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LOCAL FLAP TECHNIQUES OUTCOME FOR SACRAL PRESSURE ULCERS CLOSURES: A SYSTEMATIC REVIEW

Yanuar Ari Pratama[a,b,c], Lakshya Nehal Samineni[d]

[a]Department of Plastic Reconstructive and Aesthetic Surgery, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia
[b]Department of Anatomy, Histology, and Pharmacology, Faculty of Medicine, Univeristas Airlangga, Surabaya, Indonesia
[c]Universitas Airlangga Hospital, Surabaya, Indonesia
[d]College of Medical Sciences, Bharatpur, Nepal

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***Corresponding author*:**
Yanuar Ari Pratama
Email address:
yanuararipratama@fk.unair.ac.id

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ABSTRACT

Introduction: Sacral pressure ulcers (PUs) pose a major challenge, especially in bedridden and elderly patients, due to risks like infection and delayed healing. Surgical reconstruction using local flaps offers effective defect closure with low donor-site complications. This systematic review analyzes local flap techniques for sacral PU reconstruction based on studies published from 2019 to 2024.
Method: A comprehensive literature search was conducted in PubMed, selecting empirical studies that met predefined inclusion criteria. Seven studies were reviewed, comprising five case series and two case reports.
Result: The findings highlight multiple local flap techniques, including the Clover-Style Fasciocutaneous Perforator Flap, Modified Parasacral Perforator-Based Bilobed Flap, and Bilobed Flap, each demonstrates favorable outcomes with high flap survival rates and minimal complications. These techniques offer advantages such as tension-free closure, enhanced vascularity, and reduced recurrence risk, making them viable alternatives for sacral PU management.
Conclusion: Local flap reconstruction is a reliable and effective method for managing sacral pressure ulcers, with high success rates and good healing outcomes. Flap selection depends on defect size, patient condition, and surgeon expertise. A multidisciplinary approach involving preoperative imaging, wound care specialists, and physiotherapists can enhance surgical success. Further research, particularly randomized controlled trials, is needed to strengthen evidence-based flap selection criteria. Overall, local flaps remain the mainstay in sacral pressure ulcer reconstruction, contributing to improved patient quality of life.

Highlights:

1. Local flap reconstruction for sacral defects due to chronic pressure ulcers faces major challenges, including a high risk of infection, recurrence, and the complex sacral anatomy.
2. Effective local flap techniques tailored to patient needs such as, the Clover Style, Modified Parasacral Bilobed, and Bilobed Flaps have improved both functional and aesthetic outcomes.

INTRODUCTION

Sacral pressure ulcers (PUs) are a serious complication in frail elderly patients, often associated with low body mass index, anaemia, and decreased physical and cognitive function.[1] These ulcers result from localized damage to the skin and underlying tissue due to pressure or shear, commonly occurring in ischial, trochanteric, sacral, and heel areas.[2] Risk factors for wound dehiscence and ulcer recurrence include age, low serum albumin levels, and previous operative failures.[3] PUs place significant physical, psychological, and financial burdens on patients and healthcare systems.[4] Management strategies include early intervention, comprehensive treatment, and surgical reconstruction when necessary. [2,3]

Local flaps effectively close sacral pressure sores, providing stable coverage with padded skin. The Limberg flap has been successfully used for moderate-sized defects, offering good padding and suture lines away from the midline.[5] The gluteal fasciocutaneous rotation-advancement flap with V-Y closure has shown promising results for defects up to 18 cm in diameter, with no major complications reported in follow-ups of up to 35 months.[6] The Reading Man flap has been found versatile and simple for small to medium-sized sores, with low complication rates.[7] These techniques provide alternatives to the traditional flap methods, allowing for tension-free closure and reduced risk of wound dehiscence. Local flaps are generally preferred for sacral pressure sore reconstruction due to their ability to provide stable coverage and good outcomes. [8] The choice of flap depends on the size and location of the defect, as well as the surgeon's experience. Other important considerations include the availability of adjacent tissue, preservation of donor site function, and minimization of tension at the suture line. Common local flaps, fasciocutaneous, musculocutaneous, and perforator based offer tailored advantages in coverage, vascularity, and tissue preservation. This study contributes to the literature in the recognition of the local flap technique, which is suitable for sacral defects after debridement of pressure ulcers.

