

Systematic Review

Outcomes of microsurgical flap techniques in the reconstruction of extensive lesions due to advanced basal cell carcinoma: a systematic review of complications, recurrence, and aesthetic satisfaction

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ABSTRACT

Basal cell carcinoma (BCC) constitutes 70–80% of non-melanoma skin cancers, with an estimated 4.3 million new cases annually in the U.S. Though rarely metastatic, advanced BCC can cause extensive local tissue destruction, particularly in facial regions, necessitating surgical excision followed by complex reconstruction. This study evaluates outcomes of microsurgical flap reconstruction in advanced BCC, with a focus on complications, recurrence, and patient-reported aesthetic satisfaction. A systematic search across six databases until May 2025 identified 263 abstracts, of which 34 full texts were reviewed; nine studies met inclusion criteria. Due to methodological heterogeneity, a narrative synthesis was conducted. Most studies reported low complication rates, with serious issues occurring in fewer than 10% of cases and no significant differences across flap types or age groups. Recurrence rates ranged from 0.22% to 4.4%; notably, 447 lesions treated with narrow margins and frozen section analysis showed a recurrence of only 0.22%. A meta-analysis reported an overall recurrence rate of 2%, with the Muffin technique associated with superior outcomes. Aesthetic results were favorable: OM flaps yielded high satisfaction rates (77.8%, $p=0.002$) with shorter operative times, and periocular reconstructions demonstrated successful outcomes in 87% of cases, outperforming radiotherapy (69%). However, definitions of "satisfactory" varied across studies. Despite limitations such as inconsistent outcome reporting and short follow-up durations, microsurgical reconstruction in advanced BCC appears safe, effective, and cosmetically satisfactory. OM flaps, in particular, are seen as efficient by both clinicians and patients. Standardized, long-term studies are essential for definitive conclusions.

Keywords: Basal cell carcinoma, Microsurgical flaps, Recurrence, Aesthetic outcomes

INTRODUCTION

Basal cell carcinoma (BCC) is among the most recurrent skin cancer. It arises from basal cells in the epidermis due

to long-term sun exposure. BCC grows slowly and rarely spreads to distant organs, but it causes serious local damage if untreated. It can invade skin, muscles or bone.^{1,2} BCC has prevalence of 70–80% of all non-melanoma skin

cancers worldwide. Approximately 4.3 million Americans are affected by this condition each year.^{3,4} The most common skin cancer is called BCC. There are 70% to 80% of skin cancer cases that are basal cell carcinomas, according to a 2011 report in *Anais Brasileiros de Dermatologia*. Researchers project that there are around 56 to 61 cases per 100,000 people in the United States every year. Particular areas in the South report up to 85 cases per 100,000, while over in the North, fewer than 25 per 100,000 are usually seen. Ultraviolet (UV) radiation is the biggest cause of skin cancer. Others fall into the category of fair skin (Fitzpatrick phototypes I–II), getting older, a history of skin cancer in your family, and specific genes. As an illustration, mutations in the PTCH gene are found in 30–75% of sporadic cases. Exposure to factors like working in the sun or getting sunburns in early life may raise the chances of getting BCC. Rates of death because of BCC are very low (less than 0.1%), but the condition can result in a lot of harm. Although it grows slowly over time, cancer can invade close-by tissues and may come back following treatment.⁵

Other risk factors include immune suppression or inherited conditions like Gorlin syndrome, arsenic exposure, and prior radiation treatment.⁶ BCC often starts as a small, slow-growing lesion. Advanced cases involve deeper invasion or significant local spread which can make treatment more challenging. Surgical removal is considered as prime treatment.⁷ Large tumors or facial tumors can leave major defects.⁸ For larger lesions, reconstructive surgery can restore both function and appearance. Microsurgical flap reconstruction is one approach. It involves transplanting skin, muscle, or other tissue from a donor site, along with its blood supply to cover the defect.^{9,10} This review focuses on outcomes after microsurgical flap reconstruction for advanced BCC. It examines three key factors: post-surgical complications, cancer recurrence, and satisfaction with aesthetic results. Surgeons and patients are both taken into account. Current studies are used for this analysis to make surgery and long-term care more effective. The purpose is to guide doctors to pick the best reconstruction and boost the quality of life of patients who have lost a lot of tissue due to BCC.

