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Systematic Review

Jaw Reconstruction with Scapular Bone Flap and Prosthetic Implant Rehabilitation: A Comprehensive Systematic Review

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Abstract: A rising demand for prosthetic-driven jaw reconstruction is encountered in maxillo-facial surgery. The free scapula flap is a workhorse of cervico-facial reconstructions, but an implant-based prosthetic rehabilitation on this flap is a debated topic. A systematic review of the papers on this subject has been conducted on Embase, MEDLINE, and Cochrane libraries following PRISMA guidelines, in order to analyze the results described in the literature. A total of nine papers were eligible for inclusion, with 83 scapula flaps overall being used for an implant-based prosthetic rehabilitation. The mandible was the reconstructed jaw in 58.0% of the cases. Overall, 249 implants were positioned (mean 3.0 implant per flap) with a 3.6% implant failure rate. In 95.2% of the cases, delayed rehabilitation was performed. Radiotherapy and the timing of implant placement did not seem to influence implant failure. Only two papers analyzed the quality of life following the rehabilitation, highlighting a functional improvement. Scapula-based implant-prosthetic rehabilitation is a feasible technique that can also benefit from the new CAD/CAM technologies and digital workflows. Nonetheless, further studies focused on this topic and on its impact on the quality of life are needed in order to analyze risk factors and to optimize the outcomes.

Keywords: scapula flap; subscapular-based flaps; microsurgery; osseous flaps; dental implants; implant-prosthetic rehabilitation; occlusion-driven reconstruction

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1. Introduction

Microsurgical jaw reconstruction is a central topic in maxillofacial surgery [1–3]. Various factors guide the choice of tissues to be used (type and extent of defect, comorbidities, and donor site), but usually, bone reconstruction using bone flaps is preferred [4–6]. Compared to the past, today's microsurgical scenario sees the aesthetic–functional result and the patient's quality of life as an essential point in the treatment pathway. It is, therefore, imperative for the surgeon facing such challenging reconstructions to know how to handle the harvesting of several types of flaps to be adapted to each individual patient. Flaps of the fibula (based on the peroneal artery), scapula (based on the circumflex artery of the scapula, SCA), and iliac crest (based on the deep circumflex iliac artery, DCIA) are most frequently chosen in this context [5–7]. The fibula flap, in particular, has historically been the most widely used, mainly due to the large volume of available bone. These advantages are in fact linked to the possibility of subsequent implant-prosthetic rehabilitation, which is reflected in the growing interest in more aesthetic and functional results in oncological surgery [8–10]. The scapular flap was first developed by Gilbert and Teotin in 1982;

subsequently, the reconstruction of the head and neck with a free scapular tip flap was first described in 1988 by Deraemaeker et al. [11,12]. Only in the last two decades, by virtue of an increased focus on personalization of care and on morbidity both in demolitive and reconstructive surgeries, scapula flap has increasingly returned to the list of choices of reconstructive surgeons [13–15]. However, in the case of a scapula flap, it is possible to insert dental implants for prosthetics with the advantage that this flap also allows the simultaneous harvesting of large portions of soft tissue with low morbidity for the donor site [7,14]. Regarding the latter point, many authors in the literature have demonstrated the low morbidity related to a slight reduction in shoulder motility and strength that hardly impacts the patients' perceived quality of life [16–18]. Moreover, the possibility of early ambulation of the patient, the low impact of atherosclerosis on the pedicle, and the non-susceptibility to peripheral obliterative arteriopathies (which might be a key problem in some flaps, such as the fibula) make it an optimal option in the treatment of elderly patients [14]. However, its use remains limited due to the location of the donor site and because some authors question the quality of the bone tissue, which can sometimes be reduced and, therefore, unsuitable for the placement of dental implants [19]. Currently, data in the literature concerning the implant-prosthetic rehabilitation of the scapula are lacking. The objectives of this systematic review are to evaluate the feasibility and results of implant-prosthetic rehabilitation in the microsurgical reconstruction of the jaws using a scapula flap, as well as long-term follow-up and possible optimization strategies for the procedure.

