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REVIEW ARTICLE

Deep inferior epigastric perforator (DIEP) flap in head and neck reconstruction: a systematic review and meta-analysis

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Abstract

Introduction Head and neck reconstruction after oncological resection or trauma presents considerable challenges due to the region's functional and aesthetic complexity. Although various free flaps are used, the Deep Inferior Epigastric Artery (DIEP) flap remains underutilized because of concerns over flap bulk and technical difficulty. This systematic review evaluates the safety, efficacy, complications, and functional and aesthetic outcomes of DIEP flaps in head and neck reconstruction.

Methods Following PRISMA guidelines, a systematic search was conducted in PubMed, EMBASE, Google Scholar, and Web of Science. Eligible studies included prospective and retrospective cohorts, as well as case series, that reported DIEP flap outcomes in head and neck reconstruction. Extracted data covered flap survival, complications, donor morbidity, functional recovery, aesthetic results, and patient satisfaction. Meta-analysis using R software calculated pooled proportions with 95% confidence intervals.

Results Out of 396 identified records, 25 studies met eligibility criteria, including 666 patients and 480 DIEP flaps. The pooled flap survival rate was 96% (95% CI, 93%–98%), with low rates of total flap failure (3%) and partial necrosis (2%). Major and minor complication rates were 4% and 9%, respectively. Functional outcomes were favorable, with 86% of patients achieving satisfactory speech and 85% resuming oral intake. Aesthetic outcomes were rated good to excellent in 85% of studies, with high donor-site satisfaction and limited need for revision. Most studies were retrospective case series with low to moderate risk of bias.

Conclusion DIEP flaps offer a reliable, muscle-sparing solution for moderate to large head and neck defects, yielding favorable functional and aesthetic outcomes with minimal donor-site morbidity, thereby supporting broader adoption in head and neck reconstruction.

Level III evidence.

Keywords DIEP flap · Head and neck reconstruction, microsurgical free flaps · Flap survival · Flap complications · Functional and aesthetic outcomes

Introduction

Reconstruction of head and neck defects is a significant concern in surgical practice. Such defects can significantly impact essential human functions and require extensive planning to restore both functionality and appearance [1]. Free tissue transfer has been used to reconstruct these defects and can be tailored to individual defect requirements [1]. Depending on the primary extraction site, several free flap options exist, including the anterolateral thigh (ALT), radial forearm, fibula, and rectus abdominis flaps [2].

The deep inferior epigastric artery perforator (DIEP) flap provides a large, well-vascularized, and flexible piece of skin ideal for head and neck reconstruction [3, 4]. However, concerns about flap bulk, the necessity for surgical thinning, and the technical complexity of harvesting have resulted in the underutilization of DIEP flaps [3–6]. Recent evidence increasingly supports its successful use, demonstrating excellent outcomes regarding flap survival and complication rates [7–9]. Masia et al. conducted a comprehensive series of 100 head and neck reconstructions using the DIEP flap, showing its high versatility and achieving an overall survival rate of 97.1%, thus confirming its suitability

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for moderate-to-large soft tissue reconstructions [10]. Zhang et al. reported successful DIEP flap applications in defects following glossectomy, midface, cheek, and skull-base surgeries, achieving a 92% overall success rate without donor-site hernias, further supporting its reliability [11]. Woodworth et al. highlighted the benefits of DIEP flaps as muscle-sparing abdominal free flaps in head and neck cancer reconstruction, reporting no abdominal wall weakness or hernias, favorable donor-site aesthetics, and an average hospital stay of 7.6 days [12]. Clemens et al. described excellent outcomes with DIEP flaps in buried contour reconstruction for complex head and neck cases, achieving 100% flap survival, durable volume retention, and high patient satisfaction in both functional and aesthetic outcomes [13]. Louie et al. demonstrated the feasibility of the DIEP flap for total laryngopharyngectomy reconstruction, successfully reconstructing extensive circumferential pharyngeal defects with large flap dimensions, achieving excellent functional results, and experiencing no postoperative leaks or minimal abdominal wall complications [14]. Recent clinical studies have consistently shown that DIEP flaps provide substantial soft-tissue volume with minimal donor-site morbidity [15].

A prior systematic review by Mayo-Yáñez et al. (2021) examined the applications and outcomes of deep inferior epigastric artery perforator (DIEP) flaps in head and neck reconstruction and reported high flap survival with low donor-site morbidity [16]. However, that review was limited by a smaller evidence base, lack of quantitative pooling, and heterogeneity in outcome reporting. Since its publication, a substantial number of additional clinical studies have emerged, expanding the reported indications and technical refinements of DIEP flap use in complex head and neck defects. The present systematic review builds upon this foundational work by incorporating an updated literature search through May 2025 and by performing quantitative meta-analyses of pooled flap survival and complication rates. In addition, this review provides a more granular synthesis of functional outcomes, aesthetic results, and donor-site morbidity, thereby offering a more comprehensive and contemporary assessment of DIEP flap performance in head and neck reconstruction.

However, despite growing clinical experience, the available literature remains heterogeneous in terms of reported outcomes and complication profiles associated with DIEP flaps in head and neck reconstruction. Therefore, this systematic review and meta-analysis aims to synthesize the existing evidence by evaluating pooled flap survival, complication rates, and functional and aesthetic outcomes.

Methods & materials

Literature search and study selection

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring transparency, accuracy, and completeness in reporting [17]. It was also registered in the International Prospective Register of Systematic Reviews (PROSPERO) (ID: CRD420251038063) and adhered to Cochrane review methods to ensure a rigorous, standardized approach to data collection, synthesis, and analysis [18]. Literature searches were conducted on May 15, 2025, using the following electronic databases: PubMed, EMBASE, Web of Science, and Google Scholar, without time frame limitation. The search algorithms used were: 'DIEP flap,' 'deep inferior epigastric perforator flap,' 'head and neck reconstruction,' 'oromandibular reconstruction,' 'maxillofacial reconstruction,' 'free tissue transfer,' and 'microvascular reconstruction.' Boolean operators included AND/OR combinations of the listed search terms. No language restrictions were applied. Gray literature sources, including conference abstracts and dissertations, were not systematically searched.

According to the PICO framework, this study focuses on patients who underwent head and neck reconstruction, using a Deep Inferior Epigastric Perforator (DIEP) free flap as the intervention. The comparison group includes other free flaps or no comparison at all. The study evaluates several key outcomes, including flap survival, complications, donor site morbidity, functional and aesthetic results, and patient satisfaction. Four investigators reviewed the titles and abstracts of the included articles and selected relevant studies for full review. Titles and abstracts were independently screened by multiple reviewers. Any discrepancies were resolved through discussion and consensus, with involvement of an additional author when required. Articles were extracted from the databases and screened using Rayyan (https://www.rayyan.ai/) [19]. When titles and abstracts did not provide sufficient information, the full text was reviewed. Even with predefined inclusion and exclusion criteria and a comprehensive database search, references of relevant studies were also screened to ensure no additional articles were missed.

