

Dental Implants on Free Deep Circumflex Iliac Artery (DCIA) Flaps: A Contemporary Systematic Review

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Abstract

Background: Implant-driven reconstruction has become a key objective in contemporary maxillofacial surgery. While the fibula flap is considered the standard option, the deep circumflex iliac artery (DCIA) flap has gained renewed interest due to its favorable bone characteristics. This study aimed to evaluate the outcomes of implant-prosthetic rehabilitation in patients reconstructed with DCIA flaps. **Methods:** A systematic review was conducted according to PRISMA guidelines. The MEDLINE, Embase, and Cochrane Library databases were searched up to June 2026. Studies reporting DCIA flap reconstruction associated with dental implant placement were included. A pooled descriptive analysis of implant-related outcomes was performed. **Results:** Sixteen studies were included, accounting for 348 DCIA flaps and 543 implants with complete datasets. Reconstruction most frequently involved the mandible and was predominantly performed in a primary setting. The pooled implant failure rate was 5.0%, although this rate is not equivalent to a time-dependent implant survival estimate. CAD/CAM technologies were reported in 35% of cases. **Conclusions:** The DCIA flap represents a reliable option for implant-driven jaw reconstruction, offering favorable bone volume, adaptable height, and anatomical curvature suitable for prosthetic rehabilitation. Implant survival rates are comparable to those of other vascularized bone flaps. The integration of digital technologies may further enhance surgical precision and expand its clinical indications. Careful patient selection remains essential to optimize outcomes.

Keywords: DCIA flap; iliac crest free flap; jaw reconstruction; dental implants; implant-prosthetic rehabilitation; microsurgery; CAD/CAM; virtual surgical planning

Academic Editor: Amaury Pozos-Guillen

Received: 25 March 2026

Revised: 2 October 2026

Accepted: 18 October 2026

Published: 28 October 2026

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1. Introduction

Functional oral rehabilitation such as dental implants must be regarded as an integral component of oncologic and reconstructive treatment trajectories rather than a delayed secondary phase. Apart from the fundamental restoration of mandibular or maxillary continuity, modern surgical reconstruction aims to systematically recover complex physiological functions, including mastication, speech, esthetics, and overall quality of life, through the implementation of prosthetically guided bone reconstruction.

In this perspective, vascularized osseous free flaps remain the gold standard of reconstruction for extensive maxillofacial defects, particularly those resulting from radical tumor ablation, advanced osteonecrosis, high-energy trauma, or complex benign pathologies [1–5]. Among the most common osseous free flaps available, the fibula flap is still widely regarded as the preferred choice because of its long vascular pedicle, significant segmental versatility, and high degree of reproducibility. However, the selection of the donor site should not be driven by surgical preference alone; rather, it must be suited to the specific morphological and reconstructive requirements of each individual patient. These factors include the three-dimensional defect geometry, specific soft tissue requirements, the availability of suitable recipient vessels, and the long-term feasibility of successful implant-prosthetic rehabilitation.

The deep circumflex iliac artery (DCIA) flap remains a suitable and highly viable alternative, especially when substantial vertical bone height and a naturally curved osseous profile are desirable to replicate the native alveolar anatomy [6–8]. Furthermore, it allows for the harvesting of significant amounts of soft tissue, possibly even in a chimeric fashion, ensuring excellent management of complex cervicofacial defects [9–12].

The DCIA flap offers several distinctive characteristics that make it particularly interesting for implant-based rehabilitation [13,14]. It provides a robust volume of high-quality bone, a natural curvature that may facilitate both mandibular and selected maxillary reconstructions, and the possibility of harvesting a composite flap, including the internal oblique muscle when additional soft tissue bulk is required. However, its clinical use has historically been limited by persistent concerns regarding donor-site morbidity, relatively short pedicle length, and high technical complexity. For these reasons, the DCIA flap has often been considered a niche solution rather than a first-line workhorse [15–19].

