullness and minimal ptosis with time [2].

Razzano et al. (2019) presented a prospective case series of 70 patients describing their novel inseting algo-

rithm [3]. The flap was positioned vertically in patients with ptotic contralateral breast or slim abdomen, or horizontally if there was a projected contralateral breast or fat abdomen. The flap was also rotated either 90 or 180 degrees depending on the number and length of the pedicles and requirement for ptosis. The authors revealed a mean overall BREAST-Q score of 82, representing excellent patient satisfaction. Atzeni et al. (2022) performed a case-control study on patients operated on using the Razzano protocol, and those oper-

Tab. 2. A summary of the flap inset techniques and outcome data.

Article	Flap inset technique	Objective outcomes	Subjective outcomes	Complications
Gravvanis et al., 2015 [1]	<p>Single aesthetic unit principle followed.</p> <p><b>Single plane flap inset:</b> Each patient is preoperatively marked in an upright position. A footprint of the healthy breast is mirrored to the mastectomy side. The mastectomy scar is excised. If the original scar presents an oblique course, it is converted to a horizontal. The new inframammary fold is incised down to the subcutaneous tissue. The skin between the mastectomy scar and inframammary fold is only deepithelialized.</p> <p><b>Dual plane flap inset:</b> As above. At the level of the mastectomy scar, the pectoralis major muscle is split, and a submuscular plane is obtained. The upper mastectomy skin is elevated en block with the pectoralis major muscle as a musculocutaneous flap and is undermined up to the preoperative markings. The flap is inset behind the pectoral muscle at the upper part and in front of the muscle at the lower part, which results in a dual-plane breast reconstruction.</p>	<p>VAS assessed by 30 evaluators.</p> <p>Dual plane flap inset assessed to have superior scar, mastectomy skin, natural transition, breast contour and overall breast appearance (<math>P &lt; 0.05</math>).</p>	<p>Patient self-evaluation form from 33 patients (66% response rate).</p> <p>Dual plane inset associated with higher patient satisfaction without wearing brassiere, greater fullness of upper pole and less ptosis with time (<math>P &lt; 0.05</math>).</p>	<p>no complications reported in either group</p>
Gravvanis et al., 2016 [2]	as above (dual plane flap inset)	none reported	<p>Patient self-evaluation form (at 2 months and 2 years). However, no pre-operative results were presented.</p> <p>Patients stated high satisfaction for the aesthetic outcome without wearing brassiere, which was attributed to the fullness of the upper pole and minimal ptosis with time.</p>	<p>No complications reported.</p> <p>A total of 29 patients had their nipple/areola complex reconstructed and 26 patients had contralateral breast mastopexy/reduction.</p>
Razzano et al., 2019 [3]	<p>Inset based on author algorithm.</p> <p>Flap positioned vertically in patients with a ptotic contralateral breast or a slim abdomen.</p> <p>Flap positioned horizontally if projected contralateral breast or fat abdomen.</p> <p>Flap rotated by 90 or 180 degrees depending on number and length of pedicles, requirement for ptosis or need for SIEV supercharging.</p>	<p>Mean overall BREAST-Q score of 82 of 100, representing excellent satisfaction but poor satisfaction with sexual well-being.</p> <p>No pre-operative BREAST-Q scores were reported.</p> <p>Fat necrosis reduced satisfaction with the chest (absolute mean reduction, 13; 95% CI, 8–18; <math>P = 0.002</math>).</p> <p>Return to theatre or revision surgery did not alter BREAST-Q scores.</p>	<p>Independent assessor scores (by breast surgeons, specialist nurse and medical secretary) scored good or very good in the majority of cases, but with no agreement between the assessors.</p>	<p>fat necrosis (4 patients, 6%); abdominal hematoma (2 patients, 3%); flap revision (2 patients, 3%); request for lipofilling (4 patients, 6); scar revision (3 patients, 4%)</p>

Tab. 2 – continuing. A summary of the flap inset techniques and outcome data.