However, a critical gap exists in the literature, most published studies are limited to case series or small cohort analyses without comprehensive comparisons among different local flap options. No systematic review has yet synthesized recent evidence regarding the effectiveness, limitations, and complication profiles of local flap techniques for sacral pressure ulcer closure. Addressing this gap is essential to guide clinical decision-making and optimize patient outcomes.

Therefore, the objective of this systematic review is to analyse and compare various local flap techniques used for the closure of sacral pressure ulcers, evaluating their survival rates, complication profiles, functional outcomes, and potential for recurrence. This review aims to identify the most effective techniques across varied patient cases.

This study offers novelty by compiling and critically appraising recent surgical innovations and modifications in local flap design, providing surgeons with updated evidence-based insights.

The findings of this review are expected to contribute to better clinical practice by informing the selection of appropriate flap techniques, reducing postoperative complications, improving wound healing, and ultimately enhancing the quality of life for patients with sacral pressure ulcers. In the long term, these insights may support the development of standardized protocols and training modules tailored to different healthcare settings.

METHODS

A systematic review approach was selected to address the research questions by analysing empirical studies published between 2019 and 2024 on the most suitable local flap techniques for sacral defect closure following pressure injuries. This study consolidates findings from various prior investigations on local flap methods for sacral pressure ulcers, allowing for a thorough and comprehensive overview. In October 2024, articles were systematically searched across databases from PubMed NLM. Keywords utilized in the search included "Local Flap," "Sacral Decubitus Ulcer," "Sacral Pressure Ulcer," "Management," and "Sacral Defect Closure," along with relevant keyword combinations. To ensure comprehensive coverage, we also examined reference lists of selected studies.

All search results were organized using Endnote 20 and reviewed to determine their eligibility for inclusion. Studies that did not meet the criteria or were exact duplicates were excluded. An initial search yielded 16 studies across databases, from which duplicates were removed. Titles and abstracts were then screened, and studies that met inclusion criteria were considered relevant for the review. This process narrowed the results to 16 studies, which were further filtered to include only empirical (experimental and explanatory) research publications. Titles and abstracts were screened to assess the relevance of the articles to the research topic. The remaining articles underwent a full-text review to confirm eligibility.

Studies were included if they involved inpatients, bedridden individuals, or older adults diagnosed with sacral pressure ulcers, and if they investigated outcomes following postoperative local flap reconstruction. Studies were excluded if they involved outpatient populations, employed non-local flap or secondary healing techniques, reported major flap complications such as necrosis or failure, used qualitative or narrative study designs, or were single-site reports and publications limited to a single-site experience were also excluded, as were duplicate publications of the same study. Relevance was assured by using a criterion based on the PICOS framework, as outlined in Table 1. Ultimately, 8 articles from the databases met the inclusion criteria and were included in the review. The review process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines, with a summary of the literature selection shown in Figure 1.

Table I. Inclusion and exclusion criteria

PICOS	Inclusion Criteria	Exclusion Criteria
Patients	Inpatients hospital, bed rest patients, and older adults	Outpatients hospital
Interventions	Postoperative local flap reconstruction for sacral pressure ulcers	Any secondary healing or operation technique non-local flap.
Comparators	No comparators	No comparators
Outcomes	Good results or minor complications of local flap in patients with sacral pressure injury.	Necrotic or failed flap
Study Design	Experimental designs, non-randomized clinical trials	Qualitative study and feature study
Publication Type	Studies published in English in databases chosen from 2019-2024	Single site reports, duplicate publications of the same study