METHODS

Search strategy and databases

A detailed search of available studies was carried out to discover the use of microsurgical flap methods to reconstruct significant lesions from advanced BCC. The search was done on PubMed, Scopus, Embase, Web of Science, CINAHL, and Google Scholar. Doing so allowed us to find indexed medical papers as well as gray texts.

Every database in our search strategy made use of tailored search methods and included both controlled terms and free-text queries. Key search terms that we used are: “microsurgical flap,” “free flap,” “basal cell carcinoma,” “skin cancer,” “reconstruction,” “complications,”

“aesthetic outcome,” “recurrence,” and “oncologic defect.”

Up to May 2025, we gathered and reviewed studies in any language. All citations were added to Rayyan QCRI in order to screen them anonymously. Among the 468 records, 57 of them were eliminated as duplicates. The screening of 411 remaining titles and abstracts was done by four skilled reviewers.

Eligibility criteria and study selection

Findings from microsurgery or complicated tissue flap use on patients with advanced or severe BCC.

At least one leading outcome was included in the study (such as the rate of complications, risk of recurrence, or how patients or surgeons felt about the result).

Research mostly focused on any anatomic site, but specifically on the scalp, nose, and area around the eyes because of their surgical and how they affect appearance.

We excluded studies that: did not specify BCC or mixed cancer types without subgroup analysis, preclinical or experimental models were considered out of criteria, lacked outcome data, and editorials, opinions, or conference abstracts.

After abstract review of 263 studies, a further review of full texts on 34 studies was done to select 9 studies that met the criteria. All problems were sorted out thanks to a second round of reviews.

Data extraction and outcomes assessed

Data were extracted using a structured, reviewer-verified form capturing: study design like retrospective, cohort, reviews, and meta-analysis; patient details like age, lesion site, comorbidities, tumor size were reported. We reported surgical techniques used like flap type, margins, specific methods like LD, ALT, or OM flaps.

Primary outcomes

It included complication rates (e.g., flap loss, necrosis, and infections), BCC recurrence rate was measured, and aesthetic satisfaction was recorded.

Secondary outcomes

Surgical time, hospital stay, revision needs are considered as secondary outcomes. Functional outcomes e.g., nasal airflow, eyelid movement if any.

Confidence intervals and the p-values found in the original papers were reported as results. As there is not one way to study body image and many tools are used, we did not perform a meta-analysis. So, we are offering a narrative synthesis approach.

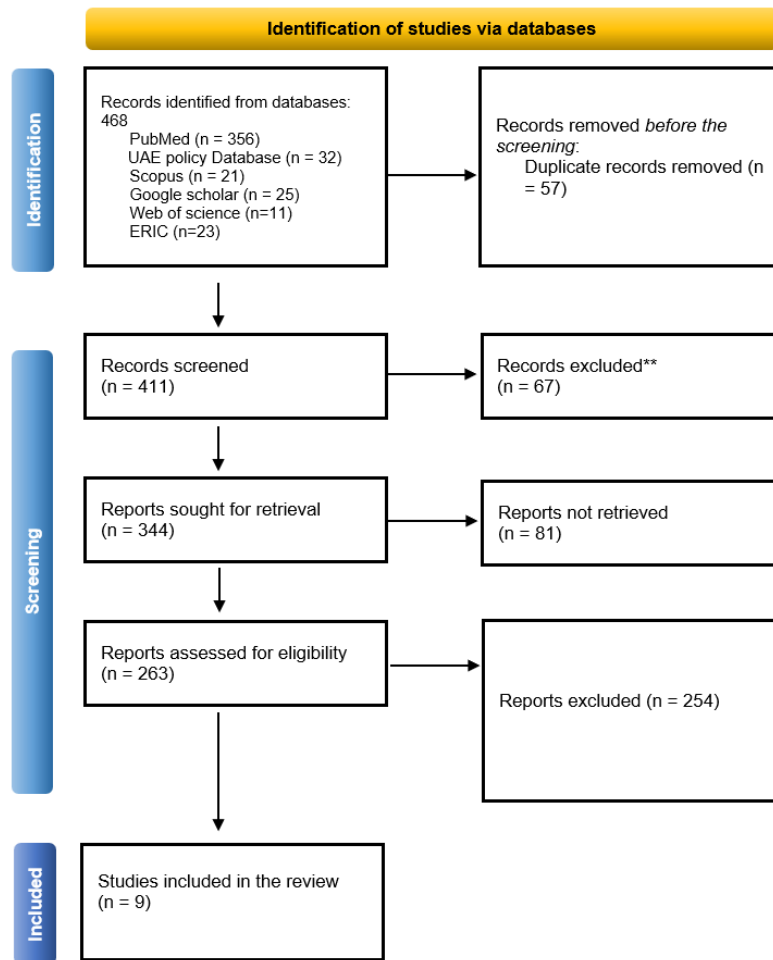


Figure 1: PRISMA check-list.