Despite these clear advantages, scientific literature specifically addressing implant-prosthetic rehabilitation following DCIA flap reconstruction remains incredibly limited and fragmented. Most available studies are retrospective in nature, frequently include highly heterogeneous clinical indications, and often report implant-related outcomes merely as secondary endpoints. Consequently, the definitive role of the DCIA flap in implant-driven jaw reconstruction is still incompletely defined in the evidence-based hierarchy.

Historically, one of the key outcomes in cases of major reconstruction using free bone flaps was the survival of the flap itself. Micro-reconstructive surgery is now considered standard practice internationally, and flap survival can be regarded as an unquestionable prerequisite, barring justified complications. For this reason, it is now possible to focus not only on functional aspects, but also on esthetic ones. Simply restoring facial contour or skeletal continuity, without adequate occlusal rehabilitation, leaves the patient with severe masticatory, phonatory and esthetic impairment. Prosthetic rehabilitation is now considered as an integral part of the oncological and reconstructive treatment pathway, rather than a secondary, optional or deferred phase. In conclusion, the absence of teeth and the inability to chew solid foods lead to nutritional deficiencies, weight loss and a serious psychological impact linked to body image perception. Restoring the dento-skeletal unit reduces overall healing times and speeds up the patient's return to a life of acceptable quality.

The aim of this systematic review was therefore to evaluate the available evidence on dental implant placement and implant outcomes in patients reconstructed with free DCIA flaps, focusing on reconstructive indications, long-term implant-related outcomes, the timing of rehabilitation, the possible influence of adjuvant radiotherapy, and the transformative contribution of digital technologies to contemporary surgical planning.

2. Materials and Methods

This study was designed as a systematic review with quantitative pooled analysis and was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [20]. The present results are reported in accordance with PRISMA checklists (Figure 1). The study was registered via the Open Science Framework (OSF) public registry (registration date: 3 June 2026; registration DOI: <https://doi.org/10.17605/OSF.IO/TPXQY>). The review aimed to summarize the current evidence regarding implant-prosthetic outcomes performed on free DCIA flaps used for maxillary or mandibular reconstruction.