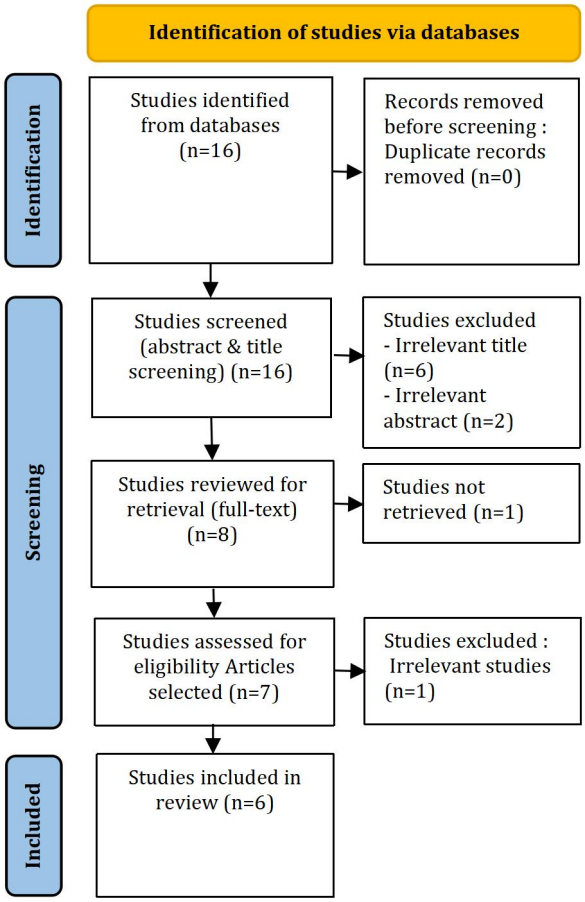

Figure 1. Literature's Selection Process Using PRISMA

RESULT

The authors synthesized data from 7 studies published between 2019 and 2024. These selected studies were organized by title, authorship, publication year, study design, intervention approach, and reported outcomes. All studies reviewed focused on surgical interventions aimed at closing sacral pressure ulcer defects using different local flap techniques. The study designs included five case series and two case reports, providing a range of empirical approaches. The flap modalities used in the studies were diverse, including the modified parasacral perforator-based flap (Maple Leaf Design), clover-style fasciocutaneous perforator flap, double VY flap, modified bilobed flap, unilateral fasciocutaneous flap transposition, and gluteus maximus V-Y advancement flap. The outcomes reported varied: most studies noted successful flap survival, with complications including hematoma, seroma, and minor dehiscence in a few cases. The studies highlighted positive healing outcomes, with many patients achieving primary or secondary intention healing after the procedure.

In general, Table II shows that local flap procedures for the reconstruction of sacral pressure ulcers achieve good clinical results and favorable success rates. Each study documented flap viability with no total necrosis or failure indicating the usefulness of these methods in sacral region defect closure.

The techniques utilized included Modified Parasacral Perforator Based Flap, Clover Style Fasciocutaneous Perforator Flap, Double VY Flap, Modified Bilobed Flap, Unilateral Fasciocutaneous Flap, and Gluteus Maximus V-Y Advancement Flap. Each technique was applied according to the clinical presentation of the patient and the adjacent available donor tissue.

In some cases, slight complications were noted such as hematoma, seroma, and wound dehiscence, which was non-significant in the context of overall results. The majority of patients were able to achieve primary intention healing and a small number secondary intention healing with no significant complications.

The results also demonstrate that local flap reconstruction is effective from a technical standpoint but especially safe for patients hospitalized with chronic ailments like the elderly or patients with restricted mobility. The average healing period was about one month and the postoperative recovery time.