2. Materials and Methods

Systematic review and meta-analysis were conducted following the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) [20].

2.1. Study Eligibility Criteria

The eligibility criteria for the studies included in this review were designed according to the Population Intervention Comparator Outcome Study (PICO) framework. The population included the patients who underwent reconstruction with a free scapula flap with simultaneous or delayed dental prosthetic-implant rehabilitation, reported complications, and the availability of the full text for review. No controls were enrolled. The evaluation of implant positioning and their survival rate was the main outcome. Peer-reviewed publications in English were included, with no restrictions to the publication year. The exclusion criteria were no specification of scapula flaps and missing data on the number of implants and success rates.

2.2. Search Strategy

The authors conducted a literature search on articles published until 1 March 2024 using three different databases: MEDLINE, Embase, and Cochrane Library searching for studies examining the jaws reconstruction with scapular bone flaps and simultaneous or delayed implant rehabilitation. The articles were surveyed applying the selection criteria on the title and abstract (phase 1) and then on the full text of those deemed appropriate after the first analysis (phase 2). In addition, a manual search was conducted for references from the selected studies. Duplicate abstracts were carefully removed.

2.3. Data Extraction

A standardized electronic data collection form was used independently by three reviewers (M.D.B., D.G.D., and F.M.) to extract the data from each of the included studies. Only data specifically regarding the scapula flaps that underwent implant positioning were extracted. The collected data include the first author's name, year of publication, study design, country, number of patients, reconstruction, timing of reconstruction, number of implants, timing of prosthetic rehabilitation, adjuvant therapies, and reported complications. Moreover, a risk of bias evaluation of each paper has been performed by the same reviewers (M.D.B., D.G.D., and F.M.) using the Newcastle–Ottawa Quality Assessment Scale [21].

2.4. Statistical Analysis

Descriptive frequencies, independent sample T-Test, Chi-square test, and V-Cramer correlations were mainly evaluated. The results reported include the 99% confidence interval (CI), 5% margin of error (ME), and statistical significance ($p < 0.05$). All the statistical analyses were performed using IBM SPSS Statistics [28.0.1.1]; IBM Corp. (Armonk, NY, USA).

3. Results

A total of 483 records were identified from the PubMed, Scholar, and Cochrane databases. After the removal of duplicates and the addition of an additional 7 articles through an additional search of the MEDLINE database, 391 articles were reviewed. After a complete review of abstracts, 374 papers were excluded because they were not relevant to the topic of this systematic review. A full-text review was performed for 17 articles. Of those, nine studies met the inclusion criteria and were included in the systematic review. On the contrary, eight papers were excluded: two because they were not relevant to the topic of this review, three because they did not specifically report data regarding scapula flaps, and three because no data regarding dental implants were encountered. A flow chart illustrating all the steps of the screening procedure is shown in Figure 1.