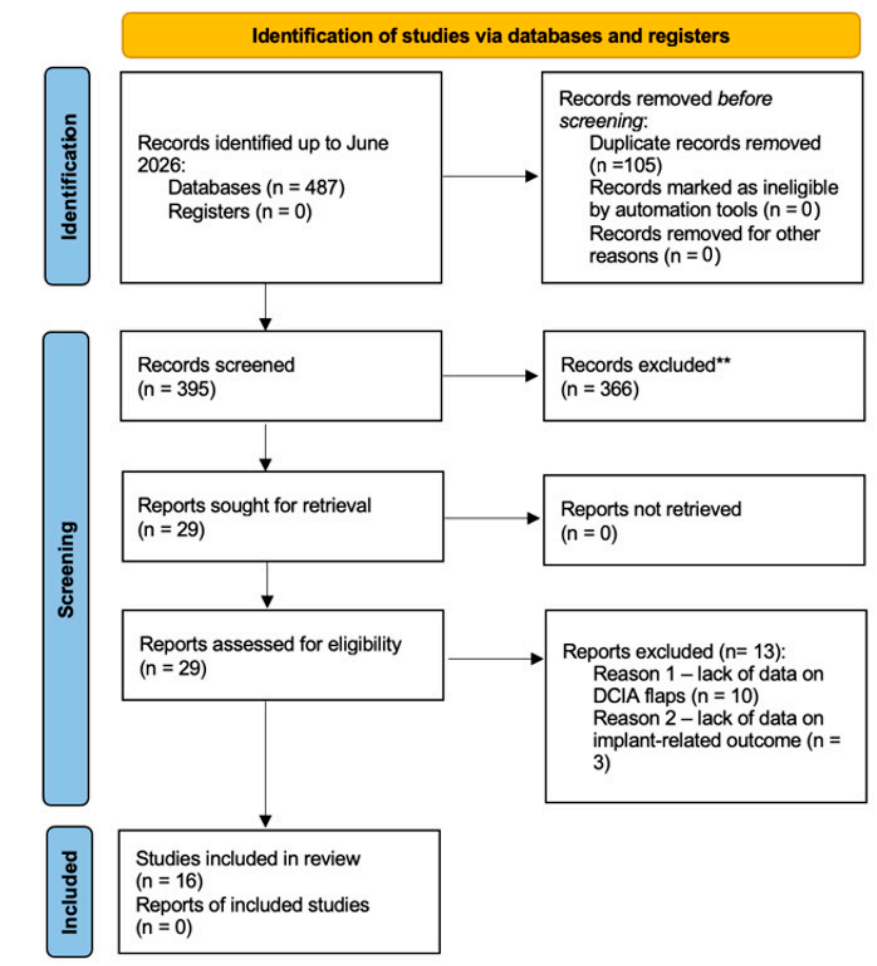


Figure 1. PRISMA 2020 flow diagram for new systematic reviews that included searches of databases and registers only [20]. ** Articles were excluded if they did not provide extractable data specific to DCIA flaps.

2.1. Study Eligibility Criteria

The eligibility criteria were defined according to the PICO framework. The population included patients undergoing maxillary or mandibular reconstruction with a free DCIA flap. The intervention of interest was dental implant placement, either immediate or delayed, followed by implant-prosthetic rehabilitation and outcomes when reported. No formal comparator was required for study inclusion. The main outcomes of interest were implanting survival or failure, timing of implant placement, timing of reconstruction, radiotherapy exposure, reconstructive site, use of digital workflow or

CAD/CAM technologies, and reported complications. Studies were included if they were peer-reviewed full-text articles in English reporting original clinical data on DCIA flap reconstruction associated with dental implant placement. Case series, retrospective studies, cohort studies, and comparative studies were considered eligible. Articles were excluded if they did not provide extractable data specific to DCIA flaps, did not report implant-related outcomes, or were reviews, technical notes without clinical outcomes, conference abstracts, or non-English publications. In cases involving mixed populations (for example, multiple flap types including the DCIA flap), the data were extracted, considering only the flap on which this quantitative pooled analysis focuses, namely the DCIA flap.

2.2. Search Strategy

A systematic literature search was performed in MEDLINE, Embase, and the Cochrane Library for studies published up to June 2026. PubMed was used as the search interface for MEDLINE. In addition, the reference lists of all included articles were manually screened to identify further eligible studies. The search strategy was developed to capture publications focused on DCIA flap reconstruction and dental implant outcomes in the maxillofacial setting. A representative search strategy was structured around combinations of the following terms: “deep circumflex iliac artery flap”, “DCIA flap”, “iliac crest free flap”, “DCIA/iliac crest”, “jaw reconstruction”, “mandibular reconstruction”, “maxillary reconstruction”, “dental implants”, “implant rehabilitation”, and “prosthetic rehabilitation”. The following search string was also used on the PubMed search engine: “(“Free Tissue Flaps” [Mesh]) AND “Dental Implants” [Mesh]”; the search string used for Embase was ““dental prosthesis and implant/exp AND ‘free tissue graft/exp”, and for Cochrane Library was “dental prosthesis and implant: ti, ab, kw AND free tissue graft: ti, ab, kw.” After database searching, all records were imported into a reference management system, and duplicates were removed before screening.

2.3. Study Selection

Two reviewers independently screened all retrieved records in two sequential phases. In the first phase, titles and abstracts were reviewed for potential eligibility. In the second phase, the full texts of potentially relevant studies were assessed in detail. Only studies with a complete English text were selected. Disagreements between reviewers were resolved by discussion, and when necessary, by consultation with a third reviewer. The study selection process was summarized in a PRISMA flow diagram.

2.4. Data Extraction

Data extraction was independently performed by two reviewers using a standardized electronic form. Only data specifically attributable to DCIA flaps undergoing implant placement were collected. The extracted variables included first author, year of publication, study design, country, number of DCIA flaps, number of patients receiving implants, reconstructive site, timing of reconstruction, number of implants, timing of implant placement, prosthetic rehabilitation timing when available, adjuvant radiotherapy, use of CAD/CAM or digital workflow, follow-up duration, implant failure, and reported complications. Where studies reported mixed cohorts including other flap types, only the DCIA-specific subgroup was retained for analysis.