Table II. Systematic Review Outcome

Reference	Study Design	Local Flap Modality for Sacral Region	Outcome
Reconstruction of Sacral Pressure Ulcer Using a Modified Parasacral Perforator-Based Flap (Maple Leaf Design): An Easier Method for Beginners (Kyung et al, 2020) [9]	Case series	Modified Parasacral Perforator-Based Flap (Maple Leaf Design)	12 Patients have no complications, 2 patients have hematoma and seroma.
Clover-Style Fasciocutaneous Perforator Flap for Reconstruction of Massive Sacral Pressure Sores (Cheng J et al, 2021)[10]	Case Series	Clover-style fasciocutaneous perforator flap	All the flaps survived, and 13 patients healed by primary intention, whereas the other 2 patients healed by secondary intention.
Surgical treatment of sacral pressure wounds in patients with COVID-19: A case series (Ferreira J et al, 2023)[11]	Case Series	Double VY Flap	All of 12 flaps survived. No major dehiscence was observed and minor dehiscence happened in 2 cases
The modified bilobed flap for reconstructing sacral decubitus ulcers (Jiao X et al, 2020)[12]	Case Series	Modified Bilobed Flap	No complications were observed after surgery, such as hematoma/ seroma under the flap, superficial infection, partial flap necrosis, sacral decubitus ulcer recurrence over the flap or sacral decubitus ulcer recurrence over the new site.
Reconstructive Surgery of Pressure Injuries in Spinal Cord Injury/Disorder Patients: Retrospective Observational Study and Proposal of an Algorithm for the Flap Choice (Sgarzani R et al, 2023)[13]	Case Series	Transposition of a unilateral fasciocutaneous flap	Minor complication with fasciocutaneous flap
The gluteus maximus V-Y advancement flap for reconstruction of extensive soft tissue loss following an advanced sacral pressure ulcer. A case report and mini review (Tchuenkam, L. W et al 2020)[14]	Case Report	Gluteus maximus V-Y advancement flap	The postoperative outcome was marked by a small hematoma, which was evacuated after suture release. Postoperative care consisted of an intensification of pressure ulcer prevention measures associated with wound care, analgesics, antibiotics and physiotherapy. Complete scarring of the wound was obtained at one month post surgery.

DISCUSSION

Local flap reconstruction remains a cornerstone in managing sacral pressure ulcers due to favorable outcomes, it is equally important to critically evaluate the associated complications and technique-specific risks that may impact long-term surgical success. Local flaps are a preferred choice for sacral defect closure because they allow the use of adjacent, well-vascularized tissue, reducing the risk of complications such as necrosis and promoting robust wound healing. This discussion synthesizes findings on commonly used local flap techniques, focusing on their effectiveness, limitations, and implications for clinical practice.

Local flap surgery is indicated for managing sacral pressure injuries, particularly moderate to deep ulcers (Stage III or IV) with significant tissue loss that have not responded to conservative treatments. Ideal candidates have adequate surrounding healthy tissue for mobilization, good local vascularity, and are in good overall health, minimizing the risk of complications. The surgery is suitable for larger wounds located in areas where flap options are feasible, such as the gluteal region, and can enhance functionality while reducing the likelihood of recurrence in high-risk patients. Careful patient selection and surgical planning are essential for successful outcomes.

The ischial region, which shows a higher complication rate, is associated with excessive pressure on the area, particularly when in a seated position. The ischial area, with its dense anatomy and insufficient subcutaneous fat, tends to experience reduced blood supply and increased friction, thereby elevating the risk of necrosis and recurrent wounds.[15,16] Ischial ulcers have been identified as an independent risk factor for pressure ulcer recurrence and wound dehiscence, often occurring due to excessive pressure when the patient is seated, causing tension on the flap and exacerbating the healing process. Therefore, flap reconstruction planning in this area must carefully consider these risks, with a more cautious approach in selecting the most appropriate flap technique and surgical methods that minimize the risk of complications.

The present study of local flap techniques for sacral defect closure in pressure ulcers identified several effective flap designs commonly employed for their functional and aesthetic benefits, such as Clover-Style Fasciocutaneous Perforator Flap,Modified Parasacral Perforator-Based Bilobed Flap, and Bilobed Flap.

Clover-Style Fasciocutaneous Perforator Flap

This technique is designed to leverage the superior and inferior gluteal arteries to enhance blood supply and minimize recurrence. It has been shown to offer high survival rates with satisfactory long-term outcomes in terms of appearance, healing, and function, making it suitable for extensive sacral defects.[10] This flap is particularly well-suited for managing sacral defects arising from prolonged immobility, infection, or trauma, and is especially beneficial in treating extensive and recalcitrant pressure ulcers in the gluteal region. Nonetheless, its application is contraindicated in cases where the perforating arteries of the buttocks have been compromised. Despite this technique demonstrated high flap survival and satisfactory cosmetic outcomes, minor complications such as partial flap necrosis, wound dehiscence, and marginal ischemia were reported, particularly in patients with comorbidities such as diabetes mellitus or poor nutritional status.[10] Furthermore, the complexity of flap design increases the risk of technical errors during surgery.