RESULTS

Primary findings

In final results, nine studies are reviewed that look at using microsurgical flaps in advanced cases of BCC. The results are measured by how often there are complications, if the procedure repeats, and how well the scar looks with time. It is not clear what the results are. There is a strong body of supportive evidence, but its details are often unclear or inconsistent. Most of these papers examine only a few patients, do not report in a standard way, and seldom analyses techniques head to head.

Complications

Across the studies, complication rates were generally low such as Gasteratos et al reported flap failure and serious complications below 10% in a review of 232 patients. Bassetto et al reported 80.5% of cases healed without complications using Integra® dermal matrices. These reports rely on retrospective data or expert consensus, not controlled trials. In del Castillo Pardo de Vera et al complication rates did not differ between flap types (LD, ALT, OM; $p>0.05$). Since the reports do not include

sufficient data on each complication, it is hard to draw conclusions. Simunovic et al noticed there was no significant distinction in complication rates between seniors and younger patients ($p>0.05$), suggesting that there is no direct link between age and surgical risk. Still, there is no consensus on what is considered a complication, and only a few types of research monitor results over the long term. Thus, doctors can depend on the complication data, but they are still missing details.

Recurrence

Findings show recurrence rate was rare across all techniques. Lacerda et al reported an overall recurrence rate of 2% in a meta-analysis of over 10,000 BCCs. Muffin technique had the lowest recurrence (0%) but followed by Tubingen (1%), with Mohs and Munich at 3% each. These numbers reflect strong tumor control when microsurgery is paired with clear margin management. Lee et al confirmed low recurrence using 2-mm margins and frozen biopsy. Only one recurrence occurred out of 447 cases (0.22%). The average follow-up was just over seven months which was not enough to judge long-term risk. Second resection rate was 5.15% ($p=0.024$) which shows initial excisions sometimes missed tumor edges, despite

intraoperative checks. No study compared recurrence between flap types.

Aesthetic outcomes

Reported results show esthetic satisfaction varied. Del Castillo Pardo de Vera et al found 77.8% of patients with OM flaps were satisfied ($p=0.002$). Flap also had the shortest surgery time (6.6 ± 0.14 hours versus 8.91 ± 0.32 for

LD; $p<0.05$). These results support OM as efficient and cosmetically effective but the sample was only nine patients. Furdová et al found that 87% of surgical cases had good cosmetic outcomes for periocular BCC, better than radiotherapy (69%). The “good” was not defined in most papers and results were drawn from varied sources with inconsistent follow-up. Other reviews echoed positive cosmetic outcomes but lacked quantified patient feedback.

Table 1: Summary of included studies.