2.5. Quality Assessment

Methodological quality and risk of bias of the included studies were assessed using the Joanna Briggs Institute (JBI) checklist for systematic reviews (Figure 2), adapted as appropriate to the predominantly retrospective design of the available literature [21]. The

checklist was compiled by two independent reviewers, and in case of disagreement, those were resolved by discussion.

2.6. Data Synthesis and Statistical Analysis

A pooled descriptive analysis was performed for the main variables of interest. Categorical variables were summarized as frequencies and percentages, whereas continuous variables were summarized using means and ranges when reported. Implant failure rate was calculated based on studies providing extractable implant-level data. Subgroup descriptive comparisons were planned according to reconstructive site, timing of reconstruction, timing of implant placement, and radiotherapy exposure. Due to the heterogeneity of study design and outcome reporting, a pooled descriptive analysis was performed. Statistical analyses were conducted using IBM SPSS Statistics 32. A two-sided p value < 0.05 was considered statistically significant.

3. Results

A total of 487 records were initially identified through database searching. After removal of duplicates and the addition of 13 articles identified through manual searching (as these articles were already known to the authors; therefore, they were directly analyzed), 395 records were screened based on title and abstract. Of these, 29 full-text articles were assessed for eligibility, and 16 studies met the inclusion criteria and were included in the final analysis [22–37]. Thirteen studies were excluded due to a lack of relevant data on DCIA flaps or implant-related outcomes. The study selection process is summarized in Figure 1. All included studies were single-center retrospective studies or case series published between 2000 and 2026. A total of 826 patients were reported across the selected studies, of whom 348 underwent reconstruction with a free DCIA flap. Among these, 162 patients received dental implant placement and were included in the implant-related analysis. Demographic data were available for 135 patients, including 83 males (61.0%) and 52 females (39.0%), with a mean age of 45 years (range: 25–60.2 years). In 27 cases, demographic data was not reported. Reconstruction most frequently involved the mandible (120 cases, 89.6%), while the maxilla was involved in 14 cases (10.4%) (Figure 3). The reconstructive site was not specified in 28 patients (17.3%). Information regarding the timing of reconstruction was available for 149 patients, of whom 142 (95.3%) underwent primary reconstruction and 7 (4.7%) underwent delayed reconstruction. Adjuvant radiotherapy was reported in 48 patients (32.7% of cases with available data). The mean length of the reconstructed segment was 7.2 cm, and most reconstructions were performed using a single-segment flap without the need for additional osteotomies. Although a total of 766 implants were reported across all included studies, only 543 implants with complete datasets and analyzable documentation were included in the quantitative analysis. The mean number of implants per patient was 4.0 (543 implants/135 patients). Regarding the timing of implant placement, 63 patients (38.9%) underwent immediate implant placement, while 99 patients (61.1%) received delayed implant rehabilitation, with a mean interval of 10.7 months. The distribution of implant placement timing and pooled implant failure rate is illustrated in Figure 4. The use of CAD/CAM technology was reported in 35.2% of cases where this information was available (Figure 5). The pooled implant failure rate was 5.0%, although this rate is not equivalent to a time-dependent implant survival estimate due to the different follow-up periods and possible different definitions of implant failure. Given the relatively limited number of failures, missing data across studies, and marked heterogeneity among the included reports, no association could be demonstrated with the currently available evidence between implant failure and timing of implant placement, timing of reconstruction, or exposure to radiotherapy. The mean follow-up duration was 37.5 months. None of the included

studies specifically focused on patient-reported outcomes or quality of life following DCIA reconstruction and implant-prosthetic rehabilitation. The main findings of the systematic review are summarized in Figures 3 and 4.