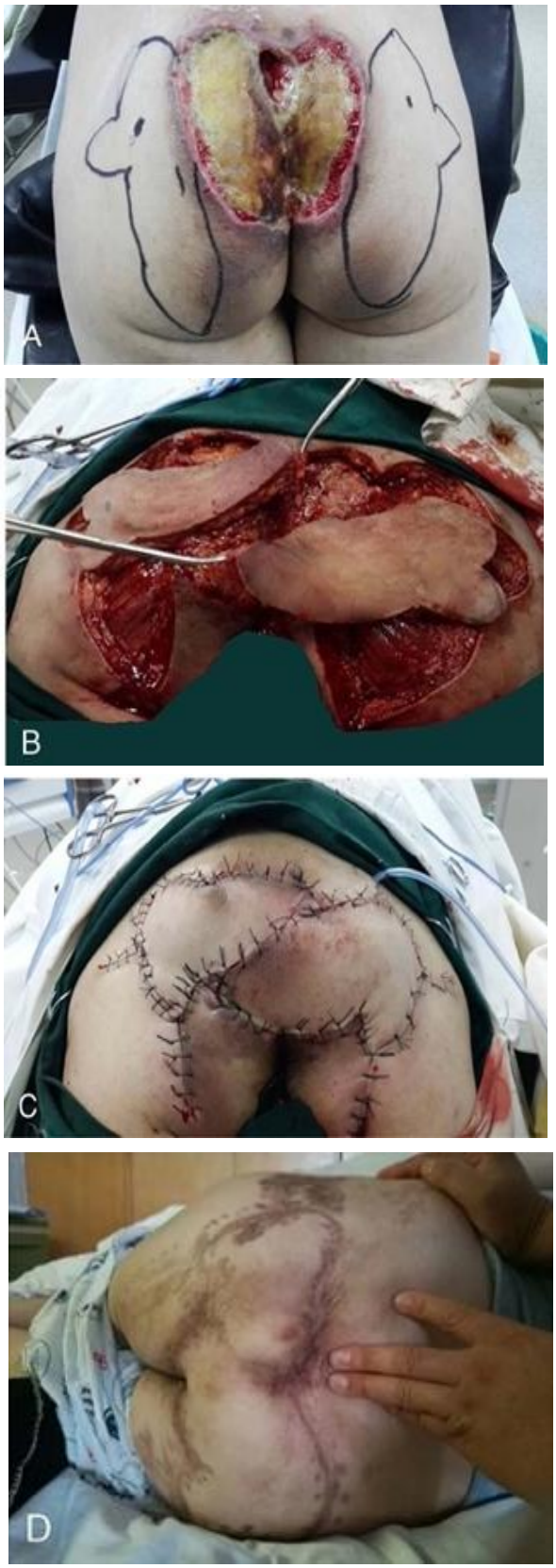

Figure 1. (A) Preoperative appearance of the sacral pressure sore. (B) Clover-style fasciocutaneous perforator flap for wound repair during the operation. (C) The recipient and donor sites were closed in a 1-stage procedure, and a drainage tube was placed under the flap. (D) The flap survived well after the 3-year follow-up, the appearance of the buttocks was satisfactory, and there was no recurrence of the bedsore.[10]

Modified Parasacral Perforator-Based Bilobed Flap

The modified parasacral perforator-based bilobed flap has emerged as an effective technique for reconstructing sacral pressure ulcers and pilonidal sinuses. This method offers several advantages, including wide defect coverage, tension-free closure, and preservation of the gluteus maximus muscle.[9,17] The flap design utilizes parasacral perforators, which provide reliable vascularization and enable regional reconstruction with well-vascularized tissues.[12]