Article	Flap inset technique	Objective outcomes	Subjective outcomes	Complications
Atzeni et al., 2022 [4]	Inset as per Razzano et al (2019) above.	Group A required 72 revision procedures, compared to 34 revisions in group B (P < 0.05). All of which were requested by the patient (including scar revision, liposuction/lipo-filling, symmetrisation, flap reposition, IMF revision and flap reduction).	not reported	Group A: wound dehiscence (3 patients, 5%), breast hematoma (1 patient, 1.7%), venous anastomosis revision (2 patients, 3.3%), partial tissue necrosis (2 patients, 3.3%), flap repositioning (1 patient, 1.7%), early revision procedures (9 patients, 15%) Group B: wound dehiscence (1 patient, 1.7%), venous anastomosis revision (2 patients, 3.3%), partial tissue necrosis (2 patients, 3.3%), flap repositioning (2 patients, 3.3%), early revision procedures (7 patients, 11.7%) P > 0.05 between two groups
Francis et al., 2022 [5]	A 6cm nipple sparing mastectomy incision was utilised in the anterior axillary line. DIEP raised and anastomosis via tradition methods. Group A: skin paddle used. Group B: purse string delayed primary retention suture with 4-0 Monocryl. Pulled together at day 5–7.	At a mean 9 months of follow-up, the Breast-Q “satisfaction with surgeon” domain was significant in Group B (P = 0.04). At a mean 12 months of follow-up, the overall Manchester scar scale of 10.3 in Group B was statistically superior to 12.6 in Group A (P = 0.04).	not reported	return to theatre (venous congestion) (1 patient in each group, 8.3%) Group A: infection (1 patient, 8.3%) Group B: hematoma (1 patient, 8.3%) P > 0.05
Dung et al., 2023 [6]	The flaps were placed obliquely, with the upper edge facing downward and inward. The upper end was fixed into the 2–3 <sup>rd</sup> intercostal space next to the sternum, and the lower end was folded to create a projection of the lateral lower pole of the breast. The flap pedicle was anastomosed to the thoracodorsal vessels (TDVs) if the contralateral flap pedicle was used; conversely, the mammary vessels (IMVs) were used.	BREAST-Q questionnaire recorded 6 months post-operatively (36/40 responses, 90% response rate). Average satisfaction score of 62.22 (range 51–78).	not reported	anastomotic revision (1 patient, 2.5%), total flap necrosis (3 patients, 7.5%), delayed wound healing (2 patients, 5%) and hematoma (1 patient, 2.5%)

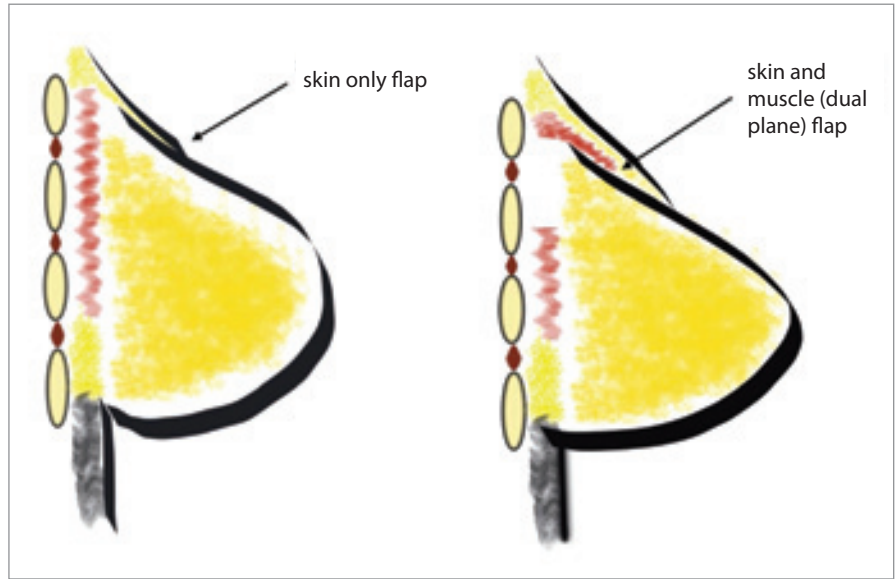
ated on without the algorithm [4]. They showed that the inseting algorithm had reduced the need for revision procedures (34 vs. 72 revisions in the control group;  $P < 0.05$ ).