The inclusion criteria were: (1) studies involving DIEP flap use in head and neck reconstruction, (2) studies reporting at least one relevant outcome, (3) randomized controlled trials, prospective or retrospective cohort studies, and case series, (4) no restriction on publication date, country of origin, or follow-up duration, and (5) no language restrictions. Articles were excluded based on the following criteria: (1) studies not reporting outcomes of interest, (2) animal studies,

(3) case reports, review articles, or editorials, (4) studies without extractable outcomes related to DIEP flap use, and (5) studies focusing on non-head and neck reconstructions (e.g., breast reconstruction). Articles were retrieved and screened by four independent investigators, and disagreements were resolved by a fifth investigator.

Screening and data extraction

Each report was retrieved by one investigator and assessed blindly by two other investigators. Three authors independently screened and extracted the following information: first author, year of publication, country of study, study design, sample size, follow-up duration, patient demographics (age, sex, comorbidities), surgical details (flap design, recipient vessels, operative time), clinical outcomes (flap survival, complications, donor site morbidity, hospital stay), patient-reported outcomes, statistical findings, and authors' main conclusions. For functional outcomes, data on speech intelligibility, swallowing function, oral diet resumption, and gastrostomy dependence were extracted where reported, along with assessment methods and timing of evaluation. A fourth author resolved unresolved concerns. Major complications were defined as events requiring surgical re-intervention or resulting in partial or total flap loss, whereas minor complications included conservatively managed events such as wound infection, wound dehiscence, hematoma, fat necrosis, or minor donor-site morbidity. Where reporting terminology varied among studies, complications were reclassified into standardized categories to enhance consistency and comparability across pooled analyses.

Quality assessment and risk of bias

The authors assessed the quality of included studies using validated tools appropriate for each study design. Case series and retrospective case series were evaluated using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Case Series [20], which examines key domains such as inclusion criteria, reporting of demographics, and outcome consistency. For retrospective cohort studies, comparative studies, and retrospective reviews, the Newcastle–Ottawa Scale (NOS) for Cohort Studies was employed [21]. This scale evaluates selection, comparability, and outcome across eight items, with a maximum score of 9; scores of 7–9 indicate low risk of bias, 4–6 moderate, and 0–3 high risk of bias. Prospective cohort studies and prospective case series were assessed using the NIH Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies [22], which covers internal validity domains such as participant selection, measurement reliability, and confounding control. All included studies were also graded according to the American Society of Plastic Surgeons' levels of evidence and recommendation strength [23]. Risk of bias assessments were used to inform interpretation of the pooled results rather than as exclusion criteria for meta-analysis. Given the predominance of retrospective observational studies and the limited number of higher-level designs, sensitivity analyses excluding lower-quality studies were not feasible without substantially reducing statistical power. Accordingly, pooled estimates were interpreted cautiously, taking into account study quality and methodological limitations.

Statistical analysis

Statistical analysis was conducted using R software (R version 4.3.2) with the meta package for meta-analysis calculations, including pooled estimates, forest plots, and heterogeneity assessment via the I^2 statistic. Descriptive statistics were computed, summarizing categorical variables such as study design, flap type, and complications as frequencies and percentages. Continuous variables—patient age, BMI, defect size, operative time, and follow-up duration—were summarized using means and standard deviations for normally distributed data, or medians and interquartile ranges for non-normally distributed data. The number of flaps included in each pooled analysis varied depending on outcome availability, as not all studies reported every endpoint. Accordingly, pooled estimates were calculated using outcome-specific denominators. A supplementary table detailing study contributions to each pooled analysis is provided (Supplementary Table S1).

Pooled proportions with 95% confidence intervals were calculated for primary outcomes, including flap survival, flap failure, partial necrosis, donor site morbidity, and major complications. Binary outcomes were computed as event rates divided by total sample size per study. Between-study heterogeneity was assessed using the I^2 statistic, with values above 50% indicating moderate to high heterogeneity. Statistical significance was set at $p < 0.05$.

Results

Study selection and characteristics

A comprehensive literature search across PubMed (128), Google Scholar (200), EMBASE (29), and Web of Science (39) yielded 396 records. After removing duplicates, 344 records were screened by two independent reviewers using predefined criteria, with disagreements resolved by consensus or a third reviewer. Fifty-four full-text articles were assessed, of which

25 met eligibility. Exclusions at full-text were due to inappropriate design or methodology (n=15), unrelated to head and neck reconstruction (n=10), or lacking relevant outcomes (n=4). These 25 studies, published between 1998 and 2025, were included in the qualitative synthesis [1–10, 12–15, 24–34] (Fig. 1). The studies comprised three designs: retrospective (case series, comparative cohorts, reviews) predominated (80%, n=20), followed by case series including one quasi-experimental study (16%, n=4), and one prospective study (4%). The United States contributed most studies (24%, n=6), followed by Spain (16%, n=4), Japan, China, and Italy (each 12%, n=3). Single studies originated from the United Kingdom, India, Germany, Israel, Canada, and Turkey, with one Spain–USA collaboration. Most studies were single-center (96%, n=24), with only one multi-center study (4%). Table 1 summarizes the basic characteristics of the included studies.

Patient demographics, oncological and clinical indications

Across the 25 included studies, individual sample sizes ranged from 2 to 130 patients, with the pooled flap survival analysis encompassing 480 DIEP flaps from 22 studies. Denominators for other pooled outcomes varied according to data availability, ranging from 360 to 495 flaps. Patient ages ranged from 3 to 85 years, averaging 60±13 years. The reported sex included 250 males and 116 females. Prior radiotherapy was documented in