Studies have reported high success rates, with complete flap survival and minimal complications such as hematoma or seroma.[9,17] The technique is particularly suitable for small to moderately sized defects and can be easily performed by less experienced surgeons.[9] Additionally, the flap allows for potential rerotation in case of recurrence, making it a versatile option for sacral reconstruction.[17]

Nevertheless, harvesting a long pedicle can be labor-intensive, and isolating the source vessel carries a risk of vascular injury, potentially resulting in venous congestion, ischemia, and ultimately compromising flap viability. To mitigate these risks and streamline the surgical procedure, we initially conceptualized a flap positioned adjacent to the defect, allowing for transposition without the need for perforator skeletonization.[9]

While the modified parasacral perforator-based bilobed flap has demonstrated high success rates, complications such as venous congestion, seroma formation, hematoma, and partial flap necrosis have been reported. [9,18-20] These complications are often related to

technical challenges during flap harvest and the variability of parasacral perforator anatomy.

Despite technical challenges and potential complications associated with anatomical variability of parasacral perforators, the consistently favorable clinical outcomes and functional advantages render the modified parasacral perforator-based bilobed flap a valuable and reliable option for reconstructing moderate complexity sacral defects.

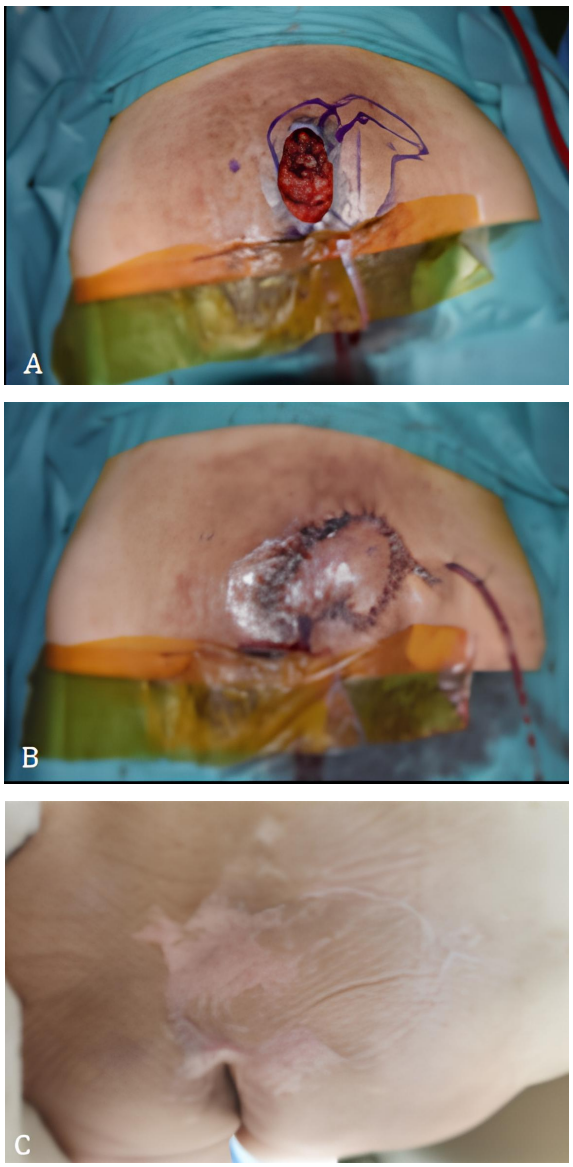

Figure 2. Photographs of case 4 showing a sacral sore (grade 4, size 7 × 4 cm): (A) preoperatively, (B) immediately postoperatively, and (C) at 10 months postoperatively.[9]