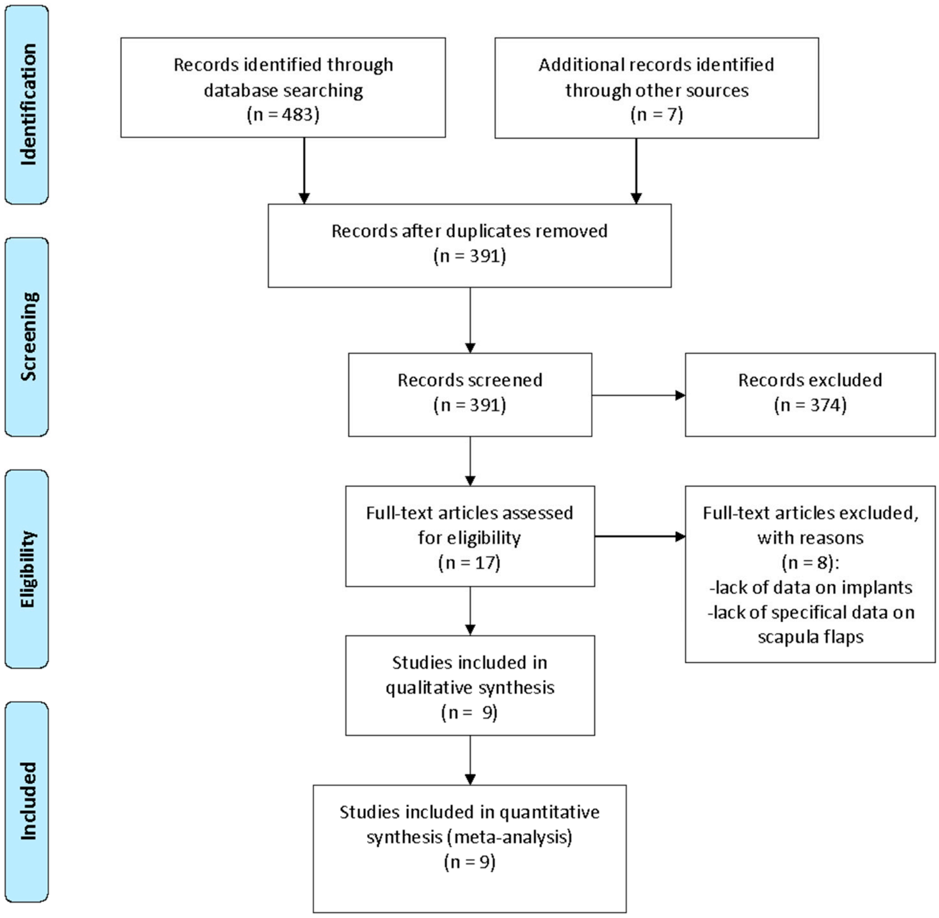

Figure 1. Search and screening strategy according to PRISMA guidelines (Moher et al., 2009 [20]).

All the studies were single-center retrospective reviews or case series and were published from 2000 to 2024. A total of 483 cases were reported, of which 191 were reconstructed with a free scapula flap, but only in 83 cases one or more dental implants were positioned and the data regarding these patients were extracted. Each patient was reconstructed with a single scapula flap and no flap failures were encountered. Of the latter patient cohort, 43 were men and 30 women, while the sex was not specified for 10 patients. The mean age was 58.2 years, of which 75% of the patients were older than 55 years. A total of 47 patients received primary reconstruction (61.9% valid), while 29 received delayed reconstruction (38.1% valid); in 7 patients the reconstructive timing was not specified. A total of 49 out of 78 patients underwent radiotherapy (62.8% valid), while in 5 patients the figure was missing. A total of 249 implants were placed with an average of 3.00 implants per patient. The reconstructive site was specified for 69 out of 83 patients; in particular, the rehabilitation involved the mandible in 40 patients and the maxilla in 29 cases. Regarding the timing of implant placement, only four patients received implant rehabilitation at the same time as surgery (4.8%), while the others received delayed rehabilitation (95.2%) with a minimum delay of 5 months from flap reconstruction. The implant failure rate was 3.6% (9 cases out of 249 total implants). The Chi-Square test showed no statistically significant correlations between implant failure rate and timing of placement ($p > 0.01$) or between implant failure rate and radiotherapy treatment ($p > 0.01$). The mean follow-up was specified in 59 patients and, according to these data, the overall mean follow-up was 33.3 months. In the remainder, a minimum follow-up of 12 months was assessed, except for the two case reports where no follow-up details were encountered. The results are summarized in Table 1. The risk of bias has been assessed using the Newcastle–Ottawa Quality Assessment Scale. Four papers were rated high-quality studies [6,22–24], while the others ranked as medium-quality studies.

Only in two papers, the results regarding the quality of life were collected. Wilkman et al. analyzed the results in terms of deglutition and speech with good outcomes [6]. Swendseid et al. analyzed the quality of life results using the FACT Head and Neck Symptoms Index (FHNSI) questionnaire, showing an improvement [25].

Table 1. Dental implants on free scapula flaps: summary of the results of the systematic review. n.s. = not specified.