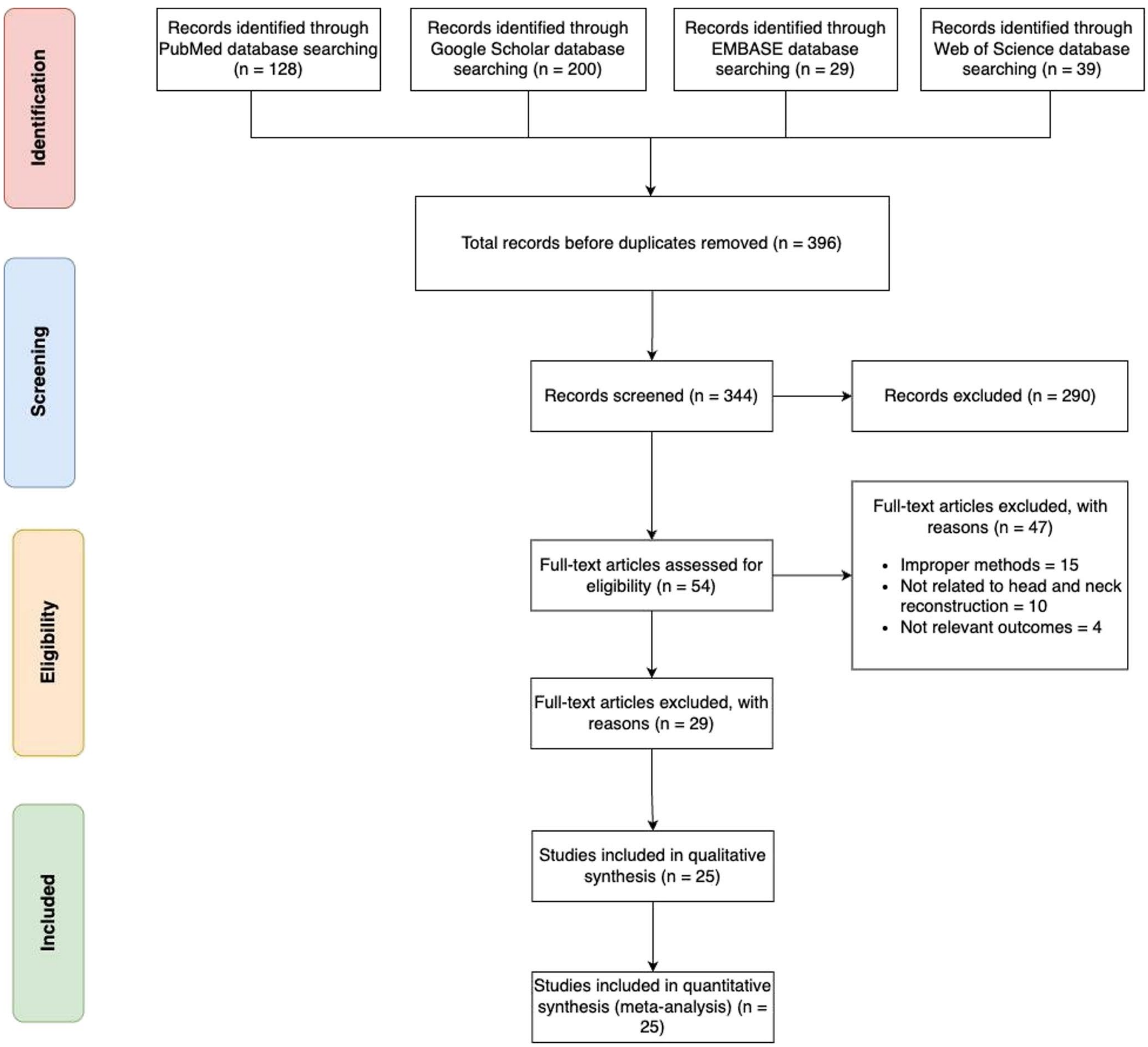

Fig. 1 PRISMA flowchart illustrating the study selection process

Table 1 Summary of included studies detailing study design, country, surgeon specialty, methodological strengths and limitations, clinical recommendations, and level of evidence

Study ID	Journal	Design	Country	Surgeon Specialty	Methodological Strengths	Limitations	Clinical Recommendations
Ibrahim, 2025 [5]	JPRAS Open	Case series	UK	Plastic Surgery	Detailed technique, long follow-up	Small sample, heterogeneous defects	DIEP flaps reliable for complex defects; dual pedicle beneficial
Jaiswal, 2023 [3]	Indian Journal of Plastic Surgery	Case series	India	Plastic Surgery	Novel application, clear inclusion	Small sample, limited outcomes	DIEP flaps viable for selected head and neck reconstructions
Ishida, 2024 [2]	Journal of PRS & Aesthetic Surgery	Retrospective comparative cohort	Japan	Plastic Surgery, ENT	Functional metrics, volumetric CT	Single center, small, retrospective	DIEP preserves volume with comparable complications
Thione, 2023 [9]	Indian Journal of Otolaryngology	Case series	Spain/USA	Plastic Surgery	Clear outcomes, novel indication	Small sample, single center	DIEP and LD flaps valid alternatives when standard options unsuitable
Akita, 2022 [6]	Journal of PRS & Aesthetic Surgery	Simulation + clinical case series	Japan	Plastic Surgery	Validated pedicle simulation tool	Small sample, limited generalizability	Thinned DIEP flaps safe for complex reconstruction
Zhang, 2014 [8]	Microsurgery	Retrospective case series	China	Head and Neck Surgery	Defined outcomes, detailed reporting	Small, single center, retrospective	Perforator flaps viable for skull base defects post tumor resection
Vega, 2011 [1]	Microsurgery	Retrospective case series	Spain	Plastic Surgery, ENT	Systematic functional assessment	Retrospective, no validated tools	Extended DIEP effective for glossectomy defects
Cappiello, 2012 [4]	Eur Arch Oto-Rhino-Laryngology	Retrospective case series	Italy	ENT / Head and Neck Surgery	Precise flap technique	Retrospective, small sample	DIEP-ra effective with lower morbidity for complex defects
López-Arcas, 2012 [7]	Journal of Oral and Maxillofacial Surgery	Retrospective case series	Spain	Maxillofacial Surgery	Consistent flap design, speech outcomes	Small sample, no control	DIEP effective for total glossectomy with good speech, limited swallowing
Leonhardt, 2008 [24]	Journal of Physiology and Pharmacology	Retrospective case series	Germany	Oral and Maxillofacial Surgery	Detailed technique, moderate follow-up	Small, no comparator, retrospective	DIEP reliable alternative to LD and rectus abdominis
Shay, 2025 [25]	Am J Otolaryngol–Head & Neck Medicine	Prospective cohort	USA	Otolaryngology	Novel PET/CT perforator localization	Single surgeon, small sample	PET/CT useful for perforator localization in DIEP harvest
Louie, 2009 [14]	Journal of Reconstructive Microsurgery	Retrospective case series	USA	Plastic Surgery	Detailed case, flap anatomy analysis	Very small, retrospective	DIEP viable for total laryngopharyngectomy, especially cachectic
Clemens, 2009 [13]	Journal of Reconstructive Microsurgery	Retrospective case series	USA	Plastic Surgery	Custom design, novel buried contour	Small sample, varied etiologies	Buried DIEP excellent for soft tissue contour defects
Woodworth, 2006 [12]	Head and Neck	Retrospective case series	USA	ENT	Focus on reduced donor morbidity	Small, retrospective	SCIA
Masià, 2011 [10]	Head and Neck	Retrospective case series	Spain	Plastic Surgery	Large sample, detailed flap types	Retrospective, single center	Extended DIEP versatile for moderate-large defects