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JBIC Critical Appraisal Checklist for Systematic Reviews and Research Syntheses

Reviewer M.F., G.P. Date June 2026

Author Di Giorgio et al Year 2026 Record Number _____

	Yes	No	Unclear	Not applicable
1. Is the review question clearly and explicitly stated?	☒	☐	☐	☐
2. Were the inclusion criteria appropriate for the review question?	☒	☐	☐	☐
3. Was the search strategy appropriate?	☒	☐	☐	☐
4. Were the sources and resources used to search for studies adequate?	☒	☐	☐	☐
5. Were the criteria for appraising studies appropriate?	☒	☐	☐	☐
6. Was critical appraisal conducted by two or more reviewers independently?	☒	☐	☐	☐
7. Were there methods to minimize errors in data extraction?	☒	☐	☐	☐
8. Were the methods used to combine studies appropriate?	☐	☒	☐	☐
9. Was the likelihood of publication bias assessed?	☒	☐	☐	☐
10. Were recommendations for policy and/or practice supported by the reported data?	☐	☒	☐	☐
11. Were the specific directives for new research appropriate?	☒	☐	☐	☐

Overall appraisal: Include ☒ Exclude ☐ Seek further info ☐

Figure 2. The Joanna Briggs Institute (JBI) checklist for systematic reviews and research syntheses [38].

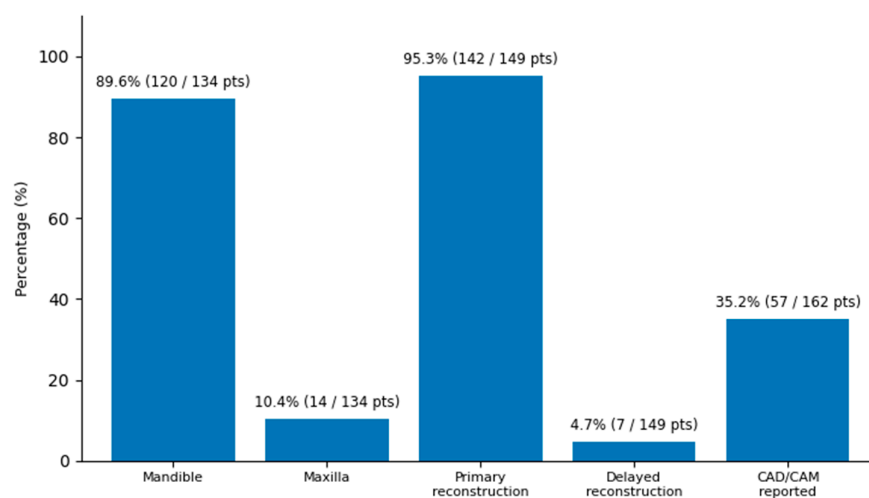


Figure 3. Distribution of reconstruction site, reconstruction timing, and reported use of CAD/CAM technologies including DCIA flap cases.