Study (author, year)	Design and methodology	Population and intervention	Outcomes and key findings	Limitations
Del Castillo Pardo de Vera et al, 2021¹¹	Retrospective comparative study; comparative analysis by flap type	30 oncologic patients with large scalp defects; LD (n=10), ALT (n=11), OM (n=9) flaps used	OM flap had highest aesthetic satisfaction (77.8%, $p=0.002$), shortest surgery time (OM: 6.6 ± 0.14 h versus LD: 8.91 ± 0.32 h, $p<0.05$); other outcomes (complications, hospital stay) not statistically significant ($p>0.05$)	Small sample size; no long-term follow-up
Bassetto et al, 2025¹²	Expert panel review; consensus and multiple case reviews	Head and neck reconstruction patients using IDRT over 2 years	80.5% complication-free healing; mean defect size 9.6 ± 1.6 cm ² ; effective functional/aesthetic restoration	No RCTs; based on expert consensus and case reports
Gasteratos et al, 2022¹³	Systematic review; 11 clinical case series analyzed	232 patients with total/subtotal nasal defects post-BCC	Most used flaps: radial (n=85), auricular (n=87), ALT (n=30); <10% complication/flap failure rate; satisfactory outcomes	Heterogeneous study designs; limited data standardization
Kosutic et al, 2019¹⁴	Review article; literature-based evaluation	NMSC patients; surgical techniques (Mohs, excision, recon)	Mohs cure rates: BCC 98–99%, cSCC 92–99%; better functional/aesthetic results	Review article, lacks original data or quantitative comparison
Lacerda et al, 2022¹⁵	Systematic review + meta-analysis (random effects); 18 studies	10,424 BCCs; different micrographic surgeries (Mohs, Munich, Tubingen, Muffin)	Overall recurrence: 2% (95% CI: 1–3%); by technique—Mohs 3%, Munich 3%, Tubingen 1%, Muffin 0%; $\chi^2=46.2$, $p=0.00$	No direct comparison between techniques; data observational
Badash et al, 2019¹⁶	Review article; literature review on surgical NMSC	Patients with facial NMSC (BCC/cSCC)	MMS: 5-year recurrence BCC 3.1–4.4%, cSCC 5.4%; best tumor clearance and aesthetic preservation	No new data; synthesis from prior studies
Simunovic et al, 2016¹⁷	Retrospective cohort; patient comparison by age	31 patients with scalp tumors (19 elderly ≥ 75 , 12 younger <75)	No flap/medical complication difference by age ($p>0.05$); more revisions in younger ($p=0.006$); comorbidity higher in elderly ($p=0.027$)	Small sample; single-center; no standardized follow-up
Furdová et al, 2020¹⁸	Literature review of periocular BCC management	Multiple treatments: surgery, vismodegib, RT, imiquimod	Recurrence: surgery 1–5%, RT 7.5%; cosmesis good in 87% (surgery) versus 69% (RT); vismodegib tumor reduction >80%, imiquimod 90% clearance	Heterogeneous data sources; varying outcome definitions
Lee et al, 2025¹⁹	Retrospective study; surgical margin excision + frozen biopsy	418 Asian patients (447 BCC cases); mean age 74.62 years	Recurrence: 0.22% (1 case); second resection in 5.15% ($p=0.024$); tumor size 0.96 cm (0.1–4.4)	Short follow-up; potential selection bias

DISCUSSION

Generally, these results suggest that personalized reconstructions are the best option in head and neck oncologic surgery. Surgeons achieved high levels of success on flap designs, ways they were applied, and any supporting therapies offered. Even though the superiority of microsurgery and Mohs was clear, studies back flexible options according to the needs of patients and the type of cancer. Progress in scalp and facial reconstruction has added more choices while balancing results, safety, and what matters to patients. Researchers del Castillo Pardo de Vera et al looked at 30 patients who had scalp reconstruction with latissimus dorsi (LD), anterolateral thigh (ALT), or omental (OM) flaps in a 2021 study. OM flaps provided the fastest operation and users were most satisfied with their looks, but there were no differences in complication rates and hospital stay between any of the three groups. Results indicate OM flaps are both effective and appealing, even though the right flap should still vary depending on an individual's condition.¹¹ These researchers evaluated whether Integra® Dermal Regeneration Template (IDRT) could be used for reconstruction of difficult craniofacial defects. IDRT worked well for cases of trauma, tumors, and burns, since 80.5% of patients healed without any problems. People noticed that their hair both looked better and worked better in places where the tissue was limited. The authors, even though satisfied with the outcomes, still called for more extensive clinical assessments.¹²

In nasal reconstruction, Gasteratos et al's systematic review showed three main flaps which are radial forearm, auricular helical rim and ALT. Gasteratos et al evidenced the utility of microsurgical techniques in restoring form and function following oncologic resection. Complication rates remained under 10% with partial necrosis most frequently observed. Auricular and radial forearm flaps were favored for their reliability. Heterogeneity in reported outcomes limited direct comparison across series.¹³

Both Kosutic et al and Badash et al confirmed that Mohs micrographic surgery (MMS) should be the treatment of choice for severe non-melanoma skin cancers (NMSC). Mohs micrographic surgery (MMS) showed less recurrence than wide local excision for both basal cell carcinoma (BCC) and cutaneous squamous cell carcinoma (cSCC), where the chances of occurrence exceed 90% after 5 years. Fine surgical techniques made it possible to achieve better cosmetic results in difficult surgeries.^{14,16}