Table 1 (continued)

Study ID	Journal	Design	Country	Surgeon Specialty	Methodological Strengths	Limitations	Clinical Recommendations
Miyamoto, 2019 [26]	The Laryngoscope	Retrospective case series	Japan	Plastic & Reconstructive Surgery	Consistent technique, oncologic context	Small, retrospective, single center	DIEP feasible for midface reconstruction
Li, 2015 [27]	Journal of Oral and Maxillofacial Surgery	Retrospective review	China	Oral and Maxillofacial Surgery	Large case series, coupler sizes/times	One DIEP case, limited data	Venous couplers reliable, reduce anastomosis time
Yanko-Arzi, 2014 [28]	Journal of Reconstructive Microsurgery	Retrospective case series	Israel	Plastic Surgery	Rare site, algorithm use	Small, limited generalizability	Free flap safe and effective for posterior neck reconstruction
Hanasono, 2011 [29]	Head and Neck	Retrospective case series	USA	Plastic & Reconstructive Surgery	Aesthetics focus, adipofascial flaps	Few DIEP cases, limited detail	Adipofascial perforator flaps restore contour, improve quality of life
Guerra, 2005 [30]	ENT Journal	Retrospective case series	USA	Plastic Surgery, ENT	Detailed flap-specific complications	Small, retrospective, single center	Perforator flaps reliable, minimize donor morbidity
Beausang, 2003 [15]	Annals of Plastic Surgery	Case series	Canada	Plastic Surgery, ENT	Concurrent flap harvest, detailed design	Small, single center	DIEP reliable for head and neck soft tissue reconstruction
Kostakoglu, 1998 [31]	British Journal of Plastic Surgery	Case series	Turkey	Plastic Surgery	Largest flap sizes, primary closure	Small, varied defects	DIEA skin flap yields large, thin flaps with minimal morbidity
Longo, 2013 [32]	Journal of PRS & Aesthetic Surgery	Prospective case series	Italy	Plastic Surgery	Prospective, functional/aesthetic scoring	Small, single center	Bilobed perforator flaps yield excellent functional/aesthetic results
Cai, 2019 [33]	Research Square (preprint)	Retrospective comparative study	China	Not specified	Comparative, standardized functional scoring	Small DIEP group, retrospective	DIEP flaps yield high patient satisfaction
Almadori, 2015 [34]	Acta Otorhinolaryngologica Italica	Retrospective case series	Italy	ENT, Plastic Surgery	Kaplan-Meier, multivariate analysis	Small DIEP subgroup	Free flaps including DIEP enable aggressive surgery and better outcomes

108 patients (16.2%), smoking in 11 (1.7%), alcohol use in 16 (2.4%), chemotherapy in 1 (0.2%), and postoperative myocardial infarction in 1 (0.2%). BMI ranged from 21.2 to 23.8 kg/m², with a mean of 22.1 ± 2.6 kg/m². Malignant or recurrent tumors were reported in 80% of studies, while 20% included mixed oncological statuses. Squamous cell carcinoma appeared in 72% of studies, adenoid cystic carcinoma in 24%, basal cell carcinoma in 12%, sarcomas in 24%, adenocarcinoma and melanoma each in 8%, and trauma or congenital conditions in 16%.

Defect and flap characteristics

Defect locations were primarily in the oral cavity and adjacent regions, with the tongue and floor of mouth most commonly reconstructed ($n = 10$, 40%), followed by the maxilla ($n = 6$, 24%) and mandible ($n = 5$, 20%). Other sites included the skull base, parotid, pharynx/larynx, scalp, nasal/sinonasal complex, orbit, and neck. Some studies addressed complex or combined anatomical subunits. Defect size was infrequently reported; where available, mean sizes ranged from 26.8 ± 16.7 cm² to 74.5 cm², with ranges spanning 2 × 3 cm to 40 × 18 cm–9 cm² to 240 cm². Vertical flap designs predominated (36%, 9 studies), followed by transverse and extended designs (each 16%, 4 studies). Bilobed, tubed, thinned axial adipose, and custom-shaped flaps were reported in 8% of studies each. Specialized designs such as polygonal, adipofascial, and pre-expanded flaps appeared in 8%. Flap sizes varied broadly, typically between 4 × 5 cm and 30 × 18 cm, averaging approximately 16.7 × 7.2 cm; some studies reported size ranges or surface area, while others omitted these details.

Surgical technique and intraoperative variables

Recipient arteries varied, with the facial artery most commonly used in 8 studies (32%), followed by the superior thyroid artery in 6 studies (24%) and the superficial temporal artery in 3 studies (12%). Other arteries reported included the common carotid, external carotid, and lingual arteries, though several studies did not specify. Recipient veins frequently used were the internal jugular vein (IJV) in 8 studies (32%), external jugular vein (EJV) in 6 studies (24%), and facial vein in 6 studies (24%), with others including superficial temporal and superior thyroid veins; some studies reported multiple veins or did not specify.

Pre-expansion or special techniques were reported in a minority of cases, including tissue expansion (3 patients), one pre-expanded DIEP flap, and perforator mapping via Doppler or PET/CT. Additional methods included zone 4 discard, butterfly flap design, liposuction, venous coupler devices, and osteocutaneous extension; many studies did not report on these techniques. Microsurgical adjuncts appeared in 6 studies (24%), such as indocyanine green angiography, venous couplers, Doppler probes, and implantable Doppler devices; the majority (76%) did not specify usage.

Operative times varied, with mean flap harvest durations from 65 to 115 min and total operative times between 325 and 489 min (approximately 5.5 to 8 h). One study reported an average reconstruction time of 3.1 h, while another recorded a total mean operative time of 12.3 h (range 10.5–23 h). Venous anastomosis time averaged about 6 min. Several studies did not provide operative time data.