Article	Scapula Flaps (n)	Reconstruction Site (n)	Dental Implants (n)	Failures (n)	Survival Rate (%)
Jelovac, D. 2023 [26]	1	Maxilla (1)	3	0	100%
Kaiser, M. 2024 [23]	5	n.s.	20	6	70%
Khadembaschi, D. 2021 [22]	22	Maxilla (9) and mandible (13)	62	2	96.7%
Lanzer, M. 2015 [27]	6	Mandible (6)	35	0	100%
Mertens, C. 2016 [28]	14	Maxilla (14)	50	0	100%
Schultes, G. 2002 [24]	18	Mandible (18)	44	0	100%
Swendseid, B. 2018 [25]	1	Maxilla (1)	3	0	100%
Wilkman, T. 2016 [29]	7	Mandible (7)	23	0	100%
Wilkman, T. 2019 [6]	9	n.s.	9	1	88.9%

4. Discussion

The scapular flap was first developed by Gilbert and Teotin in 1982 and has since been recognized as a versatile free flap in head and neck surgery, particularly in cases requiring complex hard and soft tissue reconstruction [11]. Its chimeric potential makes the scapula flap ideal for oromandibular and craniofacial defects, although it has remained underused for decades. The free scapula flap has been increasingly recognized over the past two decades as a viable alternative to the better-known fibula and iliac crest flaps. Anatomically, it is important to specify the chimeric nature of the scapula flap and its vascular tree. As primarily described by Hallock, a chimeric flap is defined as a combination of regional flaps converging into a single major pedicle. This allows for spatiality between the components of the flap and its various tissues, making it possible to perform complex reconstructions without using multiple flaps [30]. The chimeric scapular flaps are possible thanks to an anatomically constant vascular system widely described in the literature [14,31]. The subscapularis system originates at the level of the axillary cavity from the homonymous artery. The subscapular artery, after having generated the circumflex artery of the scapula, which is necessary for the setup of the parascapular bone component, continues into the thoracodorsal artery. The latter is fundamental in the setting up of chimeric flaps; with a length varying from 6 to 18 cm, it allows the harvesting of the soft tissue component given by the latissimus dorsi muscle and in 85% of the cases provides the angular branch which, with an average length ranging from 2.5 to 8 cm, leads to the tip of the scapula and is, therefore, to be preserved in cases in which the bony component of the tip of the scapula must be harvested [14,15]. The latter is generally the most frequently used bone component of scapular chimeric flaps in jaw reconstruction. Its unique usefulness has been demonstrated in frail patients and those with significant comorbidities, such as peripheral atherosclerotic disease, in whom there may be concern about the adequacy of blood supply to the peripheral limbs after flap retrieval [7]. The scientific literature is divided between authors who prefer a simultaneous ablation and the harvest of the flap with the patient in a supine position and authors who prefer an ablation and reconstruction at two different times with the patient in a prone position or in lateral decubitus. In fact, the proximity to the head and neck makes a simultaneous two-team oro-maxillo-facial resection and scapular harvest very challenging, thus inevitably increasing the operation time and with it the peri-operative adverse events. This is particularly important in elderly patients who are often selected for this flap. From the latter point of view, it is important to highlight that scapular bone flap allows early ambulation, also in first post-operative day, resulting in a lighter post-operative patient care management and in a minimization of adverse effects in elderly patients during hospitalization [17]. Various supine and/or semi-lateral decubitus methods have been described in the literature over the years to enable simultaneous ablation and flap harvesting [32]. To follow this purpose, support stands such as the Mayo stand or the Spider limb positioner have also been introduced [33,34]. Today, the simultaneous one is the preferred approach by the senior authors. From a morbidity perspective, numerous articles have demonstrated its efficacy, reproducibility, and low cost in relation to the donor site [13]. Regarding the latter aspect, from a functional point of view, the authors have already described a significant reduction in the strength and external rotation of the shoulder in the absence of a significant reduction in the quality of life reported by patients [17]. Similarly, Patel et al. evaluated the range of motion of the active shoulder (ROM) and measured the shoulder strength using the Microfe2, demonstrating a significant difference between the operated shoulder and the contralateral healthy one without subjectively impacting the patient's perception [18]. Ferrari et al. also investigated scapula donor site morbidity, both objectively (using the Costant–Marley test) and subjectively (using the Disability Arm, Shoulder, and Hand (DASH) test). In their case series, no significantly impacting changes in the quality of life of the treated patients were found. In addition, a progressive improvement in shoulder function was demonstrated in tests performed after surgery in a long-term setting. Peri-operatively, the two most frequently reported complications were seroma, which was reported in 16% of the cases in the case series of Ferrari et al., and post-operative pain, which was easily managed with normal anti-inflammatory painkillers such as paracetamol [16]. In addition, the vascular pedicle appears to be the least affected by atherosclerosis, offering an advantage in smokers, such as most oral cancer patients [14,35]. Moreover, it allows one to bypass possible problems