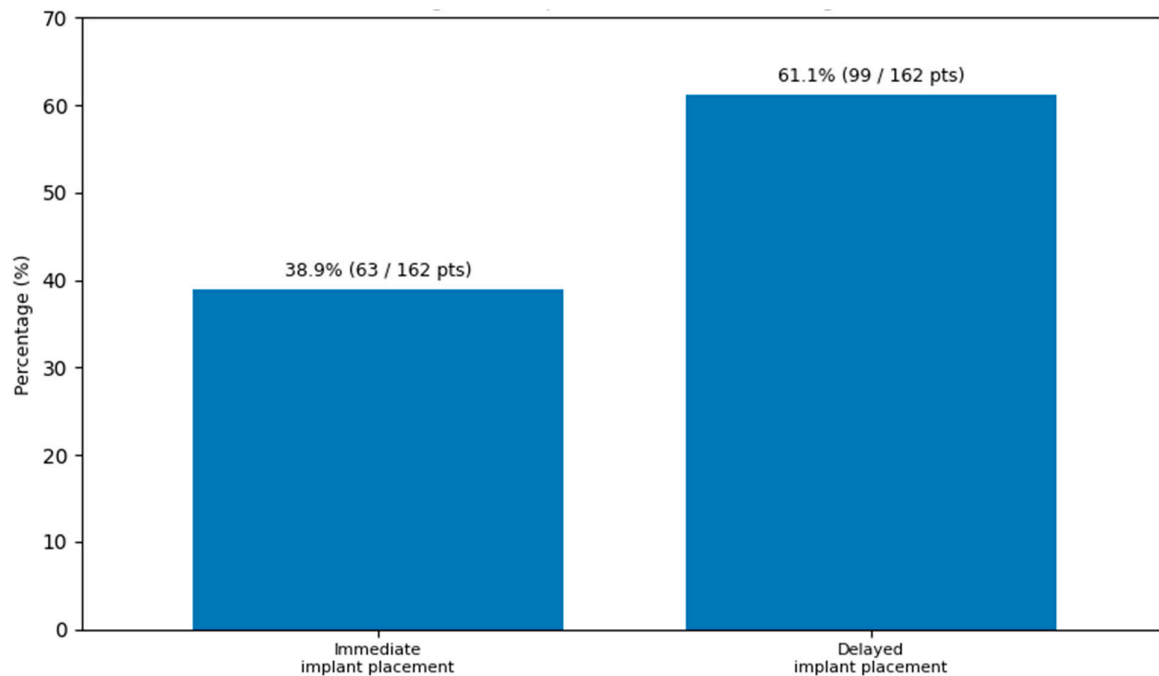


Figure 4. Distribution of immediate versus delayed implant placement in DCIA flap reconstruction.

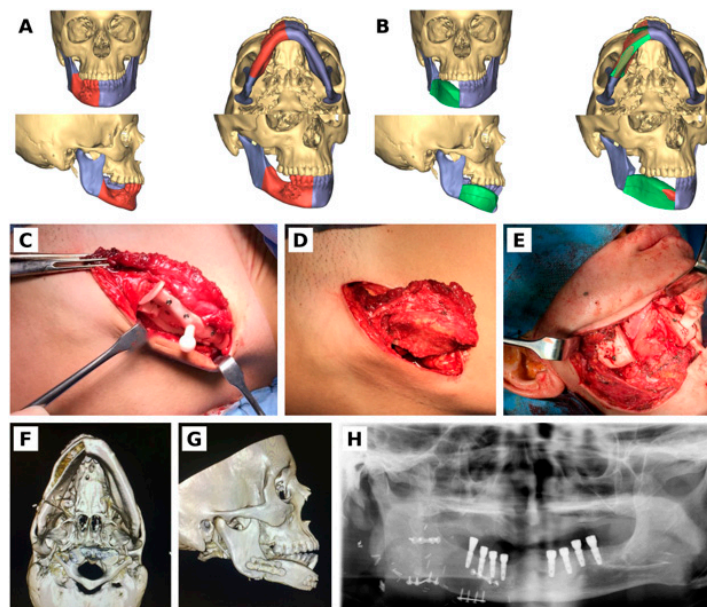


Figure 5. A multi-panel figure illustrative case, showing the preoperative virtual plan (A,B) intraoperative flap positioning (C–E), and the final prosthetic result (F–H) [39].

4. Discussion

This systematic review highlights the role of the DCIA flap as a reliable option for implant-driven jaw reconstruction, showing favorable outcomes and implant survival rates and specific anatomical advantages that may support prosthetic rehabilitation. From a reconstructive perspective, the DCIA flap provides significant vertical bone height, which can reach up to 5 cm, as well as adequate width and a natural curvature that closely resembles the native mandibular and, in selected cases, maxillary anatomy. These characteristics facilitate implant placement and prosthetic-driven reconstruction,

particularly when compared to the fibula flap, whose vertical height is limited and requires more complex multi-segment osteotomies [40]. In the present analysis, the mean defect length was 7.2 cm, and most reconstructions were performed using a single-segment flap, reducing operative time, simplifying fixation, and potentially lowering complication rates [41].