Outcomes and complications

The meta-analysis included 25 studies on DIEP free flaps in head and neck reconstruction. Because not all studies reported every outcome, the denominator for each pooled analysis varied (Supplementary Table S1). Among 22 studies encompassing 480 flaps, the pooled flap survival rate was 96% (95% CI, 93%–98%) with no significant heterogeneity ($I^2 = 0.0\%$, $p = 0.967$) (Fig. 2). Flap failure was reported in 19 studies with 360 flaps, showing a pooled failure rate of 3% (95% CI, 2%–6%) and no heterogeneity ($I^2 = 0.0\%$, $p = 0.9997$) (Fig. 3). Partial flap necrosis was reported in 24 studies (435 flaps) with a pooled rate of 2% (95% CI, 1%–5%), also without heterogeneity ($I^2 = 0.0\%$, $p = 1.0000$) (Fig. 4). Major complications occurred in 22 studies (495 flaps) at a pooled rate of 4% (95% CI, 3%–7%), with flap loss reported in 86% of these studies. Venous thrombosis and fistula formation were reported in 19% and 10% of studies as leading cause of flap failure, respectively (Fig. 5). Minor complications were pooled from 20 studies (363 flaps) with a rate of 9% (95% CI, 5%–16%) and low-to-moderate heterogeneity ($I^2 = 16.5\%$, $p = 0.2482$). The most common minor complications were wound infection

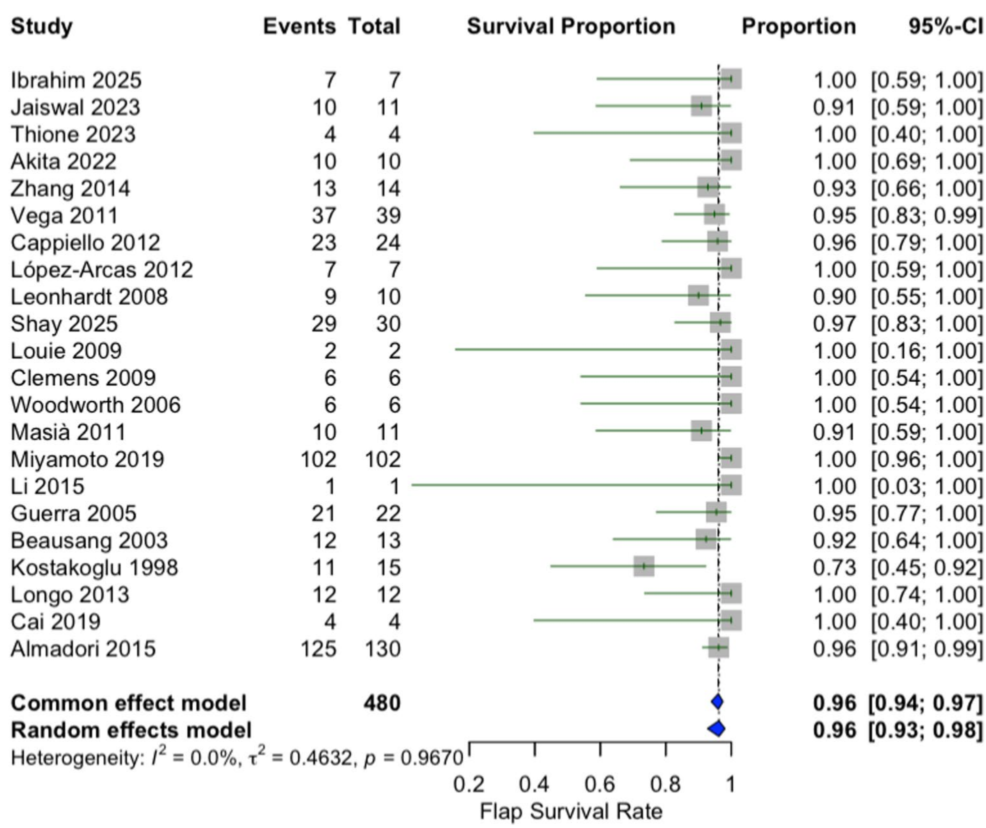

Fig. 2 Forest plot displaying the pooled flap survival rate of DIEP free flaps in head and neck reconstruction across 22 studies, demonstrating a high survival rate of 96% with no significant heterogeneity

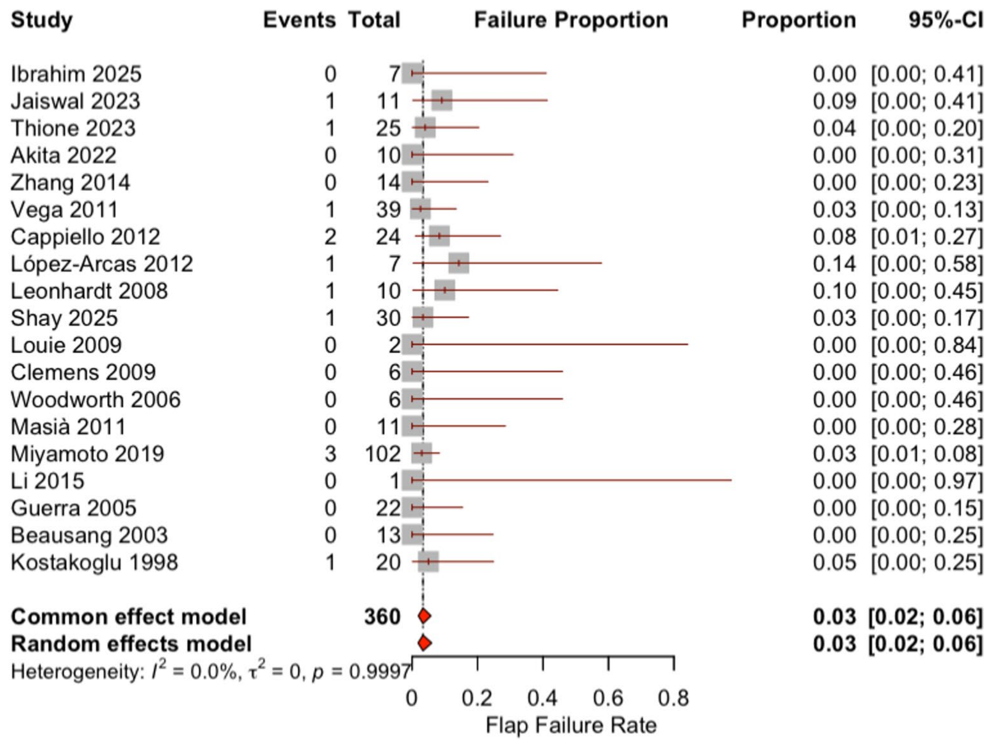

Fig. 3 Forest plot showing the pooled flap failure rate of DIEP free flaps from 19 studies, with an overall failure rate of 3% and no significant heterogeneity