related to peripheral obliterative arteriopathy diseases, which have smoking and dyslipidemia as their risk factors. Considering that the majority of the cases involve the lower limbs, this may represent a serious issue that needs to be carefully evaluated in patients who are candidates for fibula flap harvesting [36]. The role of atherosclerosis in the iliac crest flap, on the other hand, is still vague and not described in detail in the scientific literature. A further advantage of this flap is the long vascular pedicle, similar to the fibula flap pedicle. Differently from the fibula flap, the scapula one also has the advantage of its possible chimeric harvesting and thus mobility between the hard and soft components of the flap, allowing the treatment of vessel-depleted necks or even the treatment of irradiated patients with invasive recurrences, where salvage surgery is required. As this systematic review has shown, the scapula flap has proved to be versatile in jaw reconstruction as it is used in a proportionally semi-symmetrical manner in both maxillary and mandibular reconstruction. In the latter, 58.0% of the case series reported in this study, despite having limited bone reserve, a composite osteomyocutaneous scapular flap in combination with latissimus dorsi was shown to reduce post-operative fistulae in mandibular reconstructions [29]. Since scapula flaps were used for both maxillary and mandibular reconstructions, it should be noted that the implant failure rate was low in both cases. A peculiarity to consider about the scapular flap compared to other free bone flaps is that related to the concept of 'implantability', which has often been addressed in the literature [19,27,37,38]. The question of implantability in the scapular flap stems from the limited bone reserve available compared to the fibula and DCIA flaps [39]. Given this premise, many studies have focused their attention on studying the possibility of the safe and adequate placement of dental implants on scapula flaps. In particular, Moscoso et al. highlighted a possible difference in terms of implantability between men and women, especially in those with a lighter body mass [19]. However, in the studies analyzed, no substantial sex difference emerged in terms of 'implantability'. These data appear to be in line with more recent papers on the subject, which have refuted previous works [27,37,38]. However, despite the various studies conducted on this topic, this systematic review shows that there are still few works specifically focusing on the outcome of dental implants in the scapular flap. Pre-operative planning certainly contributes positively to this outcome, allowing the surgeon to make the best use of the available amount of bone [25,40,41]. Interestingly, about 38.1% of the reconstructions were secondary reconstructions compared to 61.9% of the reconstructions simultaneous with resective surgery. These data are probably explained by the possibility of using the healing time for careful and personalized planning of the reconstruction, which in more recent times has also started to make use of new customized technologies [25]. These technologies, in addition to the greater precision of reconstruction and implant placement, also allow a reduction in surgical time and can be merged with new computer-vision technologies in order to identify and preserve noble structures if feasible [41–43]. As can be clearly seen in Table 1, implants were almost never placed at the same time of jaw reconstruction, with a percentage of 4.8%, while in the remaining 95.2%, the implants were positioned at least 5 months after the surgery. This common choice is probably due to the will of waiting for the healing time of flap tissues and for the volumetric settlement of the soft tissues. This concept is not only related to locoregional healing and scarring, but also to actinic effects induced by radiotherapy. Adjuvant treatment must always be considered as a likely eventuality in the treatment of cancer patients with bone-infiltrating malignancies. Indeed, it is no coincidence that 62.8% of the patients in the cohort analyzed in the systematic review received adjuvant radiotherapy. Moreover, since the indication for reconstructive surgery is almost always related to an oncological cause, there is also the advantage of the direct post-operative monitoring of any early recurrence. The disadvantage of this choice, however, is that of the late functionalization of the reconstruction, which is an increasingly crucial problem in reconstructive surgery today [44]. Regarding the implant failure rate, this complication was seen to occur in less than 5% of the cases. Compared to the cases reported for fibula flaps and DCIA, this percentage is similar and there does not seem to be a substantial difference in this field between the major microsurgical bone flaps [39,45]. However, it should be noted that smoking habits and the ability to maintain adequate oral hygiene were hardly ever investigated in the selected articles. Since the primary indication for resection is usually oncological in nature, patients are often smokers, a major risk factor for oral cancer. At the same time, poor oral hygiene also promotes its occurrence, especially due to chronic infections [46]. But smoking habit and poor oral hygiene are also two key factors in preventing implant failure, as they strongly predispose to infections and peri-implantitis. As shown, for example, by Kaiser et al., peri-implantitis was the cause of failure in almost 80% of the cases and was diagnosed in almost 20% of the remaining implants [23]. Although the percentage of smokers