Bilobed Flap

The bilobed flap is an effective technique for reconstructing sacral pressure ulcers, offering reliable vascular supply and minimal donor site morbidity. This flap can be based on the superficial branch of the superior gluteal artery or the posterior branch of the fourth lumbar artery, providing a simple and reliable reconstruction option.[12,21,22] The design can be mathematically standardized to optimize coverage while minimizing the area used.[23] Perforator-based bilobed flaps have shown success in treating sacral sores, allowing for tensionless wound closure and the possibility of rerotation in case of recurrence.[17] This technique is particularly useful for extensive stage four sacral pressure ulcers, as it provides well-vascularized tissue and satisfactory aesthetic results.[24] Overall, the bilobed flap should be considered a valuable tool in the reconstructive algorithm for managing sacral pressure ulcers.[12,24] While fairly simple to make and apply, the bilobed flap does pose risks. Complications such as tip necrosis, wound infection, seroma formation, and dehiscence of the wound have been noted, most commonly in extensive sacral defects or in patients with compromised local perfusion. Such complications are likely due to excessive tension at the margins of the flap, insufficient vascularity of the distal flap, or imperfect surgical technique.[12,17,25-27]

Several precautionary measures are required to offset these risks. Thorough preoperative planning, such as proper patient selection and flap size adjustment, is crucial. The flap should be properly sized to ensure coverage without tension, while preserving key perforator vessels to maintain perfusion and prevent ischemia.

Close postoperative observation is needed to detect early signs of vascular compromise, infection, or fluid accumulation. Compliance with

standardized wound care protocols, optimal pressure offloading, and early intervention based on complication can significantly optimize surgical outcomes.

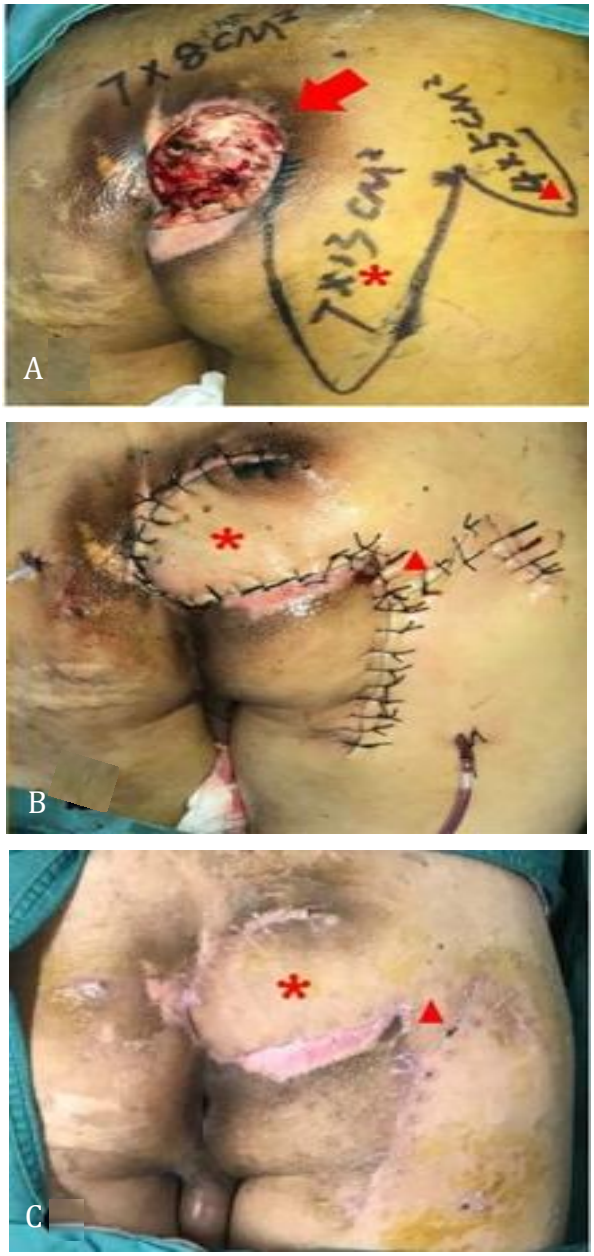

Figure 3. A man with pressure ulcer (stage IV) was treated by the bilobed flap supplied by the superficial branch of superior gluteal artery or the posterior branch of the fourth lumbar artery, (A) before operation; (B) after operation; (C) one year later. Arrow: ulcer position; asterisk: Lobe 1; triangle: Lobe 2.[12]

These flap options are selected based on patient-specific factors such as defect size and condition, aiming to balance ease of application, flap survival, and aesthetic results. The techniques evaluated in this review highlight the evolution of sacral pressure ulcer reconstruction, where local flap procedures are continually adapted to improve patient outcomes in complex wound care settings.