Another relevant advantage of the DCIA flap is the quality and quantity of corticocancellous bone, which is particularly suitable for implant osseointegration [42,43]. In the present review, the pooled implant failure rate was 5.0%, which is comparable to that reported for fibula and scapula free flaps, taking all necessary precautions in analyzing these data [44–47]. The possibility of harvesting a composite flap including internal oblique muscle further expands its indications, allowing improved soft tissue management and potentially reducing complications such as oro-cervical fistulas [48,49]. However, the DCIA flap is not without limitations. The relatively short vascular pedicle, typically ranging from 8 to 10 cm, may limit its use in vessel-depleted necks or in cases requiring simultaneous neck dissection [50]. In such scenarios, contralateral anastomosis or alternative flaps may be required [51]. Additionally, donor-site morbidity remains a concern, particularly in elderly patients, where reduced mobility and the risk of abdominal wall complications must be carefully considered [52]. Emerging approaches, such as single-stage reconstruction with immediate implant placement (“Jaw in a Day”), further support the role of DCIA flaps in implant-driven protocols [53–55]. In the present analysis, immediate implant placement was performed in a substantial proportion of patients and did not appear to negatively affect implant survival. This strategy may significantly reduce rehabilitation time and improve patient-perceived outcomes, particularly in oncological settings [56]. Despite these promising findings, several limitations must be acknowledged. The available literature is predominantly retrospective and heterogeneous, with incomplete reporting of relevant risk factors such as smoking, oral hygiene, and detailed radiotherapy protocols. These factors are known to influence both oral cancer development and implant survival [57]. Moreover, patient-reported outcomes and quality-of-life measures are largely absent [58], limiting the ability to fully assess the functional impact of reconstruction. From a clinical perspective, flap selection should be individualized. While the fibula flap remains the most versatile option, the DCIA flap may represent a valid choice in selected cases where vertical bone height, anatomical curvature, and implant-driven reconstruction are primary goals. Careful patient selection, thorough preoperative planning, and integration of digital technologies are key factors in optimizing outcomes.

5. Limitations

This systematic review has several limitations that should be acknowledged. First, the available literature specifically addressing implant-prosthetic rehabilitation on DCIA flaps is limited, resulting in a relatively small number of included studies and heterogeneous datasets. This scarcity of focused evidence restricts the robustness of the conclusions, particularly regarding implant-related risk factors and the influence of different clinical variables. Second, most of the included studies were retrospective case series, with inherent risks of selection bias, incomplete data reporting, and variability in outcome definitions. As shown by the JIB checklist, the overall level of evidence remains limited. Another important limitation is the lack of standardized reporting of clinically relevant variables, such as smoking status, oral hygiene, implant characteristics, and detailed radiotherapy protocols, all of which may significantly influence implant survival and long-term outcomes. Furthermore, patient-centered outcomes were largely absent in the analyzed studies. In particular, no study specifically evaluated the impact of implant-prosthetic rehabilitation on temporomandibular joint function, speech, mastication, and

overall quality of life. As highlighted in the literature on other reconstructive flaps, such as fibula and scapula flaps, occlusion-driven rehabilitation may have a significant functional and psychosocial impact. Finally, the heterogeneity in study design, surgical techniques, and reporting methods limited the possibility of performing a formal meta-analysis, and therefore the present results should be interpreted with caution. The term quantitative pooled analysis is far more appropriate for this type of systematic review. Furthermore, thirteen studies were identified through manual searching, which suggests that the database search strategy may not have captured the whole body of relevant literature; nevertheless, all studies were included following the same predefined criteria. Finally, it should be stated that the registration via Open Science Framework (OSF) public registry (registration date: 3 June 2026) is defined as Generalized Systematic Review Registration, classified as a retrospective registration.

6. Conclusions

The objective of contemporary maxillofacial reconstruction has undergone a profound evolution, transitioning from the simple restoration of anatomical continuity to the achievement of comprehensive implant-prosthetic rehabilitation. With this in mind, the DCIA free flap has emerged not merely as an alternative, but as a sophisticated and reliable option for implant-driven jaw reconstruction. Its clinical utility is based on a combination of favorable bone volume, adaptable vertical height, and a natural anatomical curvature that closely mimics the native alveolar ridge, providing a superior foundation for dental prosthetic loading compared to more linear donor sites. The flap's bone height—often reaching up to 4 or 5 cm—bypasses the need for complex “double-barrel” techniques frequently required with the fibula flap to achieve sufficient height for a functional prosthetic plane. Furthermore, clinical data indicates that implant placement in DCIA-reconstructed jaws is associated with high survival rates, which are statistically comparable to the more traditional fibula or scapula free flaps. Crucially, these survival outcomes do not appear to be significantly compromised by external variables such as adjuvant radiotherapy, surgical timing, and implantation timing.