Francis et al. (2022) presented a prospective case series of 24 patients, looking at the need for a skin paddle vs. delayed primary retention suture (DPRS) (Fig. 2) [5]. At 12 months of follow-up, the overall Manchester Scar Scale in the DPRS group was statistically superior to the skin paddle group ( $P = 0.04$ ). They found no significant difference in complications, including infection.

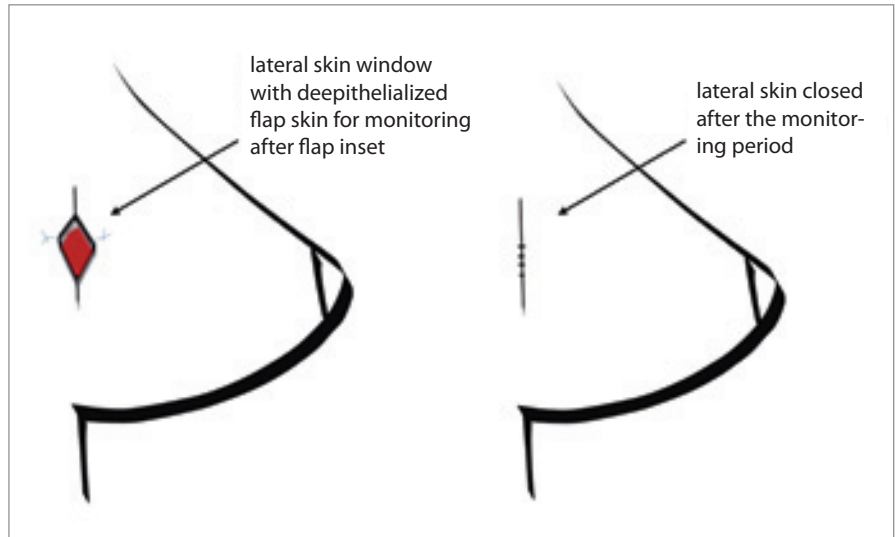
Dung et al. (2023) reported a case series of 40 patients with oblique inset of the DIEP flap [6]. BREAST-Q results revealed good aesthetic results and an average satisfaction score of 62, although total flap necrosis was seen in 3 patients (7.5%) and delayed wound healing in 2 patients (5%).

**Conclusion**

Although DIEP flaps are considered a workhorse for breast reconstruction, the number of revision surgeries for breast asymmetry is still high worldwide [7]. Optimising the procedure, including the inset level, may reduce revision surgeries. Although limited by the availability of well-designed research and sample sizes from the available evidence, the single aesthetic unit principle, dual-plane inset and elimination of the need for a skin paddle (such as using DPRS) all lead to superior aesthetic outcomes. Flap positioning (vertical, horizontal or oblique) and rotation, depending on the abdominal fat content or the degree of ptosis in the contralateral breast can also aid in optimising aesthetic outcomes. The presence of algorithmic inseting may also improve outcomes. Limitations of this review include a small sample size of patients and a small number of studies. There is also lack of robust evidence to suggest a gold standard way of inseting a DIEP flap and there is no one technique par-



**Fig. 1. Gravvanis et al. (2015) investigated outcomes difference between single vs. dual plane inset [1].**



**Fig. 2. Francis et al. (2022) delayed primary retention suture (DPRS) technique [5].**

ticularly superior to others. Surgeons must consider individual patient aesthetic needs and tissue characteristics to formulate a tailor-made solution for their patient.

**Roles of authors**

M. Kadhum – conceived the search strategy, executed the search and drafted the paper; C. Symonette – critically reviewed the first draft of the paper and redrafted it as needed; M. U. Javed – conception of the idea for the paper, performed an independent search of the

review strategy for quality assurance, and critically reviewed the first draft.

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