In the meta-analysis conducted by Lacerda et al, they assessed the chances of recurrence following different micrographic procedures for BCC. All together, the complication rate was only 2%, but the rate of recurrence depended on the procedure, ranging from 0% to 3%. Head-to-head trials were few, so no method could be named as superior, but the data shows that overall, micrographic techniques benefit patients. A research study by Simunovic et al explained that that age by itself does not

lead to more surgical risks in elderly free flap scalp reconstruction patients. Even though older patients had additional health concerns, they did not experience more complications. Among patients, younger people went through revision surgery more regularly. It becomes clear from the data that older patients with scalp malignancies can get free flap reconstruction safely.¹⁷ Furdová et al compared surgical and non-surgical treatments for periocular BCC. Mohs surgery provided the best cosmetic and oncologic outcomes though newer agents like vismodegib and imiquimod have shown promise in inoperable or advanced cases. Despite favorable early responses, long-term data on these therapies was sparse.¹⁸

Lee et al looked at 2 mm of surgical margin, using frozen section tests, in 447 basal cell carcinoma cases. It was only necessary to remove less tissue, as the total recurrence was 0.22%, proving that conservative margins did not negatively affect the results. This method might suit well when treating people who focus on appearances and have minor skin lesions.¹⁹

Using new methods for asset of blood flow and ways to connect nerves during surgery is improving the results for extensive BCC lesions. ICG fluorescent dye makes it possible to assess flap circulation as surgery is performed. It confirms that there is enough blood flow before the final attach, which can reduce chances of the flap dying partially due to a lack of blood. The technique is most useful when used in patients whose bed has received previous radiation or has been resected repeatedly.^{20,21}

Sensory restoration is also gaining traction as a functional endpoint. In head and neck reconstructions around the lips, eyelids, and cheeks, neural coaptation during free flap transfer improves long-term sensation. Techniques now routinely involve identifying and connecting donor and recipient sensory nerves and early studies show improved protective sensation and reduced neuropathic pain.^{22,23}

Another area of progress is composite tissue reconstruction. When resecting deep or invasive lesions involving bone, muscle, or dura, surgeons are increasingly turning to osteocutaneous flaps like the fibula, scapula, or DCIA (deep circumflex iliac artery). These offer structural support and robust soft tissue coverage in a single-stage procedure. Enhanced fixation methods, such as patient-specific titanium plates derived from VSP, contribute to stable and anatomically accurate outcomes.²⁴⁻²⁶

Improvements in postoperative care are contributing to the increased success of flaps. Non-invasive continuous monitoring is possible with the use of special Doppler probes and near-infrared spectroscopy implanted on the fetus. Through these instruments, doctors are able to detect blood flow problems at an earlier stage and address them promptly. Improved salvage rates and reduced ICU stays have been seen when cardiac surgery patients are given perioperative therapy as part of the postoperative protocol.²⁷ Sometimes, when the choice of donor tissue is

limited, the use of dermal derivatives followed by flap closure at a later date allows for phenomenal flexibility. Taking the staged approach helps create a more secure wound bed and may work well when it's not sure how much tissue the surgeon should take during oncology. This way, reconstruction planning can be done more precisely once the pathology is known. Psychosocial dimension is receiving more structured attention. Facial reconstruction impacts identity and social function. Using both the FACE-Q and PROMIS, one can measure what patients say about how they feel and their everyday capability. With these measurements, clinicians can pick the best technique and determine the course of long-term care.

CONCLUSION

We believe that using microsurgical flap techniques for advanced basal cell carcinoma is effective and provides good outcomes in terms of complication rates, recurrence, and satisfaction of patients. A majority of studies confirm that complications are rare (less than 10%) and occurrence of a recurrence is low (about 0.22–4.4%) for these surgical procedures. When choosing, the omental (OM) flap is singled out for its benefits. It offers good results in terms of lower operative times (77.8%) and higher patient satisfaction than compared with LD and ALT flap procedures. Still, more information is still needed to fill the existing gaps. Various studies are affected by separation in their study designs, lack of standard reporting, and sticking to short follow-ups. This prevents us from getting general conclusions. Still, available reports seem to indicate that flap procedures succeed better than radiotherapy in maintaining both the shape and use of the abdominal wall. These flaps are best used in complicated basal cell carcinoma cases, especially in places where appearance is very important. The use of the OM flap could result in better performance and better experiences for the patient. If frozen section analysis is used in surgery, it might help lower the risk of recurrence when the margins around the tumor are very small. In the future, studies should concentrate on making outcome measures uniform, tracking patients for a longer period, and using patient viewpoints. Prospective surveys that compare flap types in the same groups may also direct how surgeons plan their approaches. At present, microsurgical flaps are supported as a treatment choice for large BCC defects, but additional evidence is needed to understand their best use.

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