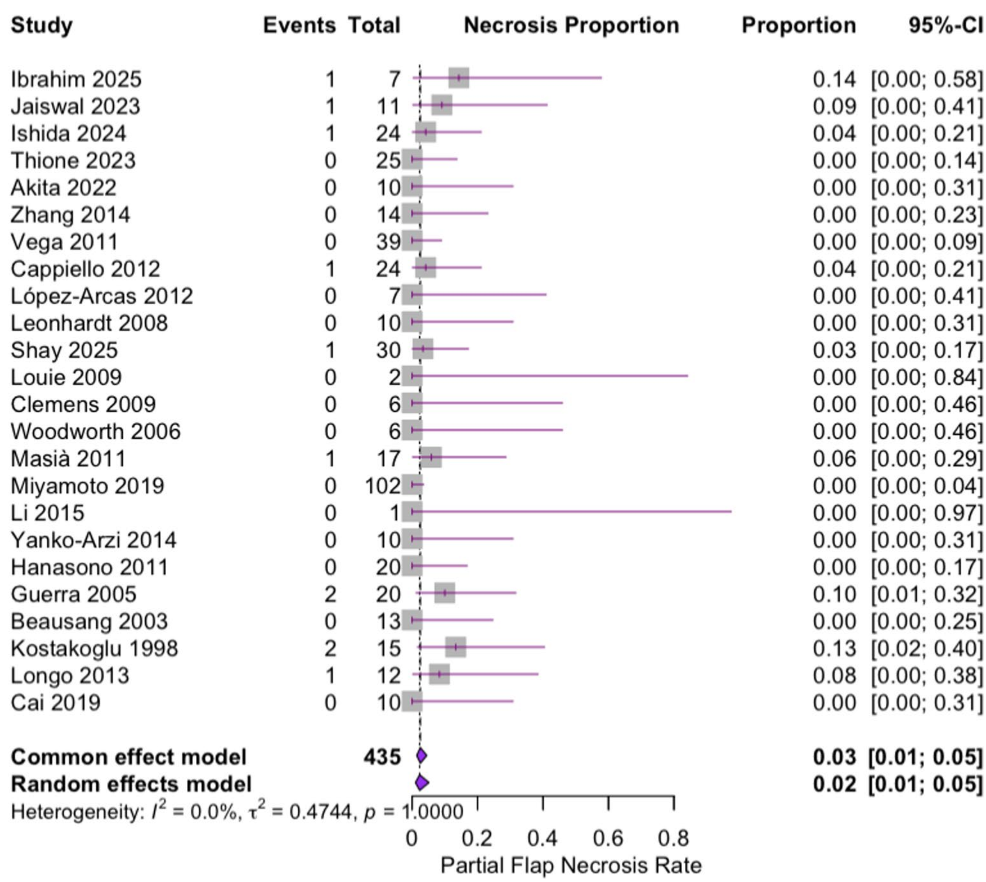

Fig. 4 Forest plot summarizing the partial flap necrosis rate across 24 studies, with a pooled rate of 2% and consistent results across studies

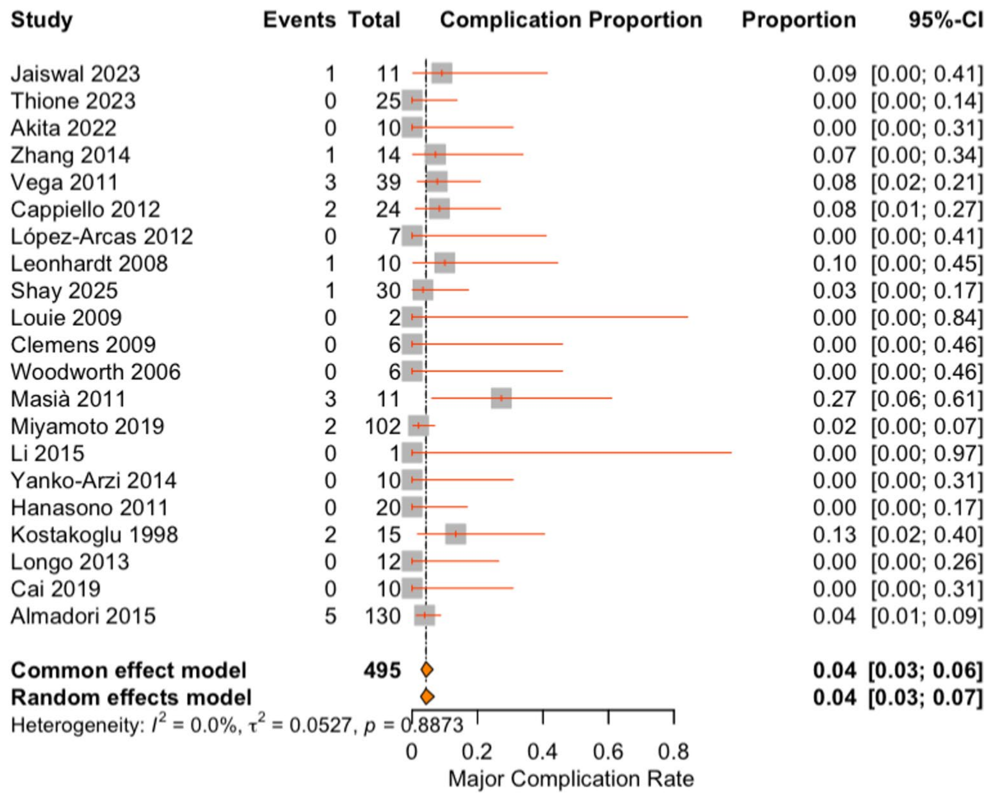

Fig. 5 Forest plot depicting the pooled major complication rate from 22 studies, estimated at 4%, including flap loss, thrombosis, and fistula formation