in head and neck cancer patients decreases after surgery, the problem of oral hygiene often persists after surgery [47,48]. Maintaining adequate mouth cleanliness after surgery is sometimes made even more complex by the type of prosthetic rehabilitation (as we will see later); post-operative outcomes, such as trismus and altered oral cavity anatomy; or radiotherapy outcomes, such as mucositis and xerostomia. Radiotherapy, in contrast, could be considered a predisposing factor for implant failure, in particular due to the reduced bone healing capacity and increased susceptibility to infections, which eventually lead to bone resorption and compromised implant stability [49–51]. Despite the data in the literature, the statistical analysis performed in this study did not show a correlation between the implant failure rate and radiotherapy treatment ($p > 0.01$). In any case, the bias of a statistically small sample should be taken into account due to the limited data currently available in the literature. As pointed out by Wilkman et al., there might be a difference in terms of bone resorption between the main flaps used for maxillary reconstruction. The scapular flap, in fact, seems to be the most prone to resorption, with 69% residual volume after 48 months. In their population, this percentage rose to 88% and 95% for the DCIA and fibula flaps, respectively. Although these data are extracted from a relatively small sample (a total of 38 patients), they can certainly provide interesting insights regarding implant placement. However, it must be said that not only the quantity, but also the quality of the bone used has its importance. Furthermore, this work shows a progressive reduction in volume over time (which does not stop after the first 6 months), despite having a limited follow-up (2 years) [6]. Therefore, more data are certainly needed to understand the extent of long-term bone resorption in different types of flaps. Another interesting finding from the work of Wilkman et al. is that there are no differences in terms of bone resorption between irradiated and non-irradiated patients. This latter finding further confirms what was reported in our analysis. The importance of this observation lies in the fact that radiotherapy undoubtedly induces a profound alteration of the soft tissues, leading to problems such as mucositis, tissue retraction, and xerostomia, which can compromise implant stability [51]. In contrast to Wilkman's work, more recently, Barton et al. retrospectively analyzed their case series (18 patients) of mandibular reconstructions with scapula flaps. A median volume loss of 0.5% and a mean volume loss of 5.1% were observed in all the flap segments. The limitation of this study is certainly related to the selective evaluation of mandibular reconstructions, whereas those of the upper jaw were not analyzed. Also in this work, however, radiotherapy did not influence bone resorption [52]. Also, in the work of Kaiser et al., no difference in implant success/survival was observed between the patients who received radiotherapy and those who did not receive radiotherapy. As expected, however, smoking negatively influenced implant survival. Interestingly, they also showed a significantly better outcome in mandibular implants than in maxillary implants [23]. Looking further into the relationship between prosthetic rehabilitation and oral health, it can be stated that the specific type of prosthetic rehabilitation (mainly fixed or removable prosthesis) is particularly impactful due to the different results in terms of achievable oral hygiene. For example, Khadembaschi et al. showed a statistically significant difference in the oral hygiene of these two groups, with the group with removable prostheses achieving much better oral hygiene than the group with fixed prostheses [22]. Unfortunately, this aspect was scarcely analyzed in the selected articles, just as the timing of the final restoration was scarcely considered. Although not crucial from a clinical point of view, it is dramatically important for the patient from a psychological point of view. Indeed, the improvements in aesthetic and functional terms are substantial and have repercussions on patients' quality of life [44,47,53]. Unfortunately, this systematic review shows that the analysis of post-operative quality of life in occlusion-guided reconstruction is a topic that has been little explored and evaluated as a primary outcome. However, in the studies that have analyzed it, functional improvement has been observed, particularly in speech [25,29]. This area also includes the assessment of the temporomandibular joint function, which can be profoundly impaired in the case of incorrect implant-prosthetic rehabilitation [1,54]. Another point to note is that implant success was better in the patients in whom osteosynthesis plates were removed before or during implant placement. Although not proven, the main hypotheses are that their removal results in better vascularization and a reduced risk of material exposure (and the subsequent superinfection) [23]. Interestingly, the role of osteotomes used during flap harvesting and shaping has not been considered. As demonstrated by Anesi et al., ex vivo on fibula specimens, the use of piezoelectric osteotomes significantly reduces bone tissue damage and produces cleaner and smoother microfractures and cutting surfaces with less bone debris/chips, allowing for better bone healing and vascularisation [55]. Both data were not present in the cohort of patients analyzed in the review, which is why a statistical analysis was not possible and future studies will be necessary.