Beyond its superior osseous characteristics, the versatility of the DCIA flap extends to its composite potential. The ability to harvest the internal oblique muscle along with the iliac crest allows for the simultaneous reconstruction of significant soft tissue deficits, and furthermore, this muscular bulk contributes to a measurable reduction in severe postoperative complications, such as oro-cervical fistulas.

The integration of digital technologies has acted as a catalyst for the resurgence of the DCIA flap. Virtual Surgical Planning (VSP) and CAD/CAM-assisted templates have effectively mitigated the traditional challenges associated with the flap's technical complexity. By utilizing patient-specific cutting guides and pre-bent plates, surgeons can achieve highly predictable flap contouring that fits the defect with millimetric precision; optimized intraosseous implant positioning, ensuring that the bone is harvested and shaped specifically to accommodate the planned prosthesis; and a significant reduction in total ischemia and operative times.

Despite these advantages, the DCIA flap harvest is a technically demanding surgery and necessitates a thorough preoperative evaluation of the donor site, particularly in elderly patients where abdominal wall integrity and postoperative mobility are primary concerns. Additionally, the relatively short vascular pedicle requires meticulous microsurgical planning, often necessitating the use of specific recipient vessels or vein grafts in vessel-depleted necks. In conclusion, considering the overall low level of the evidence, the DCIA flap could represent a more than valid alternative to the fibula flap in selected clinical scenarios, such as cases when vertical bone height, anatomical curvature, and a long-term, implant-driven prosthetic goal are the primary objectives of the

reconstructive team. As digital workflows become more universal, the predictability and clinical indications for the DCIA flap are expected to expand, further cementing its role in the top tier of maxillofacial reconstructive options.

7. Future Directions

Future developments in DCIA-based reconstruction will likely be driven by advances in digital technologies, biomaterials, and outcome standardization. First, the integration of digital workflows into surgical planning represents a key area of progress. Virtual surgical planning, CAD/CAM technologies, and patient-specific guides are increasingly being adopted in maxillofacial surgery, offering improved precision, reproducibility, and efficiency. These tools can optimize both flap harvesting and implant positioning, potentially reducing operative time and improving functional outcomes. Second, further research into biomaterials and bone biology is warranted. Advances in implant surface technology, osteosynthesis materials, and bone healing modulation may contribute to enhancing osseointegration and reducing implant failure rates. In any case, the extremely limited amount of data available on this specific topic highlights the need for short-term, multicenter, prospective studies, in which the success and failure rates of prosthetic rehabilitation using implants are standardized, as well as cost-effectiveness analyses. Finally, further studies are needed that directly compare DCIA, fibula flaps and scapular free flaps. By exploring these aspects in greater depth and defining reproducible and standardizable outcomes, research in this field could certainly be carried out to a higher standard. Finally, the development of standardized data collection protocols and reporting guidelines would improve the comparability of studies and facilitate higher-quality evidence synthesis. The implementation of core outcome sets for maxillofacial reconstruction may represent an important step toward more robust and clinically meaningful research.

Author Contributions: Conceptualization, M.D.M., V.T., G.P., A.B., and V.V.; methodology, M.D.B., D.D.G., M.F., P.P.; validation, M.D.B., D.D.G., A.B., and V.V.; formal analysis, M.D.M., V.T., A.B., and V.V.; investigation, M.D.B., D.D.G., V.P., M.F., P.P.; resources, P.P., M.D.M., A.B., and V.V.; data curation, M.D.B., D.D.G.; writing—original draft preparation, M.D.B., G.P., D.D.G., M.F., P.P.; writing—review and editing, M.D.M., V.T., A.B., and V.V.; visualization, M.F., P.P., V.P., M.D.M., V.T.; supervision, M.D.B., D.D.G., A.B., and V.V. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Acknowledgments: The review was registered on the Open Science Framework (OSF) public registry (3 June 2026, license CC0 1.0 Universal, Registration DOI: 10.17605/OSF.IO/TPXQY).

Conflicts of Interest: The authors declare no conflicts of interest.

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