Local flap reconstruction for sacral defects demonstrates several strengths contributing to its widespread adoption in clinical practice. These techniques utilize adjacent, well-vascularized tissue, which supports robust healing and reduces the risk of complications such as necrosis and wound dehiscence. Moreover, the versatility of flap designs, such as the clover-style fasciocutaneous perforator flap, the modified parasacral perforator-based bilobed flap, and the traditional bilobed flap allows for tailored approaches based on defect size, location, and patient condition. Many of these methods also offer favourable aesthetic and functional outcomes, with high survival rates and low recurrence, even when performed by less experienced surgeons.

However, these techniques are not withoutv limitations. Harvesting perforator based flaps can be technically demanding and time consuming, with a significant risk of vascular injury that may lead to venous congestion or ischemia. Additionally, patients with compromised local vasculature or a history of previous surgeries in the region may not be suitable candidates. Most supporting evidence is drawn from small case series, limiting broader generalizability.

The novelty of this review lies in its synthesis of recent advancements in flap techniques and its proposal of conceptual modifications, such as avoiding perforator skeletonization by designing flaps adjacent to the defect to simplify procedures and enhance flap viability. Furthermore, by incorporating long-term follow-up data, this analysis offers valuable insights into the durability and

real-world effectiveness of these reconstructive strategies, emphasizing their evolving role in complex wound care management.

This systematic review is primarily based on case series and small cohort studies, limiting the generalizability of findings. Variations in surgical expertise, patient selection criteria, and follow-up durations further contribute to heterogeneity among studies. Additionally, the lack of randomized controlled trials underscores the need for more rigorous future research to establish standardized protocols for sacral pressure ulcer reconstruction.

This systematic review has several limitations. First, most included studies were case series or case reports, which inherently carry lower levels of evidence and may introduce publication bias. Second, sample sizes were small and lacked randomization, limiting the generalizability of findings. Third, variation in surgical expertise, flap design modifications, and follow-up durations across studies introduced heterogeneity, making direct comparisons challenging. Lastly, many studies did not include long-term outcome data, particularly concerning recurrence and functional recovery. Further research should prioritize randomized controlled trails and standardized outcome measures to validate the clinical efficacy of local flap techniques in sacral pressure ulcer reconstruction.

CONCLUSION

Local flap reconstruction techniques, including the Clover-Style Fasciocutaneous Perforator Flap, Modified Parasacral Perforator-Based Bilobed Flap, and the Bilobed Flap, have shown high rates of flap survival, functional recovery, and acceptable complication profiles in the surgical management of sacral pressure ulcers. Proper flap selection, guided by patient condition, defect characteristics, and surgeon experience, plays a pivotal role in minimizing complications and enhancing wound healing outcomes. Moreover, the integration of preoperative imaging techniques, such as Doppler ultrasound and MRI, can facilitate the identification of vascular anatomy, thereby aiding in the selection of the most appropriate flap design. Additionally, a multidisciplinary approach involving wound care specialists, nutritionists, and physiotherapists can optimize the preoperative and postoperative management of this patient and further improves surgical success and reduces recurrence. Future research should focus on prospective, randomized controlled studies with standardized outcome measures to develop best practice protocols and improve long-term outcomes in complex wound care.

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CONFLICT OF INTEREST

The authors declare no conflict of interest in this study.

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AUTHOR CONTRIBUTION

YAP contributed to the conception and design of the study; analysis and interpretation of the data; drafting of the article; critical revision of the article for important intellectual content; final approval of the article; provision of study materials or patients; statistical expertise; obtaining of funding; and administrative, technical, or logistic support.

LNS contributed to the critical revision of the article for important intellectual content; final approval of the article; statistical expertise; administrative, technical, or logistic support; and the refinement of grammar and language to ensure compliance with the International Committee of Medical Journal Editors (ICMJE) standards and journal-specific guidelines for authors.

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