Despite the comprehensive nature of this systematic review, some limitations must be taken into consideration. The first and most important is related to the small number of scientific studies on the topic, which are mainly retrospective in nature and with heterogeneous study methodologies. Furthermore, as previously highlighted, the poor collection of data specifically on the placement of dental implants on scapular flaps limits the generalizability of the results. In particular, the authors believe that more targeted research on risk factors for implant failure and on quality of life and functional outcomes could have a profound impact on patient care.

5. Conclusions

The microsurgical scapular bone flap appears to be a safe and versatile option for jaw reconstruction. The aim of the present review was to determine whether the placement of dental implants is a feasible option in the scapula flap and the results of the literature. It was found to be a feasible option with results comparable to those of the implants in the fibula and DCIA flaps. Given the new technologies available today, a digital workflow is suggested to optimize the available bone resources and also to focus on functional results. Finally, although it is widely considered a versatile option, it is important to note that the scapular flap procedure is complex and requires detailed surgical planning and significant surgeon experience. In addition, the patient must be appropriately assessed to determine the feasibility and suitability of this procedure based on general medical conditions and specific needs. However, compared to the number of patients undergoing reconstructive microsurgical procedures with this flap, implant-prosthetic rehabilitations are still poorly described in the literature, data are limited, and the small sample size is a bias for in-depth statistical studies. More retrospective and randomized studies are needed in the future to implement the data on this topic.

6. Future Directions

The standard of care is, therefore, an increasing orientation towards occlusion-guided reconstruction, which allows customized implant-prosthetic rehabilitation. This ensures a better quality of life for patients through improved results in terms of speech, swallowing, nutrition, and aesthetics. Digital CAD-CAM flow will be increasingly central and necessary in the design of prosthetic rehabilitation with classic endosseous implants or patient-specific implants [56]. In this connection, it is appropriate to mention maxillary sub-periosteal implants. As described by Mommaerts, this technique revives a concept from around 80 years ago combined with the most modern CAD-CAM techniques [57]. This technique was very popular in the 1950s, but was gradually supplanted by the non-osseointegrative material, Vitallium, in favor of titanium implants. Currently, however, this technique is making a comeback, especially in the cases of severe bone atrophy, thanks to prosthetically guided CAD-CAM planning and the fact that even sub-periosteal implants are now made of titanium to promote osseointegration. It is, therefore, easy to imagine that this type of implant could be used in the future for the rehabilitation of complex free flaps, such as the scapular flap, where implant placement may be more difficult (e.g., a maxillary reconstruction with a very thin scapula). Currently, however, comparisons between the feasibility of a sub-periosteal implant and an endosseous implant are not yet present in the literature although it may represent a starting point for future direction.

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