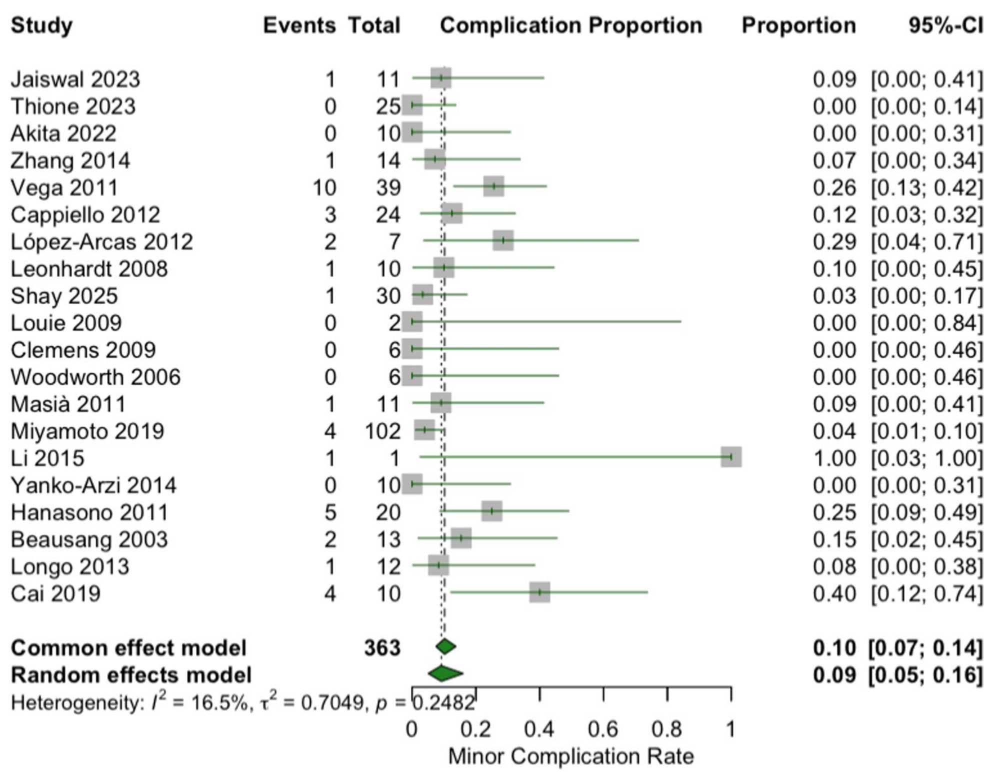

Fig. 6 Forest plot illustrating the pooled minor complication rate from 20 studies, with an overall rate of 9% and low to moderate heterogeneity

(26%), fistula, and wound dehiscence (Fig. 6). Functional outcomes were reported in 10 studies, though definitions and assessment methods varied considerably (Supplementary Table S2). Speech intelligibility was reported in three studies encompassing 64 patients undergoing glossectomy reconstruction: Vega et al. (n=39, 87% good or acceptable), Longo et al. (n=12, 92% normal or acceptable), and Beausang et al. (n=13, intelligible speech in glossectomy patients), yielding an approximate pooled rate of 86%. Oral diet resumption was reported by Vega et al., with 85% of 39 patients tolerating oral intake following total or subtotal glossectomy. Notably, López-Arcas et al. reported that 57% of 7 patients required permanent gastrostomy; however, this cohort consisted exclusively of patients undergoing total glossectomy with complete tongue base resection, representing the most severe end of the defect spectrum. This apparent contradiction between high oral diet resumption and high gastrostomy dependence reflects differences in defect severity across study populations rather than inconsistency in flap performance. Functional recovery following glossectomy is predominantly determined by the extent of resection rather than reconstructive method.

Aesthetic outcomes were reported in 14 studies; 85% described results as good to excellent, and one study reported 100% donor site satisfaction. Minor revisions were needed in about 7% of cases. Pooled complication rates for infection, dehiscence, and thrombosis were approximately 7% ($n=26/363$), 10% ($n=30/305$), and 6% ($n=19/305$), respectively, across 25 studies reporting these outcomes. Patient satisfaction, assessed in 9 studies using various methods, was generally high, with some reporting 100% satisfaction and improved quality of life. Because outcome reporting varied across studies, pooled analyses were conducted using outcome-specific denominators, and only studies reporting a given endpoint were included in each corresponding meta-analysis.

Postoperative management

Postoperative monitoring was mainly clinical (reported in 6 studies, 24%) and Doppler-based (3 studies, 12%), with one study using indocyanine green fluorescence angiography (ICG-FA) and another employing implantable Doppler devices. Follow-up duration varied widely, ranging from 1 to 185 months, with a mean of approximately 23.3 months (SD ~ 16 months).

Level of evidence and bias assessment

The methodological quality of included studies was assessed using design-specific tools. Case series were evaluated using the JBI Critical Appraisal Checklist for Case Series [20]. Thirteen of the seventeen case series demonstrated low risk of bias, with clearly stated inclusion criteria, adequate demographic and clinical data, and transparent outcome reporting. The remaining four studies showed moderate risk due to unclear case selection or incomplete inclusion of eligible participants. Cohort studies were assessed using the NOS for cohort studies [21]. Four of the six studies scored between 7 and 8 out of 9, indicating low risk of bias. These studies met key criteria related to cohort representativeness, outcome assessment, and adequate follow-up. The other two studies scored 5–6, reflecting moderate quality primarily due to limitations in comparability and incomplete follow-up information. Two prospective observational studies were assessed using the NIH Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies [22]. Both were rated as having fair quality, with a moderate risk of bias stemming from the lack of blinding, no adjustment for confounding variables, and the absence of sample size justification. However, both employed clearly defined objectives, standardized measurement methods, and complete follow-up. All studies were additionally categorized according to the ASPS levels of evidence [23]. Out of 25 included studies, 3 were level III, and 22 were level IV, reflecting the predominance of retrospective case series and descriptive designs in the literature (Table 2).

Discussion

This systematic review and meta-analysis evaluated the safety, efficacy, and clinical outcomes of DIEP flaps in head and neck reconstruction. Across 25 included studies, DIEP flaps demonstrated high survival rates (96%), low failure rates (3%), and consistently favorable functional and aesthetic outcomes. These findings consolidate current knowledge and underscore the flap's viability in complex reconstructive scenarios involving the head and neck.

In contrast to the earlier systematic review by Mayo-Yáñez et al., which synthesized a smaller and more heterogeneous body of evidence without quantitative pooling, the present review incorporates a broader and more contemporary literature base and applies meta-analytic methods to provide pooled estimates of flap survival and complication rates, while still acknowledging that heterogeneity in study design and outcome reporting limits high-certainty inference [16]. Several studies support these findings. Masia et al. reported a 97.1% flap survival rate in a multicenter series [10], while Zhang et al. documented a 92% success rate in a heterogeneous cohort of head and neck defects reconstructed with DIEP flaps [11]. Woodworth et al. further emphasized the muscle-sparing advantage of DIEP flaps, citing minimal donor site morbidity and no hernia formation [12]. Several flap options exist for head and neck soft tissue reconstruction, each with reported advantages and limitations. The rectus abdominis musculocutaneous (RAM) flap provides reliable bulk but has been associated with abdominal wall morbidity including weakness and hernia [4, 6]. The anterolateral thigh (ALT) flap offers versatility and a long pedicle but may provide insufficient volume in patients with low subcutaneous fat [4, 6]. The DIEP flap, as a muscle-sparing

Table 2 Risk of Bias Assessment of Included Studies According to Study Design and Validated Appraisal Tools

Study (Author, Year)	Study Design	Bias Assessment Tool Used	Risk of Bias Rating	ASPS Level of Evidence
Ibrahim, 2025 [5]	Case Series	JBI Checklist	Low	IV
Jaiswal, 2023 [3]	Case Series	JBI Checklist	Low	IV
Ishida, 2024 [2]	Cohort Study	NIH Tool	Fair	III
Thione, 2023 [9]	Case Series	JBI Checklist	Low	IV
Akita, 2022 [6]	Case Series	JBI Checklist	Low	IV
Zhang, 2014 [8]	Case Series	JBI Checklist	Low	IV
Vega, 2011 [1]	Case Series	JBI Checklist	Low	IV
Cappiello, 2012 [4]	Case Series	JBI Checklist	Low	IV
López-Arcas, 2012 [7]	Case Series	JBI Checklist	Low	IV
Leonhardt, 2008 [24]	Case Series	JBI Checklist	Low	IV
Shay, 2025 [25]	Cohort Study	NIH Tool	Fair	III
Louie, 2009 [14]	Case Series	JBI Checklist	Low	IV
Clemens, 2009 [13]	Case Series	JBI Checklist	Low	IV
Woodworth, 2006 [12]	Case Series	JBI Checklist	Low	IV
Masià, 2011 [10]	Case Series	JBI Checklist	Low	IV
Miyamoto, 2019 [26]	Case Series	JBI Checklist	Low	IV
Li, 2015 [27]	Case Series	JBI Checklist	Low	IV
Yanko-Arzi, 2014 [28]	Case Series	JBI Checklist	Low	IV
Hanasono, 2011 [29]	Case Series	JBI Checklist	Low	IV
Guerra, 2005 [30]	Case Series	JBI Checklist	Low	IV
Beausang, 2003 [15]	Case Series	JBI Checklist	Low	IV
Kostakoglu, 1998 [31]	Case Series	JBI Checklist	Low	IV
Longo, 2013 [32]	Case Series	JBI Checklist	Low	IV
Cai, 2019 [33]	Cohort Study	NOS	Moderate	III
Almadori, 2015 [34]	Case Series	JBI Checklist	Low	IV
Summary	———	———	———	**Level III: 3 (12%); Level IV: 22 (88%)**

alternative, theoretically reduces donor site morbidity while providing adequate soft tissue volume [2, 4, 6]. However, it is important to note that direct comparative studies evaluating functional and aesthetic outcomes among these flap types in head and neck reconstruction are lacking. The single comparative study included in this review (Ishida et al., 2024) compared DIEP to RAM flaps for glossectomy reconstruction and reported comparable complication rates with potential advantages in volume preservation for DIEP flaps, though the sample size was limited. Accordingly, current evidence does not establish the superiority of any single flap type, and flap selection should be individualized based on defect size and location, patient body habitus, prior surgical history, and surgeon expertise.

These results suggest that DIEP flaps represent a feasible reconstructive option for selected head and neck defects when surgeon expertise and patient factors are appropriate [2, 4, 6, 10, 11]. Their versatility in design enables precise tailoring to complex anatomical defects, which may improve functional and cosmetic outcomes [8, 14].

The observed low statistical heterogeneity ($I^2 = 0\%$ for most outcomes) warrants cautious interpretation, as it may not reflect true homogeneity given the substantial clinical diversity among included studies. Several methodological factors may explain this finding. First, publication bias may have led to preferential reporting of successful cases, thereby narrowing the range of observed outcomes. Second, selective outcome reporting, whereby complications are inconsistently documented or underreported, may have artificially reduced variability across studies. Third, the reliance on narrow binary outcome definitions (e.g., flap survival vs. failure) rather than graded or continuous measures may have obscured heterogeneity that would be apparent with more granular assessments of partial necrosis, functional recovery, or aesthetic outcomes. Fourth, small study effects, characterized by imprecise estimates from limited sample sizes, can conceal underlying heterogeneity, as confidence intervals from individual studies may overlap substantially despite true differences in effect. Consequently, pooling clinically diverse observational studies carries inherent methodological limitations, and the low I^2 values should not be interpreted as evidence of consistent treatment effects across all clinical contexts.

Future studies should directly compare functional outcomes—particularly speech and swallowing—among DIEP, ALT, and RAM flaps in head and neck reconstruction using standardized assessment methods [2, 4]. In the present review, functional outcomes were inconsistently reported across studies, often derived from small patient subsets, and assessed using heterogeneous methods without validated instruments. The high gastrostomy dependence rate observed in total glossectomy cohorts underscores that functional recovery is predominantly determined by defect extent and location rather than flap selection, highlighting the need for standardized and stratified outcome reporting in future investigations. In addition, the use of adjuncts such as PET/CT imaging for preoperative planning and perforator mapping merits attention [8, 25]. This review is, to our knowledge, the first to provide a quantitative meta-analysis focused exclusively on DIEP flaps in head and neck reconstruction. The study followed a comprehensive search strategy and adhered closely to PRISMA guidelines. Independent screening and data extraction by two reviewers minimized selection bias. Several important limitations should be acknowledged, as they affect the interpretation of our findings. First and most critically, the evidence base is composed predominantly of retrospective, single-center case series (22 of 25 studies, Level IV), with only 3 comparative cohort studies (Level III), resulting in an overall classification of Level III–IV evidence. This fundamental limitation prevents causal conclusions from being drawn and limits the certainty of all reported outcomes. Second, the lack of comparative or controlled studies precludes meaningful conclusions about the relative effectiveness of DIEP flaps compared with other reconstructive options such as ALT or RAM flaps. Third, selection bias is likely, as patients were often selected based on defect characteristics and surgeon preference, which may have led to overestimation of favorable outcomes. Fourth, there was substantial variation in how outcomes were defined and reported, particularly for functional recovery, aesthetic outcomes, and donor-site morbidity, which limited meaningful data synthesis and detailed comparison. Fifth, follow-up duration was often short or inconsistently reported, reducing confidence in long-term outcome assessment. Sixth, although statistical heterogeneity was low for several pooled outcomes, this may reflect the methodological factors discussed above rather than true clinical homogeneity. Finally, publication bias cannot be excluded, as studies with positive results are more likely to be published, potentially inflating reported survival and success rates.

Taken together, the findings support broader clinical use of DIEP flaps for head and neck reconstruction in appropriate candidates. Future research should prioritize prospective, multicenter trials comparing DIEP to other flap types using standardized outcome measures and validated quality-of-life instruments. Emphasis on long-term follow-up will be critical to guide evidence-based surgical decision-making.

Conclusion

This systematic review and meta-analysis suggests that DIEP flaps represent a reliable and effective option for head and neck reconstruction, with high reported survival rates, low complication profiles, and generally favorable functional and aesthetic outcomes. The muscle-sparing nature of the flap is associated with minimal donor-site morbidity, supporting its use in patients requiring moderate to large soft-tissue reconstruction. Despite concerns regarding flap bulk and technical demands, the available evidence indicates that DIEP flaps may be considered in appropriately selected cases. However, the current literature is limited by predominantly retrospective study designs, small sample sizes, and heterogeneity in outcome reporting. Future prospective, multicenter comparative studies are warranted to confirm these findings and to further refine flap selection based on standardized functional outcomes, patient-reported satisfaction, and long-term quality-of-life measures.

